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PUCO EXHIBIT FILING

Date of Hearing: November 18, 2019

Case No. 17-2295-EL-BGN-Volume VI

PUCO Case Caption: IN: the Application of Republic Wind, LLC, for a Certificate of Environmental Compatibility and Public Need for a Wind-Powered Electric Generating facility in Seneca and Sandusky Counties, Ohio.

List of exhibits being filed:

Applicant Exhibits 1M, 3A & 4O

State's Exhibits 9-16

Seneca Exhibits 3

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Date Submitted: _____

BEFORE THE OHIO POWER SITING BOARD

- - -

In the Matter of the Application of Republic Wind, LLC, for a Certificate Of Environmental Compatibility and Public Need for a Wind-Powered Electric Generating Facility in Seneca and Sandusky Counties, Ohio.	Case No. 17-2295-EL-BGN

- - -

PROCEEDINGS

Before Mr. Jay S. Agranoff and Ms. Anna Sanyal, Administrative Law Judges, at the Ohio Power Siting Board, 180 East Broad Street, Room 11-C, Columbus, Ohio, called at 9:00 a.m. on Monday, November 18, 2019.

- - -

VOLUME VII

- - -

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- - -

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of	:	
Republic Wind, LLC for a Certificate to	:	
Site Wind-Powered Electric Generation	:	Case No. 17-2295-EL-BGN
Facilities in Seneca and Sandusky	:	
Counties, Ohio.	:	

PREFILED TESTIMONY
OF

Derek F. Collins
SITING, EFFICIENCY, AND RENEWABLE ENERGY DIVISION
RATES AND ANALYSIS DEPARTMENT
PUBLIC UTILITIES COMMISSION OF OHIO
ON BEHALF OF STAFF OF THE OHIO POWER SITING BOARD

STAFF EX. 9

Dated: October 28, 2019

1 1. Q. Please state your name and business address.

2 A. My name is Derek F. Collins, and I recently retired from working at the

3 Public Utilities Commission of Ohio (PUCO).

4

5 2. Q. By whom are you employed and what is your position?

6 A. I worked as an employee of the PUCO, formerly employed as a Geology

7 Specialist in the Siting, Efficiency and Renewable Energy Division of the

8 PUCO's Rates and Analysis Department.

9

10 3. Q. Please summarize your educational background and work experience.

11 A. I hold a Bachelor's Degree from Ohio University in Geology (1980). I had

12 been employed by the State of Ohio from 1986 and specifically with the

13 PUCO from 2010 to 2019. I worked exclusively on power siting activities

14 during that time. I have developed analyses for over 25 cases before the

15 Ohio Power Siting Board ("Board"). My responsibilities typically include

16 geotechnical review and the preparation of analysis for the siting of major

17 utility facilities in Ohio.

18

19 4. Q. Have you testified in prior proceedings before the Board?

20 A. Yes.

21

22 5. Q. What is the purpose of your testimony in this proceeding?

1 A. With my testimony, I am sponsoring a portion of the Staff Report of
2 Investigation (Staff Report). Specifically, I was a Staff analyst for portions
3 of the Staff Report pertaining to ecological impacts, specifically, the public
4 and private water supply, geology, and slopes and soil suitability.
5
6 6. Q. Are you testifying to any specific conditions in the Staff Report? If so,
7 which ones?
8 A. No.
9
10 7. Q. Does this conclude your testimony?
11 A. Yes, it does. However, I reserve the right to submit supplemental testimony
12 as described herein, as new information subsequently becomes available or
13 in response to positions taken by other parties.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Prefiled Testimony of Derek F. Collins, submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 28th day of October, 2019.

/s/ Jodi J. Bair

Jodi J. Bair
Assistant Attorney General

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in

Case No(s). 17-2295-EL-BGN

Summary: Testimony of Derek Collins electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of	:	
Republic Wind, LLC for a Certificate to	:	
Site Wind-Powered Electric Generation	:	Case No. 17-2295-EL-BGN
Facilities in Seneca and Sandusky	:	
Counties, Ohio.	:	

PREFILED TESTIMONY
OF

Tyler Conklin
SITING, EFFICIENCY AND RENEWABLE ENERGY DIVISION
DEPARTMENT OF RATES AND ANALYSIS
OHIO POWER SITING BOARD STAFF

STAFF EX. 10

October 28 2019

1 1. Q. Please state your name and business address.

2 A. My name is Tyler Conklin. My business address is 180 E. Broad

3 Street, Columbus, Ohio 43215.

4

5 2. Q. By whom are you employed?

6 A. I am employed by the Public Utilities Commission of Ohio (Commission).

7

8 3. Q. Please describe your job title and duties?

9 A. I am employed as a Utilities Analyst 2 in the Siting, Efficiency, and

10 Renewable Energy Division of the Rates and Analysis Department. In this

11 position, I review net metering and interconnection issues, renewable energy

12 applications, assigned areas in Applications for a Certificate of

13 Environmental Compatibility and Public Need to construct major utility

14 facilities and economically significant wind farms, and other duties.

15

16 4. Q. Would you briefly state your educational background and work history?

17 A. I have a Bachelor of Arts degree in Economics and a Masters of Arts degree

18 in Economics from Kent State University. From 2018 to present, I have been

19 employed in my current position at the Commission.

20

21 5. Q. Have you previously testified before the Ohio Power Siting Board?

22 A. Yes.

1

2 6. Q. What is the purpose of your testimony in this case?

3 A. I am testifying in support of the Staff Report of Investigation (Staff Report)

4 in this case. I am testifying in support of the specific sections of the Staff

5 Report where I was the main contributing author. Specifically, I contributed

6 to the economics sections of the Staff Report.

7

8 7. Q. Were you responsible for any specific conditions in the Staff Report?

9 A. No.

10

11 8. Q. Does this conclude your testimony?

12 A. Yes, it does. However, I reserve the right to submit supplemental testimony

13 as new information subsequently becomes available or in response to

14 positions taken by other parties.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Prefiled Testimony of Tyler Conklin, submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 28th day of October, 2019.

/s/ Jodi J. Bair

Jodi J. Bair
Assistant Attorney General

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Case No(s). 17-2295-EL-BGN

Summary: Testimony of Tyler Conklin electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of	:	
Republic Wind, LLC for a Certificate to	:	
Site Wind-Powered Electric Generation	:	Case No. 17-2295-EL-BGN
Facilities in Seneca and Sandusky	:	
Counties, Ohio.	:	

PREFILED TESTIMONY
OF

Jon C. Pawley
SITING, EFFICIENCY AND RENEWABLE ENERGY DIVISION
DEPARTMENT OF RATES AND ANALYSIS
OHIO POWER SITING BOARD STAFF

STAFF EX. 11

October 28, 2019

1 1. Q. Please state your name and business address.

2 A. My name is Jon C. Pawley, and my business address is 180 East Broad

3 Street, Columbus OH 43215.

4

5 2. Q. By whom are you employed and what is your position?

6 A. I am employed by the Public Utilities Commission of Ohio (Commission)

7 as a Utility Specialist 3 in the Siting, Efficiency and Renewable Energy

8 Division of the Commission's Rates and Analysis Department.

9

10 3. Q. Please summarize your educational background and work experience.

11 A. I received an Associates of Applied Science degree in Architectural Tech-

12 nology from SUNY Alfred State College in 1986, a Bachelor of Arts (B.A.)

13 degree in Environmental Design from the University at Buffalo in 1991,

14 and a Masters of City and Regional Planning degree from The Ohio State

15 University in 1993.

16

17 I have been employed at the Commission for roughly twenty years. Most

18 recently, my responsibilities at the Commission have primarily involved

19 social and cultural resource matters associated with site planning of major

20 utility facilities in the state of Ohio. I have also been the Staff project lead

21 on numerous applications for a Certificate of Environmental Compatibility

1 and Public Need before the Board. Additionally, I have over ten years of
2 experience in public and private sector development planning.
3
4 4. Q. Have you testified in prior proceedings before the Ohio Power Siting
5 Board?
6 A. Yes. I have testified in numerous proceedings before the Board.
7
8 5. Q. What was your role in this case?
9 A. I was a Staff analyst for a portion of the Staff Report of Investigation (Staff
10 Report).
11
12 6. Q. What section of the Staff Report of investigation did you work on?
13 A. The sections pertaining to regional planning, demographics and setbacks.
14
15 7. Q. Are you responsible for any conditions in the Staff Report? If so, which
16 ones?
17 A. No, I am not responsible for any conditions recommended in the Staff
18 Report. Specific to setbacks, witness Conway is responsible for Conditions
19 42 and 43.
20
21 8. Q. Does this conclude your testimony?

1 A. Yes it does. However, I reserve the right to submit supplemental testimony,

2 as new information subsequently becomes available or in response to

3 positions taken by other parties.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Prefiled Testimony of Jon C. Pawley, submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 28th day of October, 2019.

/s/ Jodi J. Bair

Jodi J. Bair
Assistant Attorney General

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Case No(s). 17-2295-EL-BGN

Summary: Testimony of Jon C. Pawley electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC for a Certificate of Environmental Compatibility and Public Need for a Wind-Powered Electric *Generating Facility in Seneca and Sandusky* Counties, Ohio	:	Case No. 17-2295-EL-BGN

PREFILED TESTIMONY
OF

Matthew Butler
SITING, EFFICIENCY AND RENEWABLE ENERGY DIVISION
DEPARTMENT OF RATES AND ANALYSIS
OHIO POWER SITING BOARD STAFF

STAFF EX. 12

October 28, 2019

1 1. Q. Please state your name and business address.

2 A. My name is Matt Butler, and my business address is 180 East Broad Street,

3 6th Floor, Columbus, Ohio 43215-3793.

4

5 2. Q. By whom are you employed and what is your position?

6 A. I am employed by the Public Utilities Commission of Ohio (PUCO) as an

7 Administrative Officer 2 in the Siting, Efficiency, and Renewable Energy

8 Division of the Rates and Analysis Department. I am assigned to work on

9 power siting issues in a public affairs capacity. Part of this role is to prepare

10 sections of OPSB staff reports.

11

12 3. Q. Please summarize your educational background and work experience.

13 A. I received a B.A. degree, History, from The Ohio State University. I have

14 been employed by the PUCO since 2000 in several roles in the Office of

15 Public Affairs and the Rates and Analysis Department. Prior to my time at

16 the PUCO, I was employed for approximately one year as an administrative

17 aide to a member of the Ohio House of Representatives.

18

19 4. Q. Have you testified in prior proceedings before the Ohio Power Siting

20 Board?

21 5. A. Yes.

22

1 6. Q. What is the purpose of your testimony in this proceeding?

2 A. I authored portions of the Staff Report of Investigation (Staff Report).

3

4 7. Q. Are you testifying to any specific conditions in the Staff Report? If so,

5 which ones?

6 A. Yes, conditions 11 through 15.

7

8 8. Q. Does this conclude your testimony?

9 A. Yes.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Prefiled Testimony of Matthew Butler, submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 28th day of October, 2019.

/s/ Jodi J. Bair

Jodi J. Bair
Assistant Attorney General

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Case No(s). 17-2295-EL-BGN

Summary: Testimony of Matthew Butler electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC for a Certificate of Environmental Compatibility and Public Need for a Wind-Powered Electric Generating Facility in Seneca and Sandusky Counties, Ohio	:	Case No. 17-2295-EL-BGN

PREFILED TESTIMONY
OF

James S. O'Dell
SITING, EFFICIENCY AND RENEWABLE ENERGY DIVISION
DEPARTMENT OF RATES AND ANALYSIS
OHIO POWER SITING BOARD STAFF

STAFF EX. 13

October 28, 2019

1 1. Q. Please state your name and business address.

2 A. My name is James S. O'Dell, and my business address is 180 East Broad

3 Street, Columbus OH 43215.

4

5 2. Q. By whom are you employed and what is your position?

6 A. I am employed by the Public Utilities Commission of Ohio (Commission)

7 as a senior Siting Specialist in the Siting, Efficiency and Renewable Energy

8 Division of the Commission's Rates and Analysis Department.

9

10 3. Q. Please summarize your educational background and work experience.

11 A. I hold Bachelor's Degrees from The Ohio State University in Political

12 Science (1988) and Sociology (1997). Additionally, I received a Master's

13 Degree in City and Regional Planning from The Ohio State University in

14 1992. I also have significant course work completed towards a Master's

15 Degree in Public Policy from Central Michigan University.

16

17 I have been employed by the Commission since 1991. I have worked

18 almost exclusively on power siting activities during that time. I have

19 developed analysis for over 350 cases before the Ohio Power Siting Board

20 (Board). My responsibilities typically include application review and the

21 preparation of analysis for major utility facilities in Ohio. Additionally, I

22 process and review minor filings such as Letters of Notification and

Construction Notices. In the past, I also have been the primary author for the Board's annual reports. I have been the lead analyst in excess of 50 applications, responsible for the preparation of staff reports and coordination of Staff review and field work for major utility facilities.

4. Q. Have you testified in prior proceedings before the Ohio Power Siting Board?

A. Yes. I have testified in many cases before the Board concerning Staff's investigation and report findings and recommendations on proposed siting projects involving power plants, wind farms, substations, and transmission lines.

5. Q. What is the purpose of your testimony in this proceeding?

A. I am sponsoring the sections of the Staff Report of Investigation (Staff Report) pertaining to the aesthetics, recreation, land use and cultural resources sections that were filed in the docket of this case on July 25, 2019. Additionally, I authored Condition 18 of the Staff Report.

6. Q. Please summarize Staff's investigation that was conducted in this case.

A. Staff's investigation included reviewing the application, conducting site visits to the proposed facility location, acquiring additional information from the applicant, obtaining input from state agencies that comprise the

Board along with other relevant state and federal agencies, and preparing a Staff Report that presents Staff's analysis, conclusions, and recommendations. As a result of Staff's investigation, Staff is recommending that the Board approve the application, subject to the conditions that are presented in the Staff Report and Supplement to the Staff Report.

7. Q. Do you have any changes or corrections to make to the Staff Report of Investigation?

A. I have no corrections to the Staff Report as docketed.

8. Q. Does this conclude your testimony?

A. Yes. However, I reserve the right to submit supplemental testimony as described herein, as new information subsequently becomes available or in response to positions taken by other parties.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Prefiled Testimony of James S. O'Dell submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 28th day of October, 2019.

/s/ Jodi J. Bair

Jodi J. Bair
Assistant Attorney General

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Case No(s). 17-2295-EL-BGN

Summary: Testimony of James S. O'Dell electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC for a Certificate of Environmental Compatibility and Public Need for a Wind-Powered Electric Generating Facility in Republic and Sandusky Counties, Ohio.	: : :	Case No. 17-2295-EL-BGN

PREFILED TESTIMONY
OF
Jason Cross
BUSINESS RESOURCES DEPARTMENT
OHIO POWER SITING BOARD STAFF

STAFF EX. 14

October 28, 2019

1 1. Q. Please state your name and business address.

2 A. My name is Jason A. Cross, and my business address is 180 East Broad

3 Street, 6th Floor, Columbus, Ohio 43215-3793.

4

5 2. Q. By whom are you employed and what is your position?

6 A. I am employed by the Public Utilities Commission of Ohio ("PUCO") as a

7 Business Process Analyst 2, in the Information Technology division of the

8 PUCO's Business Resources Department. At the time of the issuance of the

9 Staff Report of Investigation (Staff Report) I was a Utilities Specialist 3, in

10 the GIS and Operations division of the PUCO's Rates and Analysis

11 Department.

12

13 3. Q. Please summarize your educational background and work experience.

14 A. I received an Associates of Science degree in Electronics Engineering

15 Technology from ITT Technical Institute in 1993 and a Bachelor of Science

16 degree in Electronics Engineering Technology from DeVry University in

17 1998.

18 I have been employed by the PUCO for roughly eighteen years, from 2001

19 to present. While employed in the Rates and Analysis Department, my

20 responsibilities at the PUCO have primarily involved engineering,

21 including, but not limited to, grid interconnection, Ohio's bulk electric

22 system, and regional transmission organizations. I have been the staff

expert on grid interconnection related items in over one hundred Staff reports.

4. Q. Have you testified in prior proceedings before the Ohio Power Siting Board ("OPSB")?

A. Yes. The most recent case I testified in was an American Electric Power Ohio Transmission Company (Case No. 11-1313-EL-BSB) proceeding. In addition, I have assisted in the preparation of multiple staff reports and investigations before the OPSB and the PUCO.

5. Q. What is the purpose of your testimony in this proceeding?

A. I am sponsoring a portion of the Staff Report. Specifically, I was a Staff analyst for portions of the Staff Report pertaining to whether the Applicant has provided information that the facility is consistent with regional plans for expansion of the electric power grid of the electric systems serving this state and interconnected utility systems and that the facility will serve the interests of electric system economy and reliability.

6. Q. Does this facility serve the interests of electric system economy and reliability?

A. Yes. The Applicant has executed an Interconnection Service Agreement with PJM Interconnection, LLC's ("PJM") and American Electric Power.

1 7. Q. Were you responsible for any specific conditions in the Staff Report? If so,

2 which ones?

3 A. Yes, condition 16.

4

5 8. Q. Does this conclude your testimony?

6 A. Yes it does. However, I reserve the right to submit supplemental testimony

7 as described herein, as new information subsequently becomes available or

8 in response to positions taken by other parties.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Prefiled Testimony of Jason Cross, submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 28th day of October, 2019.

/s/ Jodi J. Bair

Jodi J. Bair
Assistant Attorney General

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Case No(s). 17-2295-EL-BGN

Summary: Testimony of Jason Cross electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC for a Certificate to Site Wind-Powered Electric Generation Facilities in Seneca and Sandusky Counties, Ohio.	:	Case No. 17-2295-EL-BGN

PREFILED TESTIMONY
OF

Mark Bellamy
SITING, EFFICIENCY AND RENEWABLE ENERGY DIVISION
DEPARTMENT OF RATES AND ANALYSIS
OHIO POWER SITING BOARD STAFF

STAFF EX. 15

October 28, 2019

1. Q. Please state your name and your business address.

A. My name is Mark C. Bellamy. My business address is 180 East Broad Street, Columbus, Ohio 43215.

2. Q. By whom are you employed and what is your position?

A. I am employed by the Public Utilities Commission of Ohio (PUCO) as a Utility Specialist in the Siting, Efficiency & Renewable Energy Division of the Rates and Analysis Department.

3. Q. Please summarize your educational background.

A. My education includes earning a Bachelor of Science in Education degree in Chemistry from Arkansas State University.

4. Q. Please summarize your work experience.

A. Prior to my employment with the PUCO, I served 6 years in the U.S. Navy as a Machinist's Mate on a submarine. I operated and maintained atmosphere control equipment, as well as performed duties as a quality assurance inspector. After the Navy, I was employed as a high school science teacher. I joined the staff of the PUCO in 2009. Part of my duties in my current position is to help implement Ohio's Renewable Portfolio Standard as well as assisting in Ohio Power Siting Board (OPSB) case reviews and analyses.

1

2 5. Q. Have you testified in prior proceedings before the OPSB?

3 A. Yes.

4

5 6. Q. What is the purpose of your testimony?

6 A. I am testifying in support of the Staff Report of Investigation (Staff Report)

7 in this case. Specifically, the noise, shadow flicker, ice throw and blade

8 shear sections.

9

10 7. Q. Are you testifying to any specific conditions? If so, what are they?

11 A. I am testifying to conditions 41, 44, 45, and 46 of the Staff Report filed on

12 July 25, 2019 and condition 58 of the Supplement to the Staff Report filed

13 on October 18, 2019.

14

15 8. Q. Is Staff recommending any changes to these conditions?

16 A. Yes. Condition 46 in the Staff Report is a duplicate of condition 41 and

17 should be deleted.

18

19 9. Q. Why is Staff recommending condition 41?

20 A. Condition 41 requires the Applicant to notify OPSB Staff as soon as

21 possible after a turbine incident such as tower collapse, turbine failure,

thrown blade or hub, ice throw beyond the setback, collector or feeder line failure, injury to any person, or nacelle fire. This condition also requires a detailed report to be submitted within 30 days. This condition will allow Staff to investigate incidents shortly after an incident happens. The detailed report will include steps the Applicant is taking to avoid future incidents. Staff will use the data from these reports to determine if preventative measures can be taken.

10. Q. Why is Staff recommending condition 44?

A. Condition 44 limits noise impacts so that no nonparticipating sensitive receptor receives adverse noise impacts.

11. Q. Why is Staff recommending condition 45?

A. Condition 45 limits shadow flicker impacts so that no nonparticipating sensitive receptor receives adverse shadow flicker impacts.

12. Q. Why is Staff recommending condition 58?

A. On September 12, 2019, at the public hearing on this application, a resident in the project area informed Staff that her house was not on the sound study map as a receptor. When Staff asked the Applicant about this receptor and the possibility of other missing receptors, the Applicant stated that the receptor in question was modeled on earlier sound studies but was not

included on the latest sound study. The Applicant also stated that there were nine other receptors not initially modeled in the sound studies. On October 10, 2019 the Applicant supplied Staff with the noise model results for the omitted receptors. Based on the model results, the noise impacts at all of the omitted receptors would be within the noise limit of ambient plus 5 dBA. The ambient noise for the project area was determined by the Applicant to be 41 dBA.

It is Staff's opinion that occupants at the missing receptor locations should have been given information on potential noise impacts much earlier in the process. Therefore, Staff recommends that the Certificate be conditioned to prohibit constructing any turbine that is modeled to impact a previously non-modeled receptor above the ambient level of the project area. The turbine location modeled to produce an impact greater than the ambient level is turbine location 37. Turbine models Siemens Gamesa SG145 (4.5 MW), Nordex N149 (4.5 MW), or Nordex N149 (4.8 MW) were modeled to produce an impact greater than the ambient level at one previously non-modeled receptor. Therefore, Staff recommends the addition of condition 58 to address this situation:

(58) The Applicant shall not use turbine models Siemens Gamesa SG145 (4.5 MW), Nordex N149 (4.5 MW), or Nordex N149 (4.8 MW) at turbine location 37.

13. Q. Did the Applicant perform an ice throw study and if so what were the results of that study?

A. Yes, the applicant produced an ice throw study and submitted it to Staff on February 27, 2019. The results of the ice throw study show that the annual probability of a 1 kg piece of ice landing beyond the property line setback or on public roads is less than 0.01% per year. This complies with Rule 4906-4-09 (E) (3) which states, "the potential impact from ice throw shall be presumptively deemed to satisfy safety considerations if the probability of one kilogram of ice landing beyond the statutory property line setback for each turbine location is less than one per cent per year."

14. Q. Does this conclude your testimony?

A. Yes, it does. However, I reserve the right to submit supplemental testimony, as new information subsequently becomes available or in response to positions taken by other parties.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Prefiled Testimony of Mark Bellamy, submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 28th day of October, 2019.

/s/ Jodi J. Bair

Jodi J. Bair
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Case No(s). 17-2295-EL-BGN

Summary: Testimony of Mark Bellamy electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC for a Certificate to Site Wind-Powered Electric Generation Facilities in Seneca and Sandusky Counties, Ohio.	: : : :	Case No. 17-2295-EL-BGN

AMENDED PREFILED TESTIMONY
OF

Mark Bellamy
SITING, EFFICIENCY AND RENEWABLE ENERGY DIVISION
DEPARTMENT OF RATES AND ANALYSIS
OHIO POWER SITING BOARD STAFF

STAFF EX. 16

November 15, 2019

1 1. Q. Please state your name and your business address.

2 A. My name is Mark C. Bellamy. My business address is 180 East Broad

3 Street, Columbus, Ohio 43215.

4

5 2. Q. By whom are you employed and what is your position?

6 A. I am employed by the Public Utilities Commission of Ohio (PUCO) as a

7 Utility Specialist in the Siting, Efficiency & Renewable Energy Division of

8 the Rates and Analysis Department.

9

10 3. Q. Please summarize your educational background.

11 A. My education includes earning a Bachelor of Science in Education degree in

12 Chemistry from Arkansas State University.

13

14 4. Q. Please summarize your work experience.

15 A. Prior to my employment with the PUCO, I served 6 years in the U.S. Navy

16 as a Machinist's Mate on the submarine, USS Louisville. I operated and

17 maintained atmosphere control equipment, as well as performed duties as a

18 quality assurance inspector. After the Navy, I was employed as a high

19 school science teacher. I joined the staff of the PUCO in 2009. Part of my

20 duties in my current position is to help implement Ohio's Renewable

21 Portfolio Standard as well as assisting in OPSB case reviews and analyses.

22

5. Q. Have you testified in prior proceedings before the Ohio Power Siting Board?

A. Yes.

6. Q. What is the purpose of your amended testimony?

A. I am amending my prefiled testimony concerning the noise section of the Staff Report of Investigation in this case.

7. Q. What changes are you supporting?

A. Based on the testimony of Issac Old and the admission of noise monitoring data from the Republic Wind transmission line case, 19-1066-EL-BTX, I am recommending that average project area ambient nighttime Leq in the transmission line case be used as an eighth monitoring point in determining the project area ambient nighttime Leq in the Republic Wind generation case.

8. Q. Why are you recommending the inclusion of the average project area ambient nighttime Leq data from the transmission line case?

A. The noise monitoring locations in the transmission line case are located in the western area of the project area. This part of the wind generation project area did not include a noise monitoring location. The inclusion of the data from the transmission line case provides a more complete picture of the wind generation project area ambient nighttime Leq.

9. Q. How does the inclusion of the transmission line data change the project area ambient nighttime Leq?

A. By including the average project area ambient nighttime Leq of the transmission line case, 36.3 dBA, as an eighth monitoring location, the project area ambient nighttime Leq changes from 41dBA to 40.42 dBA, which I recommend be rounded to 40.5 dBA.

10. Q. If the project area ambient nighttime Leq 40.5 dBA is adopted, what would the noise limit be at non-participating receptors?

A. The noise limit would be 40.5 dBA plus 5 dBA or 45.5 dBA except that in the daytime the facility may operate at the greater of: the project area ambient nighttime Leq plus five dBA; or the validly measured ambient Leq plus five dBA at the location of the sensitive receptor.

11. Q. Is Staff recommending a condition because of the change in the project area ambient nighttime Leq?

A. Yes. The Applicant has demonstrated that each of the turbine models would comply with the noise limit of 46 dBA. However, if the OPSB adopts Staff's recommended change to the project area ambient nighttime Leq, the modeled impact of the proposed turbines on non-participating receptors would be as shown in the table below:

Non-participating receptors modeled to be impacted over 45.5 dBA

Vestas V150 4.2 MW	Siemens SG4.5-145	Nordex N149 4.5 MW	Vestas V150 5.6 MW	Nordex N149 4.8 MW	Vestas V136 3.6 MW	Nordex N149 5.5 MW	Nordex N149 5.7 MW
9	13	32	15	32	15	1	21

Therefore, Staff recommends adding condition 60 if the OPSB adopts the Staff's recommend change to the project area ambient nighttime Leq:

(60) At least 30 days prior to construction, the Applicant shall submit a noise study showing that cumulative noise impacts at any non-participating receptor, for each of the proposed turbines will not exceed the project area ambient nighttime Leq by more than 5 dBA.

12. Q. Does this conclude your testimony?

A. Yes, it does. However, I reserve the right to submit supplemental testimony, as new information subsequently becomes available or in response to positions taken by other parties.

PROOF OF SERVICE

I hereby certify that a true copy of the foregoing Amended Prefiled Testimony of Mark Bellamy, submitted on behalf of the Staff of the Ohio Power Siting Board, was served via electronic mail, upon the following parties of record, this 15th day of November, 2019.

/s/Robert A. Eubanks
Robert A. Eubanks

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Case No(s). 17-2295-EL-BGN

Summary: Motion for Leave to File the Amended Prefiled Testimony of Mark Bellamy Instanter and Request for Expedited Treatment electronically filed by Mrs. Kimberly M Naeder on behalf of OPSB

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC for a Certificate to Site Wind-Powered Electric Generation in Republic and Sandusky Counties.	))))	Case No. 17-2295-EL-BGN

Direct Testimony of

Bill McCallister

On behalf of

Seneca County Park District

SENECA COUNTY PARK DISTRICT EXHIBIT # 3

Q 1: State your name, educational and professional background.

A 1: Bill McAllister. I am a 1974 Graduate of Bowling Green State University with a Liberal Studies degree and a 2005 Master's Degree in Organizational Management from Springfield College, Springfield, MA. I have spent my 40+ year career with the YMCA, retiring in 2018, including 18 years as CEO of the Fostoria YMCA and 10 years as consultant with the YMCA of the USA

Q 2: What is the Seneca County Park District?

A 2: The Seneca County Park District (SCPD) was founded in 1996. Under the jurisdiction of Seneca County Probate Court, SCPD consists of 10 parks comprising of more than 600 acres. From its inception in 1996 until the first levy was passed in 2016, the SCPD was operated by volunteers and through donations. There are now three full-time and two part-time employees. The annual operating budget is $600,000. The SCPD Board of Commissioners is made of five people selected by Probate Judge Jay Meyer. There are more than 50 volunteers who help out with programs, fundraising, maintenance and policy making. Programs offered include a very successful nature-based preschool program, and a variety of outdoor educational and recreational programs for all ages. Many people use the parks for individual and family hiking, fitness, and nature appreciation. The parks are used by people of all ages, from Seneca County and the surrounding counties.

Q 3: State your relationship to the SCPD?

A 3: I have been a board member since 2012 and currently chair the strategic planning committee. I co-chaired the successful 2016 levy campaign.

Q 4: Of the parks within the SCPD, which park is closest to the proposed wind turbines in the Republic Wind Project?

A 4: Bowen Nature Preserve located in West Lodi.

Q 5: Are you personally familiar with Bowen Nature Preserve?

A 5: Yes. It is a 58 acre nature preserve with trails, grasslands, wildlife and approximately 6 acres of woodland. It became part of the SCPD in 2007.

Q 6: If the turbines are constructed as proposed by Republic Wind will those turbines be visible from Bowen Nature Preserve?

A 6: Yes. As I understand the proposed construction, it is my belief that I'll be able to see a wind turbine in every direction while at Bowen Nature Preserve unless my view is blocked by an obstruction such as a tree.

Q 7: What is Seneca County Park District Exhibit #1?

A 7: This exhibit shows the locations of the proposed turbines in relationship to Bowen Nature Preserve. Twenty-one turbines are to be constructed within two and one-half miles of the nature preserve. Ten turbines are to be constructed within one mile of the nature preserve. This exhibit was created using the latitude and longitude for the proposed turbines provided on FAA Document Dated 06/26/2019 for Aeronautical Study No. 2018-WTE-11673-OE. This exhibit fairly and accurately depicts the location of Bowen Nature Preserve in relationship to proposed wind turbines within 2 ½ miles of the boundary of the Bowen Nature Preserve.

Q 8: What is Seneca County Park District Exhibit #2?

A 8: This exhibit depicts fairly and accurately depict the general location of the various parks of the SCPD.

Q 9: What is the position of the SCPD regarding the construction of the Republic Wind project?

A 9: The District does not in general oppose the construction of wind turbines as an alternative energy source, however we do oppose any construction of any wind turbines within 2 ½ miles of any of our parks' boundary. The District

respectfully believes that the scenic quality of our parks will be significantly harmed by viewing wind turbines at relatively short distances.

Q 10: Does this conclude your testimony?

A 10: Yes, but I reserve the right to update my testimony.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Direct Testimony of Bill McCallister was served upon the following Parties of Record on this the 11th day of November via electronic or regular US mail.

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 AppEx 1 A.

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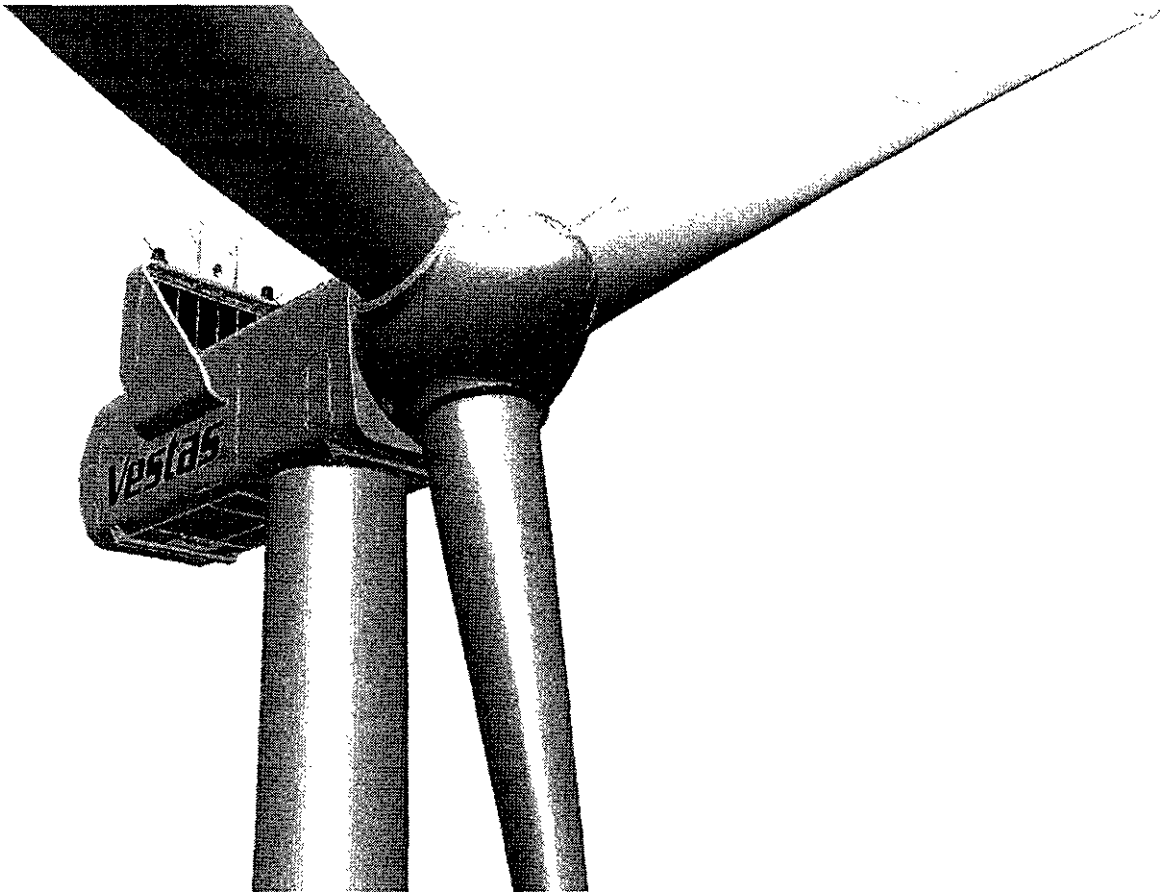
General Description
4MW Platform



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1 Introduction

The 4MW Platform wind turbine configurations covered by this General Description are listed below with designations according to IEC61400-22.

DIBt 2012 wind classes are also listed where applicable.

Please refer to the Performance Specification for the relevant turbine variant for full wind class definition.

This General Description contains data and descriptions common among the platform variants.

The variant specific performance can be found in the Performance Specifications for the turbine variant and operational mode required.

Turbine Type Class	Turbine Type | Operating Mode
V117-4.0/4.2 MW Strong Wind	V117-4.0 MW IEC IB / IEC IIA 50/60 Hz | Mode 0
	V117-4.0 MW IEC IB / IEC IIA 50/60 Hz | Reactive Power Optimized Mode (QO1)
	V117-4.2 MW IEC S / IEC IIA 50/60 Hz | Power Optimized Mode (PO1)
	V117-3.8 MW IEC IB / IEC IIA 50/60 Hz | Load Optimized Mode (LO1)
	V117-3.6/3.x MW IEC IB / IEC IIA+ 50/60 Hz | Load Optimized Mode (LO2)
V117-4.0/4.2 MW Typhoon	V117-4.0 MW IEC IB-T / IEC IIA-T 50/60 Hz | Mode 0
	V117-4.0 MW IEC IB-T / IEC IIA-T 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V117-4.2 MW IEC S-T / IEC IIA-T 50/60 Hz | Power Optimized Mode (PO1)
	V117-3.8 MW IEC IB-T / IEC IIA-T 50/60 Hz | Load Optimized Mode (LO1)
	V117-3.6/3.x MW IEC IB-T / IEC IIA+-T 50/60 Hz | Load Optimized Mode (LO2)
V136-4.0/4.2 MW	V136-4.0 MW IEC IIB / IEC S 50/60 Hz | Mode 0
	V136-4.0 MW IEC IIB / IEC S 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V136-4.2 MW IEC S 50/60 Hz | Power Optimized Mode (PO1)
	V136-3.8 MW IEC IIB / IEC S 50/60 Hz | Load Optimized Mode (LO1)
	V136-3.6 MW IEC IIB / S 50/60 Hz | Load Optimized Mode (LO2)
	V136-4.0 MW DIBt S 50 Hz | Mode 0
	V136-4.0 MW DIBt S 50 Hz | Reactive Power Optimized Mode (QO1)
	V136-4.2 MW DIBt S 50 Hz | Power Optimized Mode (PO1)
	V136-3.8 MW DIBt S 50 Hz | Load Optimized Mode (LO1)
	V136-3.6 MW DIBt S 50 Hz | Load Optimized Mode (LO2)
V150-4.0/4.2 MW	V150-4.0 MW IEC IIIB / IEC S 50/60 Hz | Mode 0
	V150-4.0 MW IEC IIIB / IEC S 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V150-4.2 MW IEC S 50/60 Hz | Power Optimized Mode (PO1)
	V150-3.8 MW IEC IIIB / IEC S 50/60 Hz | Load Optimized Mode (LO1)
	V150-3.6 MW IEC IIIB / S 50/60 Hz | Load Optimized Mode (LO2)
	V150-4.0 MW DIBt S 50 Hz | Mode 0

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Turbine Type Class	Turbine Type | Operating Mode
V150-4.0/4.2 MW (cont'd)	V150-4.0 MW DIBt S 50 Hz | Reactive Power Optimized Mode (QO1)
	V150-4.2 MW DIBt S 50 Hz | Power Optimized Mode (PO1)
	V150-3.8 MW DIBt S 50 Hz | Load Optimized Mode (LO1)
	V150-3.6 MW DIBt S 50 Hz | Load Optimized Mode (LO2)

Table 1-1: 4MW Platform turbine configurations covered.

2 General Description

Vestas 4MW Platform comprises a family of wind turbines sharing a common design basis.

The 4MW Platform family of wind turbines includes V105-3.45/3.6 MW, V112-3.45/3.6 MW, V117-3.45/3.6 MW, V126-3.45 MW LTq, V126-3.45/3.6 MW HTq, V136-3.45/3.6 MW, V117-4.0/4.2 MW Strong Wind, V117-4.0/4.2 MW Typhoon, V136-4.0/4.2 MW and V150-4.0/4.2 MW.

For V105-3.45/3.6 MW, V112-3.45/3.6 MW, V117-3.45/3.6 MW, V126-3.45 MW LTq, V126-3.45/3.6 MW HTq and V136-3.45/3.6 MW, please refer to General Description 0053-3707.

This General Description only applies to V117-4.0/4.2 MW Strong Wind, V117-4.0/4.2 MW Typhoon, V136-4.0/4.2 MW and V150-4.0/4.2 MW.

These turbines are pitch regulated upwind turbines with active yaw and a three-blade rotor.

The turbines covered in this General Description are equipped with rotor with diameters residing in the range 117 m to 150 m and a rated output power of 4.0 MW.

A 4.0 MW Reactive Power Optimized Mode (QO1) is available for all variants.

A 4.2 MW Power Optimized Mode (PO1) is available for all variants.

Also, a 3.8 MW Load Optimized Mode (LO1) and a 3.6 MW Load Optimized Mode (LO2) is available for all variants. However, for V117, the LO2 power rating for the high turbulence intensity IEC 2A+ design climate is not yet fixed.

The wind turbine family utilises the OptiTip® concept and a power system based on an induction generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintain the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

Operating the wind turbine in 4.0 MW Reactive Power Optimized Mode (QO1) is achieved by applying an extended ambient temperature derate strategy compared with 4.0 MW Mode 0 operation.

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Operating the wind turbine in 4.2 MW Power Optimized Mode (PO1) is achieved by applying an extended ambient temperature derate strategy and reduced reactive power capability compared with 4.0 MW Mode 0 operation.

3 Mechanical Design

3.1 Rotor

The wind turbine is equipped with a rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle.

Rotor	V117	V136	V150
Diameter	117 m	136 m	150 m
Swept Area	10751 m^2	14527 m^2	17671 m^2
Speed, Dynamic Operation Range	[redacted]		
Rotational *Direction*	Clockwise (front view)		
Orientation	Upwind		
Tilt	[redacted]		
Hub Coning	[redacted]		
No. of Blades	3		
Aerodynamic Brakes	Full feathering		

Table 3-1: Rotor data

3.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam or with embedded structure.

Blades	V117	V136	V150
Type Description	Airfoil shells bonded to *supporting beam*	Prepreg or infused structural *airfoil shell*	Prepreg or infused structural *airfoil shell*
Blade Length	[redacted]		
Material	Fibreglass reinforced epoxy, carbon fibres and Solid Metal Tip (SMT)		
Blade Connection	Steel roots inserted		
Airfoils	High-lift profile		
Maximum Chord	[redacted]		
Chord at 90% blade radius	[redacted]		

Table 3-2: Blades data

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3.3 Blade Bearing

The blade bearings are double-row four-point contact ball bearings.

Blade Bearing	
Lubrication	[redacted]

Table 3-3: Blade bearing data

3.4 Pitch System

The turbine is equipped with a pitch system for each blade and a distributor block, all located in the hub. Each pitch system is connected to the distributor block with flexible hoses. The distributor block is connected to the pipes of the hydraulic rotating transfer unit in the hub by means of three hoses (pressure line, return line and drain line).

Each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade bearing via a torque arm shaft. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Pitch System	
Type	Hydraulic
Number	1 per blade
Range	[redacted]

Table 3-4: Pitch system data

Hydraulic System	
Main Pump	Two redundant internal-gear oil pumps
Pressure	[redacted]
Filtration	[redacted]

Table 3-5: Hydraulic system data.

3.5 Hub

The hub supports the three blades and transfers the reaction loads to the main bearing and the torque to the gearbox. The hub structure also supports blade bearings and pitch cylinders.

Hub	
Type	Cast ball shell hub
Material	Cast iron

Table 3-6: Hub data

3.6 Main Shaft

The main shaft transfers the reaction forces to the main bearing and the torque to the gearbox.

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Main Shaft	
Type Description	Hollow shaft
Material	Cast iron or forged steel

Table 3-7: Main shaft data

3.7 Main Bearing Housing

The main bearing housing covers the main bearing and is the first connection point for the drive train system to the bedplate.

Main Bearing Housing	
Material	Cast iron

Table 3-8: Main bearing housing data

3.8 Main Bearing

The main bearing carries all thrust loads.

Main Bearing	
Type	[redacted]
Lubrication	[redacted]

Table 3-9: Main bearing data

3.9 Gearbox

The main gear converts the low-speed rotation of the rotor to high-speed generator rotation.

The disc brake is mounted on the high-speed shaft. The gearbox lubrication system is a pressure-fed system.

Gearbox	
Type	Planetary stages + one helical stage
Gear House Material	Cast
Lubrication System	Pressure oil lubrication
Backup Lubrication System	[redacted]
Total Gear Oil Volume	[redacted]
Oil Cleanliness Codes	[redacted]
Shaft Seals	[redacted]

Table 3-10: Gearbox data

3.10 Generator Bearings

The bearings are grease lubricated and grease is supplied continuously from an automatic lubrication unit.

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3.11 High-Speed Shaft Coupling

The coupling transmits the torque of the gearbox high-speed output shaft to the generator input shaft.

The coupling consists of two 4-link laminate packages and a fibreglass intermediate tube with two metal flanges.

The coupling is fitted to two-armed hubs on the brake disc and the generator hub.

3.12 Yaw System

The yaw system is an active system based on a robust pre-tensioned plain yaw-bearing concept with PETP as friction material.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed (50 Hz)	[redacted]
Yawing Speed (60 Hz)	[redacted]

Table 3-11: Yaw system data

Yaw Gear	
Type	Multiple stages geared
Ratio Total	[redacted]
Rotational Speed at Full Load	[redacted]

Table 3-12: Yaw gear data

3.13 Crane

The nacelle houses the internal safe working load (SWL) service crane. The crane is a single system hoist.

Crane	
Lifting Capacity	[redacted]

Table 3-13: Crane data

3.14 Towers

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. The towers are designed with the majority of internal welded connections replaced by magnet supports to create a predominantly smooth-walled tower.

Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (that is, in the gravitational direction) by a mechanical connection. The smooth tower design reduces the required steel thickness, rendering the tower lighter compared to one with all internals welded to the tower shells.

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Available hub heights are listed in the Performance Specification for each turbine variant. Designated hub heights include a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange and a distance from tower top flange to centre of the hub of 2.2 m.

Towers	
Type	Cylindrical/conical tubular

Table 3-14: Tower structure data

3.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel. The roof section is equipped with wind sensors and skylights.

The skylights can be opened from inside the nacelle to access the roof and from outside to access the nacelle. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the front nacelle bedplate.

The crane girders are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, the cooling system and transformer. The nacelle cover is installed on the nacelle bedplate.

Type Description	Material
Nacelle Cover	GRP
Bedplate Front	Cast iron
Bedplate Rear	Girder structure

Table 3-15: Nacelle bedplate and cover data

3.16 Thermal Conditioning System

The thermal conditioning system consists of a few robust components:

- The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.
- The CoolerTop® comes as standard in a "naked" form, with no side cover panels. Side cover panels are available as an option.
- The Liquid Cooling System, which serves the gearbox, hydraulic systems, generator and converter is driven by an electrical pumping system.
- The transformer forced air cooling comprised of an electrical fan.

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3.16.1 Generator and Converter Cooling

The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.2 Gearbox and Hydraulic Cooling

The gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the nacelle. In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.3 Transformer Cooling

The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the converter and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

3.16.4 Nacelle Cooling

Hot air generated by mechanical and electrical equipment is dissipated from the nacelle by a fan system located in the nacelle.

3.16.5 Optional Air Intake Hatches

Specific air intakes in the nacelle can optionally be fitted with hatches which can be operated as a part of the thermal control strategy. In case of lost grid to the turbine, the hatches will automatically be closed.

4 Electrical Design

4.1 Generator

The generator is a three-phase asynchronous induction generator with cage rotor that is connected to the grid through a full-scale converter. The generator housing allows the circulation of cooling air within the stator and rotor. The air-to-water heat exchange occurs in an external heat exchanger.

Generator
[redacted]

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Generator	
[redacted]	

Table 4-1: Generator data

4.2 Converter

The converter is a full-scale converter system controlling both the generator and the power quality delivered to the grid. The converter consists of 3 machine-side converter units and 3 line-side converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency AC power from the generator into fixed frequency AC power with desired active and reactive power levels (and other grid connection parameters) suitable for the grid.

The converter is located in the nacelle and has a grid side voltage rating of 720 V. The generator side voltage rating is up to 750 V dependent on generator speed.

Converter	
Rated Apparent Power [S_N]	[redacted]
Rated Grid Voltage	
Rated Generator Voltage	
Rated Grid Current	
Rated Generator Current	
Enclosure	

Table 4-2: Converter data

4.3 HV Transformer

The step-up HV transformer is located in a separate locked room in the back of the nacelle.

The transformer is a three-phase, two-winding, dry-type transformer that is self-extinguishing. The windings are delta-connected on the high-voltage side unless otherwise specified.

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Original Instruction: T05 0067-7060 VER 00

The transformer comes in different versions depending on the market where it is intended to be installed.

- For 50 and 60 Hz regions the transformer is as default designed according to IEC standards, but also complying to European Ecodesign regulation No 548/2014 set by the European Commission. Refer to Table 4-3.

4.3.1 Ecodesign - IEC 50 Hz/60 Hz version

Transformer	
Type description	[redacted]
Basic layout	
Applied standards	
Cooling method	
Rated power	
Rated voltage, turbine side	
U_m 1.1kV	
Rated voltage, grid side	
U_m 24.0kV	
U_m 36.0kV	
U_m 40.5kV	
Insulation level AC / LI / LIC	
U_m 1.1kV	
U_m 24.0kV	
U_m 36.0kV	
U_m 40.5kV	
Off-circuit tap changer	
Frequency	
Vector group	
Peak Efficiency Index (PEI) [2]	
U_m 24.0kV	
U_m 36.0kV	
U_m 40.5kV	
No-load loss [2]	
U_m 24.0kV	
U_m 36.0kV	
U_m 40.5kV	
Load loss @ power consumption HV, 120°C	
U_m 24.0kV	
U_m 36.0kV	
U_m 40.5kV	
No-load reactive power [3]	
Full load reactive power [3]	
No-load current [3]	
Positive sequence short-circuit impedance @ rated power, 120°C [4]	
Positive sequence short-circuit	

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Transformer	
resistance@ rated power, 120°C [3]	[redacted]
Zero sequence short-circuit impedance@ rated power, 120°C [3]	
Zero sequence short-circuit resistance@ rated power, 120°C [3]	
Inrush peak current [3]	
Dyn5	
YNyn0	
Half crest time [3]	
Sound power level	
Average temperature rise at max altitude	
Max altitude [5]	
Insulation class	
Environmental class	
Climatic class	
Fire behaviour class	
Corrosion class	
Weight	
Temperature monitoring	
Overvoltage protection	
Temporary earthing	

Table 4-3: Transformer data for Ecodesign IEC 50 Hz/60 Hz version.

NOTE [redacted]

4.4 HV Cables

The high-voltage cable runs from the transformer in the nacelle down the tower to the HV switchgear located at the bottom of the tower. The high-voltage cable is a four-core, rubber-insulated, halogen-free, high-voltage cable.

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Original Instruction: T05 0067-7060 VER 00

HV Cables	
High-Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Pre-terminated	HV termination in transformer end. T-Connector Type-C in switchgear end.
Maximum Voltage	[redacted]
Conductor Cross Sections	[redacted]

Table 4-4: HV cables data

4.5 HV Switchgear

A gas insulated switchgear is installed in the bottom of the tower as an integrated part of the turbine. Its controls are integrated with the turbine safety system, which monitors the condition of the switchgear and high voltage safety related devices in the turbine. This system is named 'Ready to Protect' and ensures all protection devices are operational, whenever high voltage components in the turbine are energised. To ensure that the switchgear is always ready to trip, it is equipped with redundant trip circuits consisting of an active trip coil and an undervoltage trip coil.

In case of grid outage the circuit breaker will disconnect the turbine from the grid after an adjustable time.

When grid returns, all relevant protection devices will automatically be powered up via UPS.

When all the protection devices are operational, the circuit breaker will re-close after an adjustable time. The re-close functionality can furthermore be used to implement a sequential energization of a wind park, in order to avoid simultaneous inrush currents from all turbines once grid returns after an outage.

In case the circuit breaker has tripped due to a fault detection, the circuit breaker will be blocked for re-connection until a manual reset is performed.

In order to avoid unauthorized access to the transformer room during live condition, the earthing switch of the circuit breaker, contains a trapped-key interlock system with its counterpart installed on the access door to the transformer room.

The switchgear is available in three variants with increasing features, see Table 4-5. Beside the increase in features, the switchgear can be configured depending on the number of grid cables planned to enter the individual turbine. The design of the switchgear solution is optimized such grid cables can be connected to the switchgear even before the tower is installed and still maintain its protection toward weather conditions and internal condensation due to a gas tight packing.

The switchgear is available in an IEC version and in an IEEE version. The IEEE version is however only available in the highest voltage class. The electrical parameters of the switchgear are seen in Table 4-6 for the IEC version and in Table 4-7 for the IEEE version.

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HV Switchgear			
Variant	**Basic**	**Streamline**	**Standard**
IEC standards	○	⊙	⊙
IEEE standards	⊙	○	⊙
Vacuum circuit breaker panel	⊙	⊙	⊙
Overcurrent, short-circuit and earth fault protection	⊙	⊙	⊙
Disconnector / earthing switch in circuit breaker panel	⊙	⊙	⊙
Voltage Presence Indicator System for circuit breaker	⊙	⊙	⊙
Voltage Presence Indicator System for grid cables	⊙	⊙	⊙
Double grid cable connection	⊙	⊙	⊙
Triple grid cable connection	⊙	○	○
Preconfigured relay settings	⊙	⊙	⊙
Turbine safety system integration	⊙	⊙	⊙
Redundant trip coil circuits	⊙	⊙	⊙
Trip coil supervision	⊙	⊙	⊙
Pendant remote control from outside of tower	⊙	⊙	⊙
Sequential energization	⊙	⊙	⊙
Reclose blocking function	⊙	⊙	⊙
Heating elements	⊙	⊙	⊙
Trapped-key interlock system for circuit breaker panel	⊙	⊙	⊙
Motor operation of circuit breaker	⊙	⊙	⊙
Cable panel for grid cables (configurable)	○	⊙	⊙
Switch disconnector panels for grid cables – max three panels (configurable)	○	⊙	⊙
Earthing switch for grid cables	○	⊙	⊙
Internal arc classification	○	⊙	⊙
Supervision on MCB's	○	⊙	⊙
Motor operation of switch disconnector	○	○	⊙
SCADA operation and feedback of circuit breaker	○	○	⊙
SCADA operation and feedback of switch disconnector	○	○	⊙

Table 4-5: HV switchgear variants and features

Original Instruction: T05 0067-7060 VER 00

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4.5.1 IEC 50/60Hz version

HV Switchgear	
Type description	[redacted]
Applied standards	
Insulation medium	
Rated voltage	
U_r 24.0kV	
U_r 36.0kV	
U_r 40.5kV	
Rated insulation level AC // LI Common value / across isolation distance	
U_r 24.0kV	
U_r 36.0kV	
U_r 40.5kV	
Rated frequency	
Rated normal current	
Rated Short-time withstand current	
U_r 24.0kV	
U_r 36.0kV	
U_r 40.5kV	
Rated *peak withstand current* 50 / 60 Hz	
U_r 24.0kV	
U_r 36.0kV	
U_r 40.5kV	
Rated duration of short-circuit	
Internal arc classification (option)	
U_r 24.0kV	
U_r 36.0kV	
U_r 40.5kV	
Connection interface	
Loss of service continuity category	
Ingress protection	
Gas tank	
Enclosure	
LV cabinet	
Corrosion class	

Table 4-6: HV switchgear data for IEC version

4.5.2 IEEE 60Hz version

HV Switchgear	
Type description	[redacted]
Applied standards	
Insulation medium	
Rated voltage	
U_r 38.0kV	

Original Instruction: T05 0067-7060 VER 00

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HV Switchgear	
Rated insulation level AC / LI	[redacted]
Rated frequency	
Rated normal current	
Rated Short-time withstand current	
Rated peak withstand current	
Rated duration of short-circuit	
Internal arc classification (option)	
Connection interface grid cables	
Ingress protection	
Gas tank	
Enclosure	
LV cabinet	
Corrosion class	

Table 4-7: HV switchgear data for IEEE version

4.6 AUX System

The AUX system is supplied from a separate 650/400/230 V transformer located in the nacelle inside the converter cabinet. All motors, pumps, fans and heaters are supplied from this system.

230 V consumers are generally supplied from a 400/230 V transformer located in the tower base. Internal heating and ventilation of cabinets as well as specific option 230 V consumers are supplied from the auxiliary transformer in the converter cabinet.

Power Sockets	
Single Phase (Nacelle)	230 V (16 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Single Phase (Tower Platforms)	230 V (10 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Three Phase (Nacelle and Tower Base)	3 x 400 V (16 A)

Table 4-8: AUX system data

4.7 Wind Sensors

The turbine is either equipped with two ultrasonic wind sensors or optional one ultrasonic wind sensor and one mechanical wind vane and anemometer. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

4.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP8000 control system.

Original Instruction: T05 0067-7060 VER 00

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Original Instruction: T05 0067-7060 VER 00

VMP8000 is a multiprocessor control system comprised of main controller, distributed control nodes, distributed IO nodes and ethernet switches and other network equipment. The main controller is placed in the tower bottom of the turbine. It runs the control algorithms of the turbine, as well as all IO communication.

The communications network is a time triggered Ethernet network (TTEthernet).

The VMP8000 control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Reactive power control and variable speed operation.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.
- Monitoring of the smoke detection system.

4.9 Uninterruptible Power Supply (UPS)

During grid outage, an UPS system will ensure power supply for specific components.

The UPS system is built by 3 subsystems:

1. 230V AC UPS for all power backup to nacelle and hub control systems
2. 24V DC UPS for power backup to tower base control systems and optional SCADA Power Plant Controller.
3. 230V AC UPS for power backup to internal lights in tower and nacelle. Internal light in the hub is fed from built-in batteries in the light armature.

UPS		
Backup Time	**Standard**	**Optional**
Control System* **(230V AC and 24V DC UPS)**	15 min	Up to 400 min**
Internal Lights **(230V AC UPS)**	30 min	60 min***
Optional SCADA Power Plant Controller **(24V DC UPS)**	N/A	48 hours****

Table 4-9: UPS data

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**The control system includes: the turbine controller (VMP8000), HV switchgear functions, and remote control system.*

***Requires upgrade of the 230V UPS for control system with extra batteries.*

****Requires upgrade of the 230V UPS for internal light with extra batteries.*

*****Requires upgrade of the 24V DC UPS with extra batteries.*

NOTE For alternative backup times, consult Vestas.

5 Turbine Protection Systems

5.1 Braking Concept

The main brake on the turbine is aerodynamic. Stopping the turbine is done by full feathering the three blades (individually turning each blade). Each blade has a hydraulic accumulator to supply power for turning the blade.

In addition, there is a mechanical disc brake on the high-speed shaft of the gearbox with a dedicated hydraulic system. The mechanical brake is only used as a parking brake and when activating the emergency stop buttons.

5.2 Short Circuit Protections

Breakers	Breaker for Aux. Power.	Breaker 1 for Converter Modules	Breaker 2 for Converter Modules
Breaking Capacity Icu, Ics	TBD	TBD	TBD
Making Capacity Icm	TBD	TBD	TBD

Table 5-1: Short circuit protection data

5.3 Overspeed Protection

The generator rpm and the main shaft rpm are registered by inductive sensors and calculated by the wind turbine controller to protect against overspeed and rotating errors.

The safety-related partition of the VMP8000 control system monitors the rotor rpm. In case of an overspeed situation, the safety-related partition of the VMP8000 control system activates the emergency feathered position (full feathering) of the three blades independently of the non-safety related partition of VMP8000 control system.

Overspeed Protection	
Sensors Type	Inductive
Trip Level (variant dependent)	[redacted]

Table 5-2: Overspeed protection data

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Original Instruction: T05 0067-7060 VER 00

5.4 Arc Detection

The turbine is equipped with an Arc Detection system including multiple optical arc detection sensors placed in the HV transformer compartment and the converter cabinet. The Arc Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if an arc is detected.

5.5 Smoke Detection

The turbine is equipped with a Smoke Detection system including multiple smoke detection sensors placed in the nacelle (above the disc brake), in the transformer compartment, in main electrical cabinets in the nacelle and above the HV switchgear in the tower base. The Smoke Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if smoke is detected.

5.6 Lightning Protection of Blades, Nacelle, Hub and Tower

The Lightning Protection System (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS consists of five main parts:

- Lightning receptors. All lightning receptor surfaces on the blades are unpainted, excluding the Solid Metal Tips (SMT).
- Down conducting system (a system to conduct the lightning current down through the wind turbine to help avoid or minimise damage to the LPS itself or other parts of the wind turbine).
- Protection against overvoltage and overcurrent.
- Shielding against magnetic and electrical fields.
- Earthing system.

Lightning Protection Design Parameters			[redacted]
Current Peak Value	i_{max}	[kA]	
Impulse Charge	$Q_{impulse}$	[C]	
Long Duration Charge	Q_{long}	[C]	
Total Charge	Q_{total}	[C]	
Specific Energy	W/R	[MJ/Ω]	
Average Steepness	di/dt	[kA/μs]	

Table 5-3: Lightning protection design parameters

NOTE The Lightning Protection System is designed according to IEC standards (see section 8 Design Codes, p. 28).

5.7 EMC

The turbine and related equipment fulfils the EU Electromagnetic Compatibility (EMC) legislation:

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- DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

5.8 Earthing

The Vestas Earthing System consists of a number of individual earthing electrodes interconnected as one joint earthing system.

The Vestas Earthing System includes the TN-system and the Lightning Protection System for each wind turbine. It works as an earthing system for the medium voltage distribution system within the wind farm.

The Vestas Earthing System is adapted for the different types of turbine foundations. A separate set of documents describe the earthing system in detail, depending on the type of foundation.

In terms of lightning protection of the wind turbine, Vestas has no separate requirements for a certain minimum resistance to remote earth (measured in ohms) for this system. The earthing for the lightning protection system is based on the design and construction of the Vestas Earthing System.

A primary part of the Vestas Earthing System is the main earth bonding bar placed where all cables enter the wind turbine. All earthing electrodes are connected to this main earth bonding bar. Additionally, equipotential connections are made to all cables entering or leaving the wind turbine.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

5.9 Corrosion Protection

Classification of corrosion protection is according to ISO 12944-2.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5-M	C3
Hub	C5-M	C3
Tower	C5-I	C3

Table 5-4: Corrosion protection data for nacelle, hub, and tower

6 Safety

The safety specifications in this section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, and (c) conducting all appropriate safety training and education.

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Original Instruction: T05 0067-7060 VER 00

6.1 Access

Access to the turbine from the outside is through a door located at the entrance platform approximately 3 meter above ground level. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is controlled with a lock. Unauthorised access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

6.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch, from the spinner by opening the nose cone, or from the roof of the nacelle. Rescue equipment is placed in the nacelle.

The hatch in the roof can be opened from both the inside and outside. Escape from the service lift is by ladder.

An emergency response plan, placed in the turbine, describes evacuation and escape routes.

6.3 Rooms/Working Areas

The tower and nacelle are equipped with power sockets for electrical tools for service and maintenance of the turbine.

6.4 Floors, Platforms, Standing, and Working Places

All floors have anti-slip surfaces.

There is one floor per tower section.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

Foot supports are placed in the turbine for maintenance and service purposes.

6.5 Service Lift

The turbine is delivered with a service lift installed as an option.

6.6 Climbing Facilities

A ladder with a fall arrest system (rigid rail) is installed through the tower.

There are anchor points in the tower, nacelle and hub, and on the roof for attaching fall arrest equipment (full-body harness). Over the crane hatch there is an anchor point for the emergency descent equipment. Anchor points are coloured yellow and are calculated and tested to 22.2 kN.

6.7 Moving Parts, Guards, and Blocking Devices

All moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and drive train.

Blocking the pitch of the cylinder can be done with mechanical tools in the hub.

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Original Instruction: T05 0067-7060 VER 00

6.8 Lights

The turbine is equipped with lights in the tower, nacelle and hub.

There is emergency light in case of the loss of electrical power.

6.9 Emergency Stop

There are emergency stop buttons in the nacelle, hub and bottom of the tower.

6.10 Power Disconnection

The turbine is equipped with breakers to allow for disconnection from all power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and bottom of the tower.

6.11 Fire Protection/First Aid

A handheld 5-6 kg CO_2 fire extinguisher, first aid kit and fire blanket are required to be located in the nacelle during service and maintenance.

- A handheld 5-6 kg CO_2 fire extinguisher is required only during service and maintenance activities, unless a permanently mounted fire extinguisher located in the nacelle is mandatorily required by authorities.
- First aid kits are required only during service and maintenance activities.
- Fire blankets are required only during non-electrical hot work activities.

6.12 Warning Signs

Warning signs placed inside or on the turbine must be reviewed before operating or servicing the turbine.

6.13 Manuals and Warnings

The Vestas Corporate OH&S Manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

7 Environment

7.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2004. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

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8 Design Codes

8.1 Design Codes – Structural Design

The turbine design has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 3 EN 50308
Tower	IEC 61400-1 Edition 3 Eurocode 3
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2
Gearbox	ISO 81400-4
Generator	IEC 60034
Transformer	IEC 60076-11, IEC 60076-16, CENELEC HD637 S1
Lightning Protection	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006 IEC 61400-24:2010
Rotating Electrical Machines	IEC 34
Safety of Machinery, Safety-related Parts of Control Systems	IEC 13849-1
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 8-1: Design codes

9 Colours

9.1 Nacelle Colour

Colour of Vestas Nacelles	
Standard Nacelle Colour	RAL 7035 (light grey)
Standard Logo	Vestas

Table 9-1: Colour, nacelle

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Original Instruction: T05 0067-7060 VER 00

9.2 Tower Colour

Colour of Vestas Tower Section		
	External:	**Internal:**
Standard Tower Colour	RAL 7035 (light grey)	RAL 9001 (cream white)

Table 9-2: Colour, tower

9.3 Blade Colour

Blade Colour	
Standard Blade Colour	RAL 7035 (light grey). All lightning receptor surfaces on the blades are unpainted, excluding the Solid Metal Tips (SMT).
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% DS/EN ISO 2813

Table 9-3: Colour, blades

10 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

10.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	**All**
Ambient Temperature Interval (Standard Temperature Turbine)	-40° to +50°C

Table 10-1: Extreme design parameters

10.2 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine.

Operational Envelope – Temperature	
Ambient Temperature Interval (Standard Turbine)	-20° to +45°C
Ambient Temperature Interval (Low Temperature Turbine)	-30° to +45°C

Table 10-2: Operational envelope – temperature

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[redacted]

10.3 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine. At ambient temperatures above the thresholds shown for each operating mode in Figure 10-1 below, the turbine will maintain derated production. [redacted]

[redacted]

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Original Instruction: T05 0067-7060 VER 00

10.4 Operational Envelope – Grid Connection

Operational Envelope – Grid Connection	
Nominal Phase Voltage	[redacted]
Nominal Frequency	
Maximum Frequency Gradient	
Maximum Negative Sequence Voltage	
Minimum Required Short Circuit Ratio at Turbine HV Connection	
Maximum Short Circuit Current Contribution	

Table 10-3: Operational envelope – grid connection

The generator and the converter will be disconnected if*:

Protection Settings	
Voltage Above 110%** of Nominal for 1800 Seconds	[redacted]
Voltage Above 116% of Nominal for 60 Seconds	
Voltage Above 125% of Nominal for 2 Seconds	
Voltage Above 136% of Nominal for 0.150 Seconds	
Voltage Below 90%** of Nominal for 180 Seconds (FRT)	
Voltage Below 85% of Nominal for 12 Seconds (FRT)	
Voltage Below 80% of Nominal for 4 Seconds (FRT)	
Frequency is Above 106% of Nominal for 0.2 Seconds	
Frequency is Below 94% of Nominal for 0.2 Seconds	

Table 10-4: Generator and converter disconnecting values

NOTE [redacted]

All protection settings are preliminary and subject to change.

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10.5 Operational Envelope – Reactive Power Capability in 4.0 MW Mode 0

The turbine has a reactive power capability in 4.0 MW Mode 0 on the low voltage side of the HV transformer as illustrated in Figure 10-2:

[redacted]

Original Instruction: T05 0067-7060 VER 00

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10.6 Operational Envelope – Reactive Power Capability in 4.0 MW Reactive Power Optimized Mode (QO1)

[redacted]

Original Instruction: T05 0067-7060 VER 00

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10.7 Operational Envelope – Reactive Power Capability in 4.2 MW Power Optimized Mode (PO1)

The reactive power capability for the 4.2 MW Power Optimized Mode (PO1) is as illustrated in Figure 10-4:

[redacted]

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Original Instruction: T05 0067-7060 VER 00

10.8 Performance – Fault Ride Through

The turbine is equipped with a full-scale converter to gain better control of the wind turbine during grid faults. The turbine control system continues to run during grid faults.

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve as illustrated below:

[redacted]

NOTE All fault ride through capability values are preliminary and subject to change.

Power Recovery Time	
Power Recovery to 90% of Pre-Fault Level	[redacted]

Table 10-5: Power recovery time

10.9 Performance – Reactive Current Contribution

The reactive current contribution depends on whether the fault applied to the turbine is symmetrical or asymmetrical.

NOTE All reactive current contribution values are preliminary and subject to change.

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Original Instruction: T05 0067-7060 VER 00

10.9.1 Symmetrical Reactive Current Contribution

During symmetrical voltage dips, the wind farm will inject reactive current to support the grid voltage. The reactive current injected is a function of the measured grid voltage.

[redacted]

10.9.2 Asymmetrical Reactive Current Contribution

[redacted]

10.10 Performance – Multiple Voltage Dips

[redacted]

10.11 Performance – Active and Reactive Power Control

The turbine is designed for control of active and reactive power via the VestasOnline® SCADA system.

Maximum Ramp Rates for External Control	
Active Power	[redacted]
Reactive Power	[redacted]

Table 10-6: Active/reactive power ramp rates (values are preliminary)

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[redacted]

10.12 Performance – Voltage Control

The turbine is designed for integration with VestasOnline® voltage control by utilising the turbine reactive power capability.

10.13 Performance – Frequency Control

The turbine can be configured to perform frequency control by decreasing the output power as a linear function of the grid frequency (over frequency). Dead band and slope for the frequency control function are configurable.

10.14 Distortion – Immunity

[redacted]

10.15 Main Contributors to Own Consumption

The consumption of electrical power by the wind turbine is defined as the power used by the wind turbine when it is not providing energy to the grid. This is defined in the control system as Production Generator 0 (zero).

The components in Table 10-7 have the largest influence on the own consumption of the wind turbine (the average own consumption depends on the actual conditions, the climate, the wind turbine output, the cut-off hours, etc.).

The VMP8000 control system has a hibernate mode that reduces own consumption when possible. Similarly, cooling pumps may be turned off when the turbine idles.

Main contributors to Own Consumption	
Hydraulic Motor	[redacted]
Yaw Motors	
Water Heating	
Water Pumps	
Oil Heating	
Oil Pump for Gearbox Lubrication	
Controller Including Heating Elements for the Hydraulics and all Controllers	
HV Transformer No-load Loss	

Table 10-7: Main contributors to own consumption data (values are preliminary).

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11 Drawings

11.1 Structural Design – Illustration of Outer Dimensions

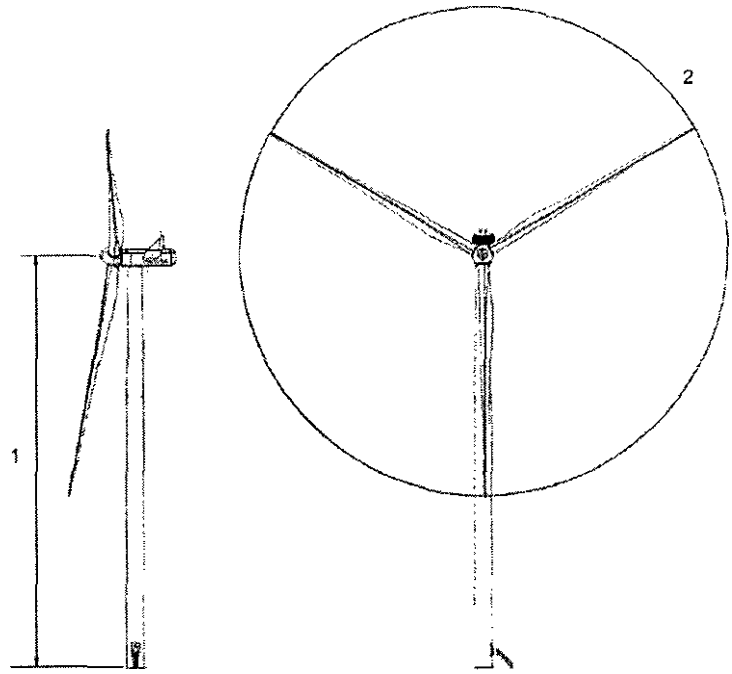

Figure 11-1: Illustration of outer dimensions – structure

1 Hub heights: See Performance Specification

2 Rotor diameter: 117-150 m

11.2 Structural Design – Side View Drawing

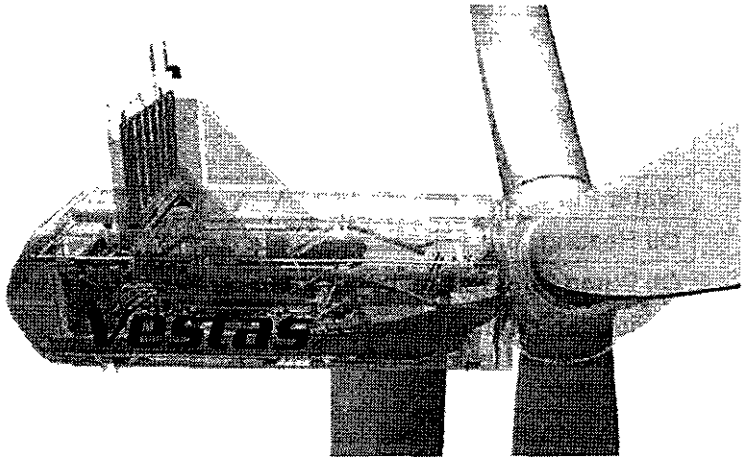

Figure 11-2: Side-view drawing

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Original Instruction: T05 0067-7060 VER 00

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- The general descriptions in this document apply to the current version of the 4MW Platform wind turbines. Updated versions of the 4MW Platform wind turbines, which may be manufactured in the future, may differ from this general description. In the event that Vestas supplies an updated version of a specific 4MW Platform wind turbine, Vestas will provide an updated general description applicable to the updated version.
- Vestas recommends that the grid be as close to nominal as possible with limited variation in frequency and voltage.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- All listed start/stop parameters (e. g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements and codes of standards.
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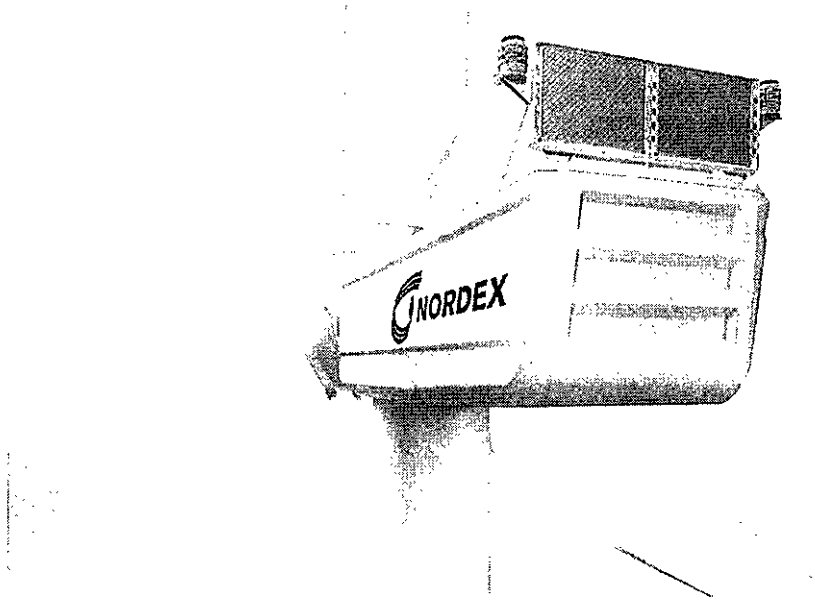
NORDEX

QB04-Safety instruction

Rescue and evacuation plan

Wind turbine class Delta4000 - Tubular steel towerWind turbine class Delta4000 - Tubular steel



Rev. 0

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Revision index

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1 General

1.1 Scope

These safety regulations present the escape and rescue plan for a Nordex Delta4000 turbine on a tubular steel tower and describe the mounting locations.

1.2 Target group

This instruction is aimed at HSE employees of Nordex.

The target group may be employees from the departments or employees of external companies commissioned by Nordex for the purpose of the safety instruction.

1.3 Abbreviations

Abbreviation	Designation / description
GPS	Global positioning system
n/a	Not applicable
PPE	Personal protective equipment
WT	Wind turbine
WGS 84	World Geodetic System 1984

1.4 Applicable documents

Document no.	Title
Instructions	
E0004553222	Delta4000 safety manual
G0112P1	Work in and around wind turbines (documented procedure), updated and published in QUIS
Other documents	
Workplace Ordinance dated 12 August 2004 (ArbStättV)	
ISO 23601 for internationally uniform fire protection symbols, escape plans and rescue plans	
ISO 7010 standard for graphical symbols – safety colors and safety signs	

1.5 Signs and symbols used

Sign/ symbol	Meaning
✓	Prerequisite
➢	A task to be carried out with no specific order
1. 2.	A task to be carried out in multiple steps Pay attention to the specific order!
➥	Result of a task
•	List with no specific order
–	Subitem of tasks or lists
ℹ	Additional information, notes and hints
📖	Reference to information in other documents

1.6 Design of the warning notes

DANGER

Type and source of the danger!

Possible consequences (optional)

- Action
- Action

1.6.1 Warning levels

Warning level	Description
DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazard with a medium level of risk which, if not avoided, may result in death or serious injury.
CAUTION	Indicates a hazard with a low level of risk which, if not avoided, may result in minor or moderate injury.
NOTE	Indicates a hazard with a low level of risk which, if not avoided, may result in property damage.

1.6.2 Notes and information

NOTE

Additional information, notes and hints

OBSERVE DOCUMENT

Reference to information in other documents

2 Safety information

OBSERVE DOCUMENT

- Safety instructions *E0004553222 Delta4000 safety manual*
- Documented procedure *G0112P1 Work in, on and around wind turbines, updated and published in QUIS*

The safety manual *E0004553222* and the documented procedure *G0112P1* must have been read and understood. The safety notes must be observed.

A prerequisite for carrying out the work described here is the compliance with all national safety-relevant standards and specifications and those defined by Nordex Energy GmbH.

The extensive health and safety regulations implemented at Nordex Energy GmbH form the basis of occupational health and safety and environmental protection.

The applicable accident prevention regulations must be observed.

When using operating materials, always observe and adhere to the manufacturer's information on existing health risks.

General safety instructions (e.g., how to handle respective tools and hoists), references to corresponding guidelines and occupational health and safety regulations, as well as generally accepted handling procedures are not mentioned.

3 Mounting the escape and rescue plans

Mounting:

- Stand out from the environment,
- Accessible and well legible,
- Permanently attached.

Locations:

- At locations where the users of the building structure can inform themselves about escape options,
- At strategic points of the escape route.

Mounting heights

- Escape and rescue plans must be mounted at a height h =1.65 m (plan center) above the standing surface of the observer.

4 Turbine

4.1 Annex 1 Escape and rescue plan for Delta4000 wind turbines - tubular steel tower

NORDEX

ESCAPE AND RESCUE PLAN

Name and location of the wind farm	
WT number	GPS coordinates (WGS84)
	Latitude°: [N/S 00.000000]_____ Longitude°: [E/W 00.000000]_____
WIND FARM OPERATOR	
Company name:	Phone number:

[redacted]

*The rescue and rappelling device is an optional equipment item

Delta4000 - Tubular steel tower

Accident

1. Remain calm
   Call for help:
   - What happened?
   - Where did it happen?
   - How many people are injured?
   - What is the extend of injuries?
   - Who reports?
   - Observe instructions, wait for questions.

   Phone:_____

2. Immediate measures:
   - Perform first-aid
   - Eliminate the hazards

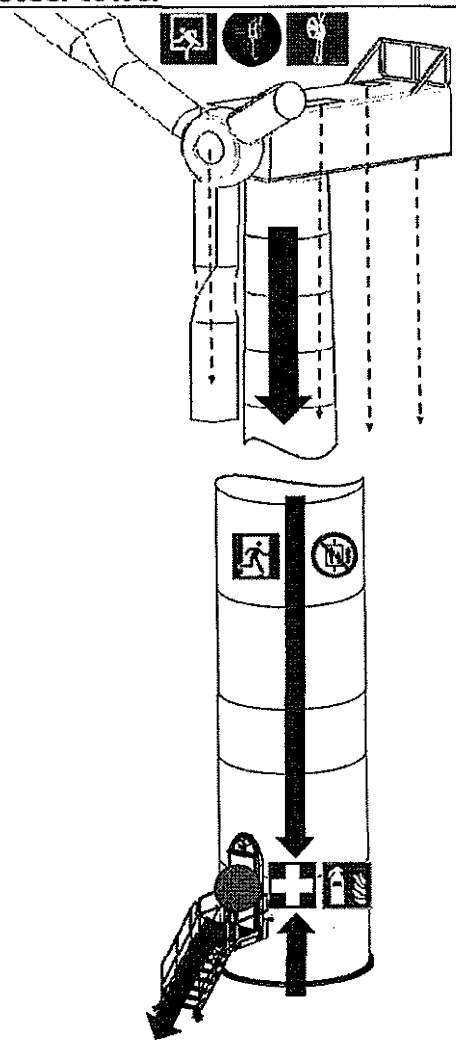
Fire

1. Attempt to extinguish the fire
2. Move to a safe location
3. Call for help:
   - What happened?
   - Where did it happen?
   - How many people are injured?
   - What is the extend of injuries?
   - Who reports?
   - Observe instructions, wait for questions.

   Phone:_____

Legend

	You are here		PPE against falling
	Emergency exit / direction of escape		Fire extinguishers
	First-aid kit		Do not use the service lift in case of fire
	Rescue equipment/rappelling equipment		Main and alternative escape routes
	Horizontal areas		Vertical areas
	Emergency exit via rappelling equipment		



Release Page:

Document title:	**Rescue and evacuation plan**

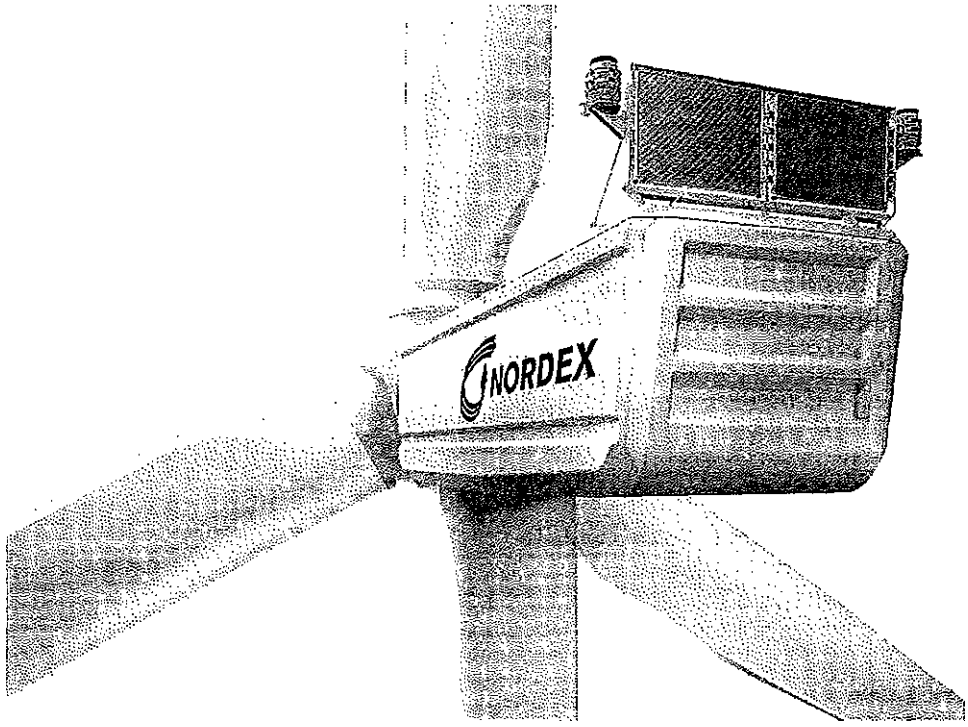
Document number: E0004675705

[redacted]

This page is part of the document Rescue and evacuation plan, Rev. 0/2018-08-16 with 13 pages.
Document has been electronically created and released.

Safety manual

Rules of conduct on, in and around wind turbines
Wind turbine class Delta4000



E0004553222

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1. Conventions

1.1 Symbols and notes

Warning of personal injury

⚠ DANGER

Failure to comply with the instructions and notes will result in life-threatening injury.

⚠ WARNING

Failure to comply with the instructions and notes may result in serious injury.

⚠ CAUTION

Failure to comply with the instructions and notes will result in injury.

Warning of material damage

NOTICE

Warning of damage to components or material

Notes and information

NOTE

Additional information, notes and hints

OBSERVE DOCUMENT

Reference to information in other documents

Integrated safety notes and information

Information and safety notes integrated into the text. Indicated by the signal word in bold: Note, Notice, Caution, Warning and Danger.

Example

Caution: To prevent damage to the paintwork, the tower sections must not touch the ground.

1.2 Notes on text format

Lists and work steps

- Work step
  - ► Result of a work step
- List
  - Subordinate list

Italic text

Identification of proper names *(e.g., manufacturer name, document title).*

2. Introduction

The present document is intended for the owner/operator, Nordex employees, and employees of contractual companies.

This document contains general regulations and notes for the safe operation, as well as the safe execution of all necessary work steps for the erection, commissioning and maintenance/repair of a Nordex wind turbine (WT).

This document applies to a wind turbine class Delta4000 WT.

Strict adherence to and observation of these regulations and notes prevent possible dangerous situations. For this reason, it is absolutely essential that all persons operating or working on a wind turbine read this document carefully and act in accordance with the instructions and regulations.

The safety manual must be understood in order to ensure safety on, in and around the WT. If questions arise when reading this document, clarify them first and consult Nordex as required.

The respective specific safety notes in the technical documentation (which, for example, describe the operation or maintenance) must also be read and understood.

In addition, the current version of the document *G0112P1 Arbeiten in, an und auf Windenergieanlagen* [*Work in and around wind turbines*] is binding for Nordex employees.

3. Abbreviations and terms

The following terms and abbreviations are used in this document:

Term	Definition
CCV	Cold climate version
CW	Clockwise
Electrically instructed person	An electrically instructed persons is somebody who has been instructed and, where necessary, trained by an electrically skilled person about the allocated task and potential risks of improper behavior as well as informed about the necessary protective equipment and protective measures.
Electrically skilled person	An electrically skilled person is somebody who on account of expert training, knowledge and experience as well as the relevant standards is capable of evaluating the tasks allocated and detecting potential risks.
LOTO procedure	Lockout/tagout procedure; a procedure for preventing unauthorized access, e.g., reactivation of electrical circuits
MV transformer	Medium-voltage transformer
PAP	Personal attachment point
PFPE	Personal fall protection equipment
Qualified person for personal protective equipment against falls from a height	Qualified person for personal protective equipment against falls from a height is somebody who, on account of expert training and experience, has sufficient knowledge in the field of personal protective equipment against falling from a height and is familiar with the relevant occupational health and safety regulations, accident prevention regulations and generally accepted standards of technology to be able to evaluate whether or not a personal protective equipment against falling from a height is in safe condition and is applied properly. In Germany, these requirements are fulfilled by anyone who has successfully participated in a training course, in accordance with the BG (Institution for Statutory Accident Insurance and Prevention) policy "Selection, training and proof of capability of experts for PPE against falling from a height" (BGG 906).
Self-contained electrical operating site	Self-contained electrical operating sites are spaces or locations which are used solely to operate electrical systems and are kept locked. Only electrically skilled and electrically instructed persons have access. Persons without electrotechnical training must enter these rooms or locations only when supervised by above-mentioned electrically skilled persons.

Term	Definition
Trained, specialized personnel	Trained, specialized personnel include those trained, instructed and authorized for the professional execution of work on WTs.
TSL	Tower service lift
WT	Wind turbine

4. Safety regulations

4.1 Intended use

The WT is solely intended to convert the kinetic energy of the wind into electrical energy, and to feed this into an existing electricity network.

The WT must be used only for the intended purpose within the specified performance limits and operating conditions.

Usage outside of these parameters is not permitted.

The manufacturer accepts no liability for damage caused by improper use or failure to adhere to safety regulations.

4.2 General rules

Persons who want to enter, operate, or work on the WT must first have read and understood this safety manual, the operating instructions and other applicable documents for the WT.

It is within the interest of your own safety and the safety of other persons to strictly adhere to the safety and operating instructions contained in these documents.

NOTE
The owner/operator must ensure that this safety manual and the current operating instructions as well as all applicable documents are always available in the WT, are freely accessible and are in a usable condition.

4.2.1 Basic occupational safety equipment

Persons who want to enter the WT must have the following basic occupational safety equipment:

- Suitable protective work clothing (for Nordex employees acc. to NORDEX PPE catalog)
- Safety shoes[redacted]
- Safety helmet with chin strap
- Safety gloves
- Safety glasses

[redacted]

Depending on the task in hand, service employees also require:

- An additional light source for work in areas with poor lighting
- For noisy work in the tower or in the nacelle: Hearing protection

- For switching actions in the medium-voltage range: Safety helmet with face protection, insulating gloves, insulating jacket, insulating mat

When using the vertical ladder or the service lift for the ascent in the tower or while staying in a fall hazard area, the personal fall protection equipment (PFPE) must also be used, see chapter 7.1 "Personal fall protection equipment (PFPE)".

4.2.2 Access

Persons with pacemaker are not permitted to enter the turbine. Strong electromagnetic fields may arise in the WT, which seriously interfere with the function of pacemakers and may result in an immediate danger to the life of the affected person.

The WT is classified as a self-contained electrical operating site. For this reason, persons who want to enter the WT or must carry out work in or on the WT must meet special requirements.

The following persons are authorized to access the WT:

- Electrically skilled persons
- Electrically instructed persons

All other persons may enter the WT only under the supervision of one of the aforementioned persons.

If a person enters a WT for the first time, on-site instructions must be provided by an electrically skilled person familiar with the WT.

The owner of the WT must take suitable measures (e.g. key authorizations) to ensure that unauthorized persons cannot access the WT.

4.2.3 Inside/around the WT

When inside the WT or in its direct proximity, safety helmet and high safety shoes must be worn.

All warning and safety signs in the WT and all operating instructions must be strictly followed.

While inside the WT, it must be ensured that unauthorized persons do not enter the WT. This is achieved by means of corresponding signs.

[redacted]

Depending on the general weather conditions, observe changes to the weather when inside the WT for prolonged periods, particularly when working in the nacelle, as well as on and in the rotor hub.

Such observation is necessary in order to take measures early enough to prevent dangerous situations caused by freshening wind or approaching thunderstorms.

Loose, long hair, loose clothing, or jewelry that may get caught or dragged into rotating parts are not permitted.

To prevent accidents from falling objects, it must be avoided to stay on the bottom tower platform in the area of the service lift.

Smoking is not permitted in the WT.

4.2.4 Operation

The WT has been designed, constructed and erected using state of the art technologies and in accordance with the relevant technical standards and regulations.

Despite this, incorrect usage can result in dangerous situations, which can put persons' health and lives, and the WT or other material assets at risk.

For this reason, the WT must be operated only:

- According to its intended use
- In technically sound condition
- In compliance with the operating and maintenance instructions

The owner/operator must perform operator control actions on the WT only after receiving expert instructions. Operator control actions by the owner/operator are limited to starting and stopping as well as querying WT production data with the aid of the software provided by the manufacturer.

Individual components of the WT must be manually operated only by trained specialized personnel, who are trained, instructed and authorized for this purpose.

Operating personnel currently undergoing training must work on the WT only under the supervision of an experienced person. A successfully completed training must be confirmed in writing.

The WT is operated automatically. Operational faults are identified by the control system, and trigger respective error messages, right through to shutting down the WT. Faults must be identified and rectified only by trained, specialized personnel.

4.2.5 Ascending to the nacelle

Only persons who are physically capable are permitted to ascend into the nacelle. There are also further requirements for specialized personnel, see "Additional safety regulations for specialized personnel" on page 16.

If a person enters the nacelle who has not passed the rappel and rescue training the following must be observed: At least two other persons must be in the WT at the same time who have both passed the rappel and rescue training and of which one must be present in the nacelle.

The following conditions and rules apply to an ascent:

- The 10-minute average wind speed is not higher than 20 m/s.
- The service lift and vertical ladder with fall protection system (valid inspection label or inspection record) are in full working order.

- The responsible Remote Monitoring team has been informed.
- The WT is stopped manually and secured against reconnection.
- Remote access to the controls must be disabled.
- The emergency lighting in the tower is functioning.

Communication

Before starting the work and during all work in and on the WT, communication or an emergency call facility must be guaranteed.

Communication must be ensured among the persons in the WT and other persons present in the wind farm and to rescue services in case of emergency.

When ascending to the nacelle, at least one mobile communication device (two-way radio, cell phone) must be carried along.

[redacted]

Entering the service lift

The following rules apply if a service lift is present:

- The track must always be inspected during an ascent and/or descent.
- During automatic travel for material transportation the simultaneous use of the ladder by persons is prohibited for all service lift variants.
- When ascending into and descending from the nacelle always use the service lift.
- It is not permitted to use the service lift and the vertical ladder at the same time, as this would endanger the person using the vertical ladder.
- The service life must be operated only by persons instructed in the operation and daily checks of the relevant service lift.
- Only use the service lift if the daily checks prescribed by the manufacturer were completed successfully and documented. The inspection plan and inspection protocol are in the service lift.
- When using the service lift, it is obligatory to always secure yourself against falling from a height. For this purpose, the PFPE must be used, connected to the attachment points in the service lift cage.
- Do not use the service lift in case of fire.

Vertical ladder

The following rules apply when using the vertical ladder:

- It is obligatory to always secure yourself against falling. For this purpose, use the PFPE in connection with the fall arrest system.

- Use PPE against falling (safety harness, fall arrester, 2 energy absorbers) to secure yourself in the tower and on the WT. Before changing the safety system, secure the attachment point with an energy absorber.
- Before using the vertical ladder, ensure that the service lift is not used at the same time.
- Before using the vertical ladder, remove any loose objects from pockets in clothing and either leave these behind or secure them against falling out. Larger or heavier objects must be transported into the nacelle with the on-board crane.
- Before and during the ascent, carry out a visual inspection on the vertical ladder and fall protection system to ensure that there is no damage.

  If in any doubt,
  - Cancel the ascent, and, if necessary, also secure yourself on the ladder upright using the lanyard with energy absorber
  - Immediately inform the responsible service company and the Remote Monitoring department
- Only one person at a time may be on the vertical ladder [redacted]
- Note that the number of persons allowed to use the vertical ladder at the same time may be restricted. Refer to the user manual.
- If a tower platform has an access hatch, this must be closed immediately after passing through it.

Personal fall protection equipment (PFPE)

The following rules apply when using the PFPE:

- Use only your personal PFPE.
- Ascent to the WT is only permitted with a valid certification in the [redacted]
- The PFPE must be checked for damage before use.
- A PFPE that has been put under stress due to a fall must no longer be used and has to be checked and, if required, replaced by a qualified person.
- In accordance with legal regulations, regular inspections must be performed on the PFPE by a qualified person (in Germany at least every 12 months).

4.2.6 Exiting the WT

The owner or operator must restore the operational state of the WT before exiting it.

This means in particular:

- Close and secure all hatches and accesses into the WT.
- Inform Nordex Remote Monitoring of the intention to leave the WT.

- The PFPE must be complete and properly stored in the correct place.
- Restart the WT if it has been stopped manually.
- Log off on the turbine PC.
- Re-establish remote access to the control system as necessary.
- Switch off the lighting.
- Lock the door in the tower base.

The same applies to specialized personnel after completion of work on the WT.

The following must also be ensured:

- The rotor lock is released,
- The guy rope and the chain for the on-board crane must be hauled in,
- The rotor brake, the pitch system, the manual control unit at the Topbox and the yaw system are released for automatic mode with the respective selector switches,
- The WT control system must be ready for operation,
- Any contamination must have been removed, and the WT must be cleared of tools and packaging.

If specialized personnel intend to briefly leave the WT, although the work is not yet complete, the following must be ensured:

- Remote access to the WT control system must not be possible
- The WT must be in a safe condition
- Unauthorized persons must not be able to access the WT

4.2.7 Special safety notes for WTs with extended temperature range

As an option, Nordex WTs can be designed for an extended temperature range.

WTs in CCV design

WTs with the CCV option are designed for operating at temperatures down to -30 °C. Work on the WT, however, is permitted only at temperatures down to -20 °C.

When staying or working inside the WT at extremely low temperatures, do not touch any metallic parts with bare hands because there is the risk of freezing to it. Wear safety gloves.

The tools and accessories must be suitable for use at extremely low temperatures.

4.3 Additional safety regulations for specialized personnel

4.3.1 General safety regulations

Work steps for erecting, commissioning, and maintaining the WT must be performed only by trained, specialized personnel.

Any work on and in the WT must be performed only after a manual stop.

During work in the WT, at least 2 employees must be on site at all times.

During work with sparking tools, a second person with a fire extinguisher must be ready in the working area.

If sparks occur, use temporary covers in the working area to prevent a fire.

In addition, the generally accepted rules on safe and proper execution of work as well as the latest versions of the accident prevention regulations must be observed.

In all countries where turbines are erected the existing national regulations concerning accident prevention and environmental protection must be adhered to.

Specialized personnel

Specialized personnel working on the WT must:

- Regularly take part in rescue training and first-aid training
- Possess a valid certificate for working at heights.

Safety equipment

- Each employee must carry and use their personal PFPE.
  The PFPE and, if applicable, the rappelling equipment provided in the WT are intended for use only by the owner.
- It is mandatory to wear safety glasses for any work inside tower and nacelle.
- Hearing protection must be used when carrying out noisy work, particularly in the tower.
  When using hearing protection, it must be ensured that those persons present are able to communicate by using hand signals agreed in advance.
- In the case of work on the hydraulic or cooling system, an emergency eyewash bottle must be carried along.

Responsibility and communication

- For the period of the work to be completed, the responsible employee is technically and disciplinary responsible for all subordinate employees.
  Before starting the work, the responsible employee must instruct subordinate employees in the safety regulations to be observed, and ensure that they are adhered to.

- The responsible employee must be familiar with the telephone numbers of the local rescue services and the power utility and keep them readily available. It must be ensured that communication with rescue services is possible at all times.
- It must be ensured that all persons involved are able to perfectly communicate at all times (if necessary, an interpreter must be used).
  An adequate number of two-way radios with uniform frequencies must be available.

Preventing re-activation and remote access

NOTE

Nordex employees only: To secure the system against reconnection, use the lockout/tagout (LOTO) procedure. [redacted]

- Prior to starting work on the WT, perform a manual stop and disable remote access to the control system. For this, the operating mode switch must be set to "Local".
  This also applies for the WT at standstill as this may be due to an error that occurred during idle mode. If the error is no longer active, the WT will automatically restart.
- If parts of the WT or the entire WT are switched off during maintenance or repair work, these parts must be secured against automatic or accidental re-activation.
- As an option, Nordex WTs can be designed for an extended temperature range

Changing settings and repair work

- To ensure that the WT can operate correctly and safely, factory-set switching points on monitoring and control components, such as pressure monitoring devices, valves, throttles or control parameters, must be changed only for testing purposes.
- Once tests have been completed, the specified values must be reset immediately.
- Only use original spare parts from the manufacturer for repair work. It is prohibited to use parts from manufacturers that have not been expressly approved by the manufacturer of the WT.
- Any damaged machine components must be replaced. If this is not possible, the WT must remain stopped.

Disassembling safety devices

- If it is necessary to disassemble safety devices in order to execute work steps, these must be re-assembled directly after the work has been completed, and must then be checked for proper functioning.
- It is not permitted to permanently put safety devices out of service.

Using the on-board crane

- Before starting the crane, stop the yaw system.
- Do not transport persons with the on-board crane.
- Do not stand or walk under suspended loads.
- Secure a wide area on the ground underneath the suspended load.
- The crane hook must be secured with a guy rope from the ground and be kept clear from the tower.
- The use of the crane must be canceled if it is likely to be unsafe due to bad weather, e.g., strong gusty wind.
- Communication between the acting persons in the nacelle and on the ground must be ensured.

4.3.2 Working in the cable vault

Live cables may get damaged during work in the cable vault. Therefore:

- Before starting any work with heavy tools and auxiliary devices, disconnect the cables in the working area.
- Do not step onto the cables.
- Protect the cables appropriately against mechanical damage.
- Check the cables for damage after completing the work.

While in the cable vault, the escape route must be kept free at all times. Using the manual control unit, position the service lift approx. 2 m above the hatch. Prevent reactivation of the service lift with the mechanical lock (transport lock) according to the manufacturer's operating instructions.

4.3.3 Using the vertical ladder during erection

During erection, it may occur that the fall arrest system is not yet available, or has not yet been released for use.

If the vertical ladder must still be used, then special rules of conduct must be adhered to:

- A sign on the vertical ladder must explicitly indicate that the fall arrest system is not yet available, and that the person ascending the vertical ladder must be secured against falling using the lanyard with energy absorber.
- Always safeguard yourself against falling by alternately attaching the two ends of the lanyard with energy absorber to the ladder uprights.

4.3.4 Working in the nacelle

During all work in the nacelle, observe the green, yellow and red signal lamps. The green signal lamp must be permanently on, the yellow and red signal lamps

must be off, see "Indicating safety-relevant situations" on page 41. If this is not the case, the WT is in a safety-relevant condition. In this case, the responsible employee must decide which work may have to be stopped.

Permissible wind speeds

Work in the nacelle is only permitted up to the following wind strengths:

- up to 9 m/s in the 10-minute average: Work at the exposed drive train if this has been locked exclusively by the rotor brake,
- up to 12 m/s in the 10-minute average: Work at the exposed drive train if this has been locked by the rotor lock,
- up to 12 m/s in the 10-minute average: Work in the hazard area of the yaw bearing and in the rotor hub.

If the permissible wind speed is exceeded, this is indicated by an acoustic and visual alarm, see "Indicating safety-relevant situations" on page 41. In this case, the responsible employee must decide which work may have to be stopped.

After entering the nacelle

Immediately after entering the nacelle, the following initial tasks must be carried out prior to performing any maintenance or repair work:

- Move the rappelling device and descender to be carried in the service vehicle into the nacelle and keep it at hand.

  Caution: If more than two persons will be staying in the nacelle, a sufficient number of rappelling equipments must be transported into the nacelle.

Fixed guards

If fixed guards (e.g., gearbox output shaft cover) must be removed during maintenance work or repairs, these must be completely reassembled with all fasteners after work is completed.

Working on the drive train

In the case of an error in the pitch system, i.e. not all rotor blades are in the 95 ° position, this error must be rectified before starting any work on the drive train.

For any work on the drive train, the rotor must always be locked on the rotor shaft. The rotor must be locked with the rotor brake only if required for completing certain work steps.

Working on the roof

Work on the nacelle roof is not permitted at 10-minute average wind speeds above 12 m/s.

Only areas that are sanded and colored must be stepped on. When working on the roof, the employee must be attached to one of the marked personal attachment points using a lanyard with energy absorber. Furthermore, the employee must remain in regular verbal or visual contact with one of the other employees. This second person must be able to initiate necessary rescues in due time.

Working alone in the nacelle

If an employee is working alone in the nacelle, he/she must remain in regular verbal or visual contact with one of the other employees who is able to initiate necessary rescues in due time.

Staying in the nacelle with the WT in operation

Staying/working in the nacelle during operation is prohibited. If it is necessary to stay in the nacelle with the WT in operation in order to complete certain work steps (e.g., for test runs), the following rules must be observed:

- All protective covers over rotating parts must be in place, unless they must be removed in order to complete the work steps.
- The guy rope and the chain for the on-board crane are hauled in.
- Lanyards that are attached to the safety harness must be taken off.
- Tight work clothes must be worn.
- A safe position in the rear part of the nacelle outside the area of the gearbox output shaft must be taken.
- Hearing protection must be worn and reliable communication between the present persons must be ensured.

4.3.5 Working on and in the rotor hub

It is permitted to access the rotor hub and perform work on or in the rotor hub only if:

- The 10-minute average wind speed is less than 12 m/s,
- The rotor is locked on the rotor shaft,
- The rotor lock is secured according to the LOTO procedure, see "Preventing re-activation and remote access" on page 17,
- The yaw system is locked,
- Regular visual and verbal contact to one of the other employees is ensured. This second person must be able to initiate necessary rescues in due time, if required.

If two employees are required for work in the rotor hub, a third employee must stay in the nacelle.

If work is to be carried out in the rotor hub, the rappelling equipment must be carried along into the hub.

During any work in the rotor hub, observe the green signal lamp. It must be permanently lit. If this is not the case, the WT is in a safety-relevant condition. Contact the responsible employee for further actions.

For all work during which persons might be endangered by the movement of a rotor blade the affected pitch drive must be disconnected and mechanically locked, see "Locking the pitch system" on page 43.

4.3.6 Working on the electrical system

NOTE

Nordex employees only: To secure the system against reconnection, use the lockout/tagout (LOTO) procedure. [redacted]

Work on the electrical system in the WT must be performed only by electrically skilled and electrically instructed persons.

Work on medium-voltage switchgear must be performed only by electrically skilled persons with a valid switching authorization.

Electrical equipment on which inspection, maintenance and repair work must be performed, must be disconnected.

Caution: Actuating the emergency stop button does not ensure that the respective equipment is dead.

To ensure that the system is dead, five safety rules must be observed:

- Switch to zero potential.
- Secure against reactivation.
- Verify that the system is dead.
- Ground and short-circuit.
- Provide protection against adjacent live parts.

To verify that all components are de-energized, use two-pole voltage testers according to IEC 61243-3, measurement category CAT III 1000 V or CAT IV 600 V. Devices that comply with this standard (not equipped for current measurement) prevent the development of arc short-circuits.

Only electrically skilled persons with switching authorization are permitted to measure voltages on converters/converter cabinets up to 1,500 V DC, and to verify that they are dead. These checks must be performed only while wearing complete and suitable PPE (helmet with face protection, insulating gloves, insulating jacket, and insulating mat), which is mandatory for persons with switching authorization.

Always keep the electrical switch cabinets locked. Only authorized persons who are in the possession of a key or special tools are authorized to access these switch cabinets. If work must be performed on a switch cabinet integrated into a fire extinguishing system, the fire extinguishing system must be deactivated before starting any work.

Any work on live parts or cables is prohibited. The only exception is troubleshooting by specialized personnel using suitable measuring instruments and test adapters, measurement category CAT III 1000 V or CAT IV 600 V.

Never clean electrical equipment with water or similar liquids.

4.3.7 Working on the hydraulic system and with hydraulic tools

Any work on the hydraulic system of the WT must be performed only by trained specialized personnel.

Before starting any work, all hydraulic parts of the turbine, including any accumulators, must be depressurized. The hydraulic pump must be disconnected.

Ensure everything is kept scrupulously clean and prevent dirt and water from entering the system when performing work on the hydraulic system.

Always wear safety glasses and safety gloves when working with hydraulic tools (e.g., hydraulic preloading of screw connections) or at the hydraulic system. User instructions and safety notes of hydraulic tool manufacturers must be observed.

4.3.8 Handling hazardous substances and environmental protection

When handling hazardous substances such as oils, greases, coolants, or cleaning fluids, observe the manufacturer's safety and using instructions applying to the product. The responsible employee must carry these instructions with him. The specified safety measures, such as safety gloves and pair of safety glasses, must be applied.

Any work that is performed on the WT must comply to the regulations of waste avoidance and of proper waste treatment and waste disposal.

Especially, ensure that substances hazardous to ground water, such as greases, oils, coolants and solvent-based cleaning fluids, cannot penetrate into the ground, into bodies of water or into the sewage system. These substances must be collected, stored, transported, and disposed of in suitable containers.

Remove any oil leaks without delay in order to avoid the risk of slipping.

Determine and eliminate the cause of abnormal leaks. If this is not possible, the WT must be shut down.

In-house and legal regulations on the reporting of environmental incidents must be observed.

To prevent fire hazards, cleaning supplies must be properly disposed of after work is completed.

4.3.9 Regulations for lifting and winch work

General

Caution: Loads may only be lifted with the on-board winch if the rotor has been braked and locked.

The regulations for crane work may be different from one country to another. The responsible employee must find out about country-specific regulations before starting the work, and must inform subordinate employees about these regulations in writing.

A contact person who is familiar with these regulations must be available for consultation.

Regulations on lifting of components

Only suitable, approved and certified lifting tackles with sufficient load capacity must be used to hoist components.

To avoid uncontrolled swinging of the load position and raise the crane hook exactly vertical above the lifting tackle when lifting loads.

No one must stand or walk under the suspended load.

All individuals must maintain adequate safety distance from suspended loads to prevent injuries from falling objects.

Special work under suspended loads, which cannot be completed in a different way, is permitted only at the express instruction of a defined responsible person. Prerequisite for this is a clear agreement with the crane operators and a safety person.

Weather conditions

During thunderstorms, all crane work must be stopped due to a risk of lightning striking the crane or a component. For behavior during thunderstorms see "Thunderstorm" on page 46.

Consult the crane operator to determine the maximum wind speed at which crane work is possible.

The limit wind speed for crane work depends on the type of crane, the design of the crane and the wind conditions.

The crane operator is fully responsible during all crane work.

The responsible employee and the crane operator mutually agree when crane work must be stopped due to the wind conditions and when they can be resumed.

4.4 Special obligations of the owner

The owner/operator is particularly responsible for ensuring a high degree of safety when operating the WT and while persons are inside the WT.

In particular, the owner must ensure that:

- Only authorized persons have access to the WT, e.g., by means of an appropriate key concept. If no authorized persons are in the WT, it must be kept locked
- The PFPE in the WT or the wind farm is carefully stored
- In a wind farm where not all WTs are equipped with a PFPE, suitable information on the storage location of the PFPEs available in the wind farm is provided in all WTs
- This document and all others stored in the WT by the manufacturer (e.g., the operating instructions for the WT and circuit diagrams) are always available in the WT and are in a usable condition

- The signs on and in the WT are in a proper condition and are replaced as necessary
- The work steps required for WT maintenance are organized and executed on time and in accordance with the manufacturer's specifications
- For their presence in the WT and that of accompanying persons a separate safety concept has been prepared and is being applied, in particular regarding rescue during an emergency

[redacted]

Inspections of special equipment

There are specific, periodic inspection obligations for WT safety equipment, various safety devices and turbine components for all countries in which turbines are erected.

These checks are not part of the standard maintenance work and must be performed by qualified and appointed persons.

The owner/operator is responsible for organizing these checks and for checking the proper and timely execution.

These special checks apply to:

- The owner's PFPE
- The personal attachment points
- The rappelling equipment stored in the WT, if applicable
- Vertical ladder and fall arrest system
- Specific pressure tanks of the hydraulic system
- The service lift
- The overhead crane and electric chain hoist
- The fire extinguishers and, if applicable, the automatic fire alarm and fire extinguishing system
- The burglar alarm system, if applicable
- The first-aid kits

For detailed information, e.g. on inspection periods, refer to the general maintenance instructions.

5. Warning and safety notes inside the WT

Corresponding signs inside the WT provide warnings about possible dangerous situations, see the following table.

Furthermore, signs containing operating notes and rules of conduct are attached to various turbine components. These must be observed at all times.

NOTE

The owner is responsible for ensuring that the signs in and on the WT are in a usable condition and are replaced as necessary.

Sign/symbol	Meaning
	Warning of a fall hazard
	Warning of a crushing hazard
	Warning of hand injury
	Warning of hazardous voltage
	Warning of slip hazard
	Warning of tripping hazard
	Warning of hot surfaces
	General warning
	Warning of outgassing batteries

Sign/symbol	Meaning
	No open flames
	No entrance for persons with pacemakers or implanted defibrillators
	Access for unauthorized persons is forbidden
	No smoking
	Do not step here
	General sign giving orders
	Wear hearing protection
	Use a helmet
	Use safety gloves
	Wear safety glasses
	Wear protective clothing
	Secure yourself with a rope
	First-aid kit

Sign/symbol	Meaning
	Escape route
	Fire extinguishers

6. Residual risks

Nordex WTs comply with state of the art technology and have high safety standards.

Despite this, certain risks remain when the WT is operated, and particularly when performing maintenance work in and on a WT.

Slip hazard due to ice

In icy conditions, there is an increased risk of slipping when approaching the WT, and particularly when using the external staircase.

In this weather conditions, watch your step accordingly when approaching the WT or take actions to avoid slipping on iced floor.

Ice throw

The primary residual risk when operating the WT is the risk of ice throw during the cold season. Where required, the owner is obliged to point out the risk of ice throw by means of suitable signs and labels, e.g., a sign in the access area.

[redacted]

If there is a risk of ice throw, take particular caution when approaching the WT. In particular, avoid standing or walking below the rotor blades.

For this reason, particularly in locations with an increased risk of icing, it is recommended to equip the WT with an ice sensor, which is optionally available.

In this case, the control system stops the WT automatically when detecting any signs of icing on the ice sensor. [redacted]

Falling objects

When working at heights, objects may be dropped accidentally.

For this reason, it is prohibited to stand or walk underneath persons working at heights. The respective area on the ground must be secured accordingly.

Falling into the safety harness

When working at heights, persons may fall into the safety harness, despite adhering to all rules of conduct.

In this case, a quick rescue is necessary in order to prevent the risk of a suspension trauma and any associated health risks for the person affected.

Tripping and slipping

There is an increased risk of tripping, especially in the nacelle and the rotor hub, due to the different height and width of steps, as well as the limited space.

Minor leaks, grease or climatic influences may also cause a risk of slipping.

For this reason, particular caution is advised while staying and moving in the WT.

7. Safety equipment

The WT is equipped with various pieces of safety equipment to ensure safety inside the WT.

NOTE

The safety equipment must be regularly inspected by a qualified person in accordance with the manufacturer's specifications.

For safety equipment that is permanently stored in the WT, the owner/operator of the WT is responsible for completing these inspections.

7.1 Personal fall protection equipment (PFPE)

In addition to the standard protective clothing, which includes at least high safety shoes (ankle-high and class S3), safety gloves and a safety helmet, personal fall protection equipment (PFPE) is required, particularly when using the vertical ladder.

It protects against falling while standing or walking in a fall hazard area.

The PFPE for the owner and one accompanying person can be obtained from Nordex.

NOTE

The scope of supply of the PFPE depends on the applicable contract.

If the supply of PFPEs has been agreed to contractually, the owner is obliged to carefully store the PFPE.

In a wind farm where not all WTs are equipped with a PFPE, the owner must provide suitable information on the storage location of the PFPEs available in the wind farm in all WTs.

7.1.1 Inspection/maintenance

The PFPE must be inspected by a qualified person in accordance with the local legislation. In Germany inspections every 12 months are required.

The owner/operator is solely responsible for organizing and monitoring the inspection of the owner's/operator's PFPE, see chapter 4.4 "Special obligations of the owner".

7.1.2 Components of the PFPE

The PFPE for specialized personnel consists of the following parts:

- One safety harness with a sternal fall-arrest eyelet, a dorsal fall-arrest eyelet and, if applicable, an abdominal climbing-protection eyelet

- A safety harness, consisting of:
  - Dorsal and sternal fall-arrest eyelet,
  - Chest eyelet and/or
  - Abdominal eyelet
- One lanyard with energy absorber as Y-rope or two separate lanyards with energy absorber
- One fall arrester, permitted for use with the respective fall arrest system in the tower
- One adjustable work-positioning lanyard
- One webbing sling
- Two snap hooks [redacted]

[redacted]

Safety harness

The safety harness has a sternal fall-arrest eyelet, e.g., for attaching a fall arrester, and a dorsal fall-arrest eyelet, e.g., for rescues, see Fig. 1.

The two lateral work-positioning eyelets of the abdominal strap can be used, for example, for the adjustable lanyard.

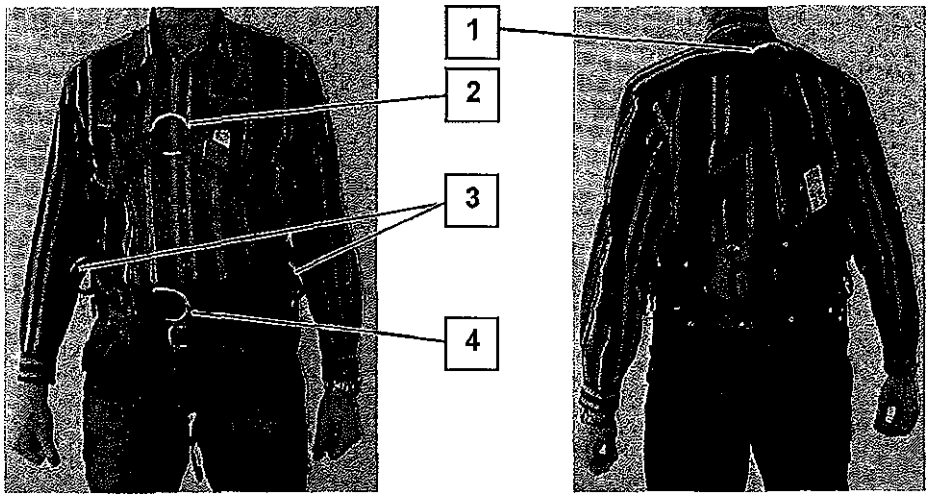

Fig. 1 *Safety harness (example)*

1 Dorsal fall-arrest eyelet
2 Sternal fall-arrest eyelet
3 Lateral work-positioning eyelets
4 Abdominal eyelet

Twin-leg lanyard with an energy absorber

The lanyard with energy absorber serves for safeguarding at a fixed attachment point, for example when there is a fall hazard during a change of location.

The lanyard with energy absorber has two large snap hooks for attaching to an attachment point, and one small snap hook for hooking into the dorsal fall-arrest eyelet of the safety harness, see Fig. 2.

The energy absorber on both halves of the lanyard ensures that the fall of a person is arrested smoothly.

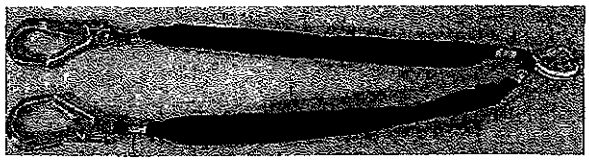

Fig. 2 Lanyard with energy absorber (example: type Shockyard V Flex)

When using a lanyard with energy absorber of the type *Shockyard V Flex*, do not attach the two snap hooks at the same height because, doing so, neither of the two energy absorbers will deploy in the case of a fall.

Adjustable work-positioning lanyard

An additional piece of safety equipment is required in order to secure yourself in awkward positions where there is a fall hazard. This also ensures to have both hands free for performing the necessary work.

For this an adjustable work-positioning lanyard available, see Fig. 3.

The adjustable work-positioning lanyard is attached to the work-positioning eyelets on the safety harness.

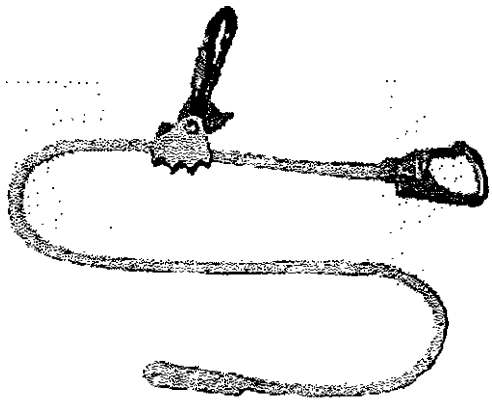

Fig. 3 Adjustable work-positioning lanyard

7.1.3 Handling the safety harness

NOTE

The handling of the PFPE is explained here with an example.

In principle, the same procedure also applies to other versions of the safety harness. Observe the manufacturer's user instructions.

- Attach the lanyard with energy absorber to the dorsal fall-arrest eyelet of the safety harness with the small snap hook and secure it.
- Attach the large snap hooks to the lateral work-positioning eyelets on the left and right side.
- Put on the safety harness like a jacket.
- Pull the right chest strap through the sternal fall-arrest eyelet and lock it into the buckle.

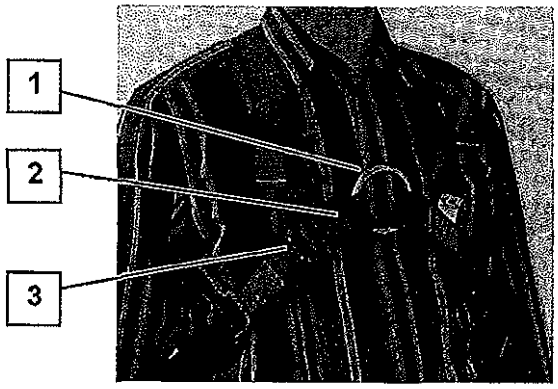

Fig. 4 Fastened safety harness (example)

1 Sternal fall-arrest eyelet
2 Right chest strap
3 Chest strap buckle

- Fasten the abdominal strap.
- Guide the leg straps through the legs from behind and lock them into the lateral buckles.

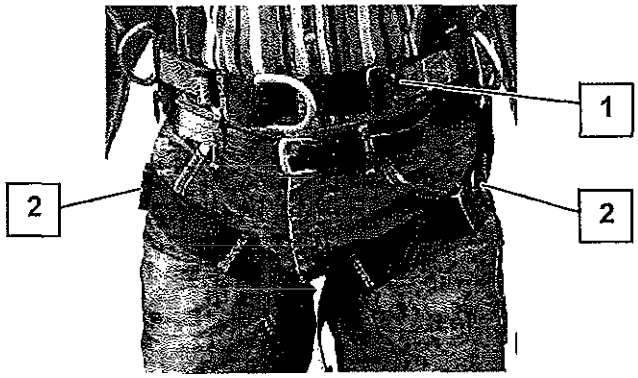

Fig. 5 Fastened safety harness (example)

1 Abdominal strap buckle
2 Leg strap buckle

- Pull all straps tight so that the safety harness fits tightly around the body.

NOTE
Rule of thumb for correct strap tension:
A flat hand may fit between strap and body, but not a fist.

7.2 Rappelling equipment

NOTE
For handling the rappelling equipment, see chapter 9.7 "Leaving the nacelle in hazardous situations".

If the service lift or the vertical ladder with the fall arrest system cannot be used for descending from the nacelle, the nacelle can be exited only by descending to the ground.

Upon owner/operator request the WT can be equipped with the rappelling equipment required for this task. This is stored sealed in a sealed aluminum box on the front part of the gearbox near the access hatch.

Service employees must carry rappelling equipment in the service vehicle. When working on the WT, the employees must take the rappelling equipment with them into the nacelle. Except for the aluminum box, this consists of the same components as the rappelling equipment for the owner/operator of the WT.

7.2.1 Equipment/accessories

The rappelling equipment consists of a transport bag, the descender with a rope corresponding to the tower height, and a 1.5 m work-positioning lanyard for attaching the descender, see Fig. 6.

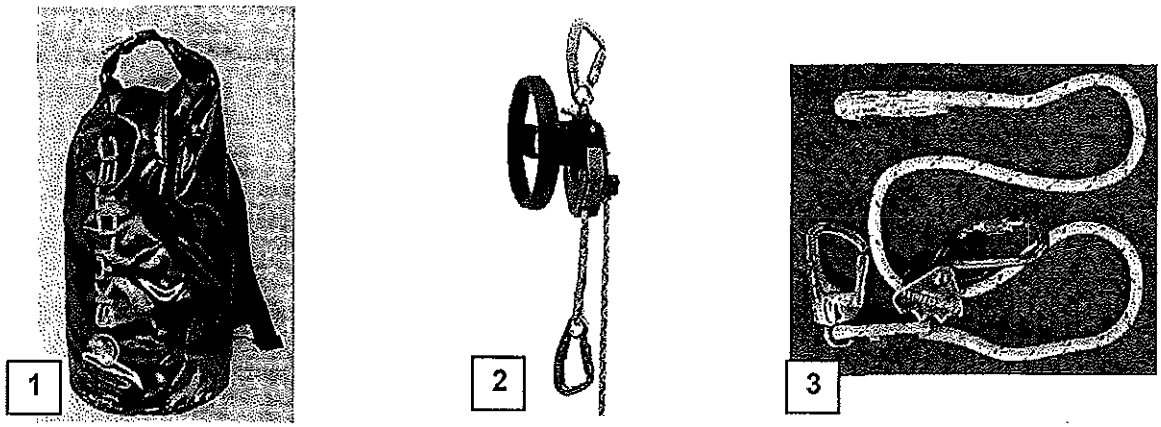

Fig. 6 Main components of the rappelling equipment

1 Transport bag
2 Descender
3 Work-positioning lanyard

The rappelling equipment also contains the following accessories, see Fig. 7:

- A U-shaped edge protection for guiding the rope over the edge of the spinner
- An edge protection for descending from the nacelle roof
- Two snap-hooks
- An ascender

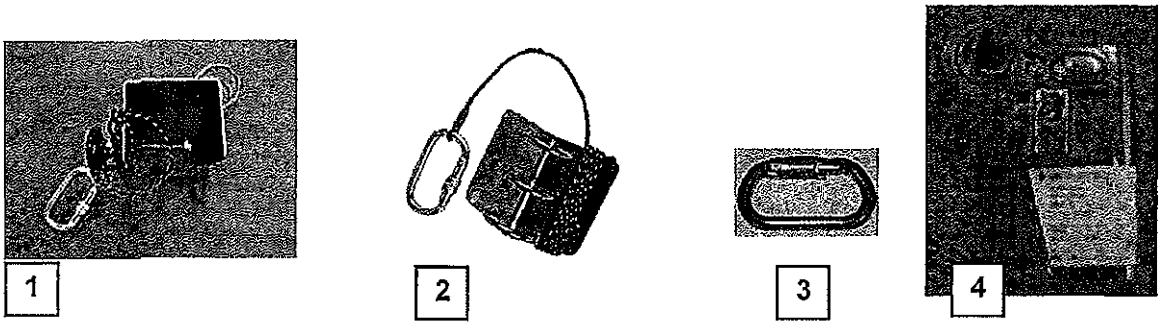

Fig. 7 Accessories for rappelling equipment

1 U-shaped edge protection
2 Edge protection for descending from the nacelle roof
3 Snap hook (2x, similar to photo)
4 Ascender

Individual pieces of equipment may differ, e.g., a webbing sling for attachment instead of a work-positioning lanyard.

7.2.2 Inspection/maintenance

In accordance with local legislation, the rappelling equipment for the Service must be inspected by a qualified person as described in the manufacturer's instructions. In Germany annual inspections are required. The optional lead-sealed descender stored in the WT is subject to a simplified inspection according to manufacturer specifications that must be performed every 12 months.

NOTE

The WT owner/operator is obliged to organize and monitor the inspection of the sealed descender deposited optionally in the WT, see chapter 4.4 "Special obligations of the owner".

7.3 Fire extinguishers

To quickly fight an incipient fire, fire extinguishers are available in the WT in the tower base and the nacelle.

The fire extinguishers must be suitable to extinguish burning solid and liquid materials and fire in electrical installations of up to 1000 V.

The number and position of the fire extinguishers are marked on the WT signs.

The WT can also be optionally equipped with a fire alarm or a fire extinguishing system.

7.4 First-aid kit

Generally, there are two first-aid kits in the WT for treating injuries:

- One in the tower base, next to the door
- One in the nacelle

8. Safety devices

The WT is equipped with various safety devices, which are particularly necessary for the safe execution of maintenance work.

8.1 Fall arrest system

The WT is equipped with a vertical ladder, provided with a fall arrest system.

Just like the PFPE, the fall arrest system must be regularly inspected by a qualified person. The owner/operator is responsible for organizing these inspections, see chapter 4.4 "Special obligations of the owner".

8.1.1 Fall arrest systems used

The *Avanti* fall arrest system with a fall arrest rail in the center of the vertical ladder is used on Nordex WTs of turbine class Delta4000.

When using the vertical ladder, only the fall arrester permitted for this fall arrest system, see Fig. 8, must be used. Only persons trained in the use of this fall arrester are permitted to use it. The fall arrester must be connected directly to the front fall-arrest eyelet of the safety harness.

Note: Refer to the operating instructions of the safety harness for which fall-arrest eyelet must be used to connect the fall arrester.

In case of a fall, the fall arrester locks in place after just a few centimeters. The delayed reaction reduces the high loads to which the falling person is subjected and their fall will be arrested safely.

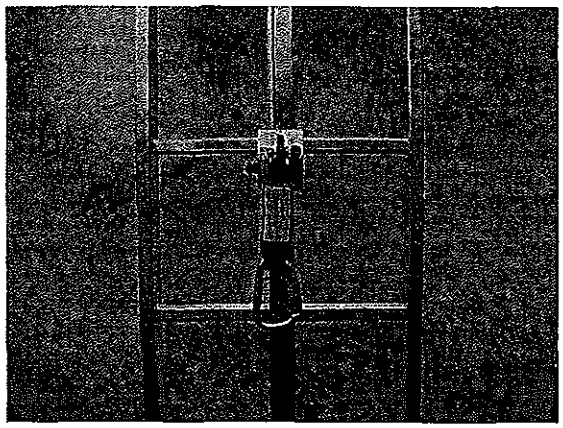

Fig. 8 Fall arrester

8.1.2 Attaching the fall arrester

The fall arrester can be opened and then attached and removed at any point on the fall arrest rail, see Fig. 10 and see Fig. 11. It is completed by an energy absorber and a snap hook, see Fig. 9.

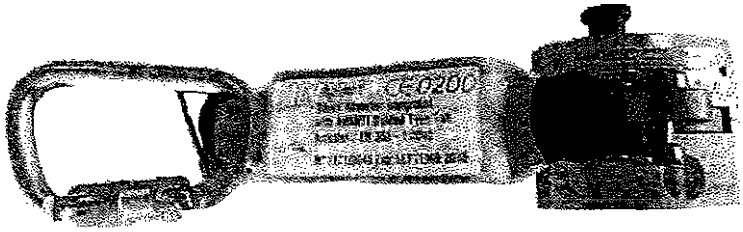

Fig. 9 Fall arrester (Avanti Eagle^{DS})

- Pull the handle and turn the lever down until the lock is released.
- Open the fall arrester: Press the right button and simultaneously pull the two parts of the runner apart.
- Attach the fall arrester to the fall arrest rail.
  Note: The arrow on the fall arrester must point upwards.
  - Laterally position the fall arrester on the fall arrest rail.
  - Lift the brake lever and place the second half of the fall arrester around the fall arrest rail.
  - Press both fall arrester halves together until the right-hand button pops out.
    Note: There is an audible click sound.

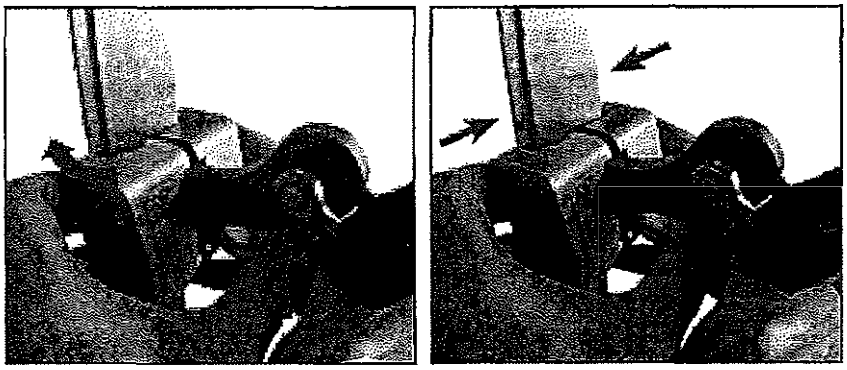

Fig. 10 Fall arrester placed against the fall arrest rail

- Pull the handle and turn the lever up until the lock locks into place.

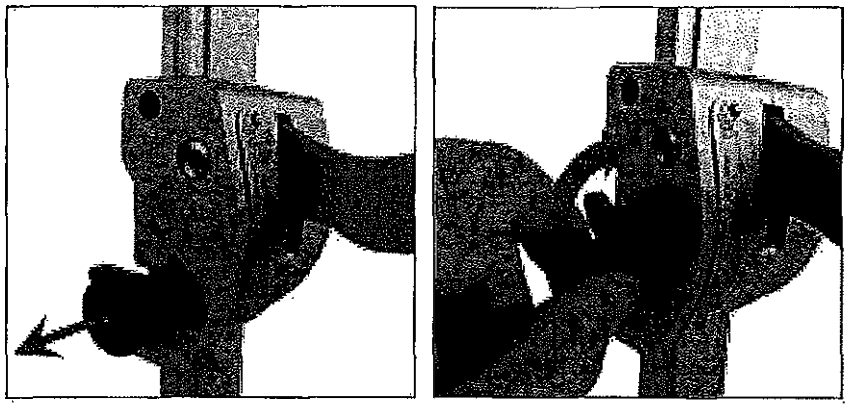

Fig. 11 Locking the fall arrester

- Check that the runner is correctly attached to the rail.
- Pull the brake lever down.
  - ► The runner is securely attached to the rail.

8.2 Rotor lock

The rotor lock reliably locks the entire drive train mechanically. It prevents risks to persons working in the nacelle and rotor hub due to the rotating parts of the drive train.

Delta4000 class WTs are equipped with a rotor lock on the rotor shaft. This consists of a bolt and the rotor lock disk, which is located on the rotor shaft. With the rotor at standstill, the bolt is inserted into one of the drill holes in the rotor lock disk.

The rotor lock must only be operated by trained specialized personnel. It is described in the WT operating instructions.

To ensure high level personal safety during work in the rotor hub and near the gearbox output shaft the rotor lock is integrated into a special key system. Only if the rotor is locked are two keys released at the locking mechanism to enable access to the rotor hub and in the area of the gearbox output shaft.

8.3 Personal attachment points

There are specific attachment points for the PFPE in the WT, to safeguard against falling from a height. These personal attachment points are indicated with yellow paint.

The lifting lugs on the gearbox can be used as additional personal attachment points in the nacelle.

8.4 Emergency stop switch

There are several emergency stop switches in the WT. They serve to stop mechanical hazards, such as the rotation of the drive train, as quickly as possible.

Actuating an emergency stop switch does not disconnect system components or the electrical energy of the WT. Electrical equipment always must be disconnected with the corresponding switchgear before performing any work on it.

Actuating an emergency stop switch triggers the safety system. An emergency pitch operation is triggered, the rotor brake applies after falling below a defined speed, and the yaw system is locked.

The emergency stop switches have a twist release. The pushbutton must be turned to the right (CW) to allow the switch to return to its original position (twist release).

To return the WT to the operational state, the safety system must be additionally reset directly on site.

The emergency stop switches can be found in the following locations:

- In the tower base to the right of the tower door
- In the following locations in the nacelle:

Fig. 12 Emergency stop switches in the nacelle

1 On the Topbox
2 On the manual control unit
3 In the ascent area to the nacelle
4 Medium voltage nacelle circuit breaker

8.5 Medium voltage circuit breaker

The nacelle also contains for emergencies only the MV shut-off switch MH. This is located near the chain storage of the electric chain hoist and designed as non-latching button.

It can be used to switch off the MV switchgear in the tower base from within the nacelle. This disconnects the WT with the exception of the pitch drives which still have a voltage supply from the batteries. The control system is also shut down with a time delay.

The WT can only be connected again by switching on the MV switchgear by a person with corresponding switching authority.

8.6 Indicating safety-relevant situations

Delta4000 class wind turbines have various visual and acoustic signaling devices that alert persons staying in the WT to safety-relevant situations. However, this signaling equipment only takes effect when the safety system is in operation and the operation mode selector switch at the Bottombox is in the position *Local* or *Stop and lock*.

The following signaling devices are available:

- A green, yellow and red signal lamp on the top tower platform
- A green, yellow and red signal lamp in the nacelle
- a green and yellow signal lamp in the rotor hub
- A horn in the tower and in the nacelle

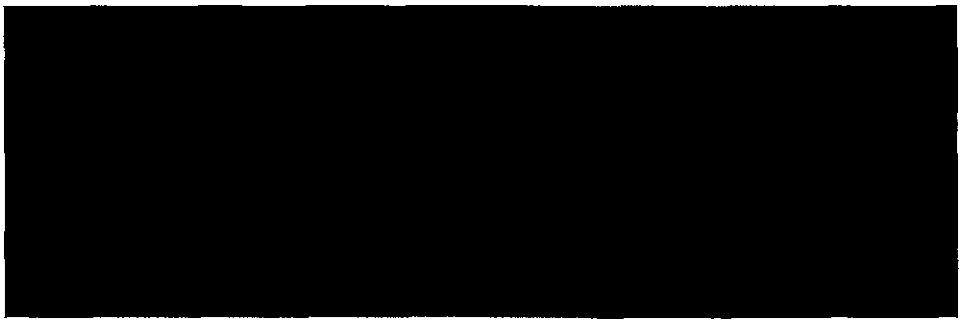

Fig. 13 Position of the signal lamps (similar to figure)

For the meaning of the individual signal patterns, refer to the following figure. The figure can also be found on a label at the Topbox in the nacelle.

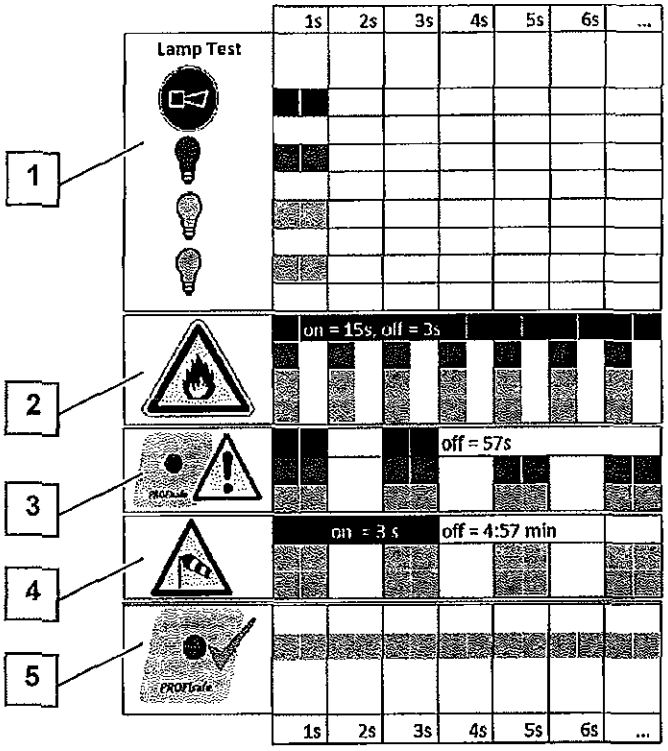

Fig. 14 *Meaning of the signal patterns*

1 Functional test
2 Fire
3 Safety-critical error
4 Too strong wind
5 Everything OK

A safety-critical error is, for example, a pressure drop on the rotor brake. Warning of too strong wind is issued if:

- The 10-minute average wind speed exceeds 9 m/s with applied rotor brake or
- The rotor speed is zero and the 10-minute average wind speed exceeds 12 m/s or
- The maximum permitted 10-minute average wind speed of 20 m/s for ascending to the WT is exceeded.

If everything is OK, the green signal lamps are constantly lit. All other signal lamps are off.

The safety-relevant situations are prioritized. Always the situation with the highest priority is indicated. However, all signal lamps flash if the statuses *Safety-critical error* and *Wind* occur at the same time.

8.7 Locking the pitch system

Safety for work in the rotor hub, particularly for tasks on the pitch drives, can be ensured through different methods, as necessary.

The supply voltage of all three pitch drives can be switched off with a switch on the center box – the service switch *+CEB=APSELESUP-SF1*.

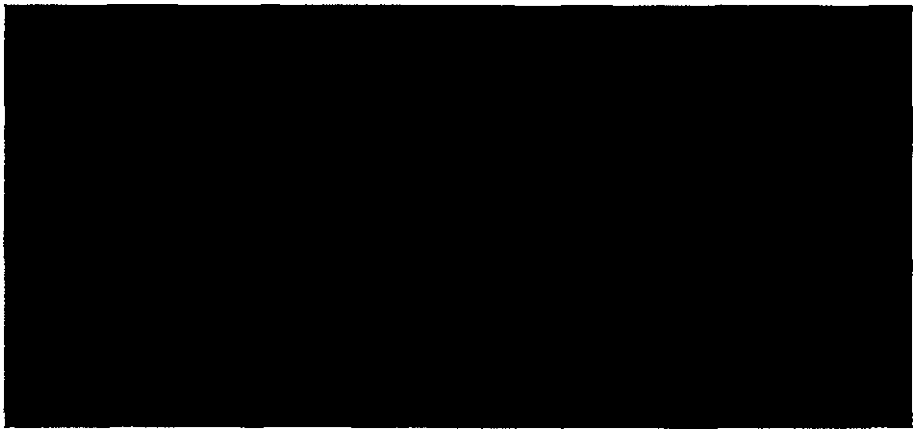

Fig. 15 Service switch (similar to figure)

When the service switch is switched off the pitch drives perform an emergency pitch operation into the 95 ° position.

To completely disconnect a pitch drive, the battery disconnector on the respective battery box also must be switched off.

To ensure reliable locking of a pitch drive, it must additionally be blocked with mechanical means.

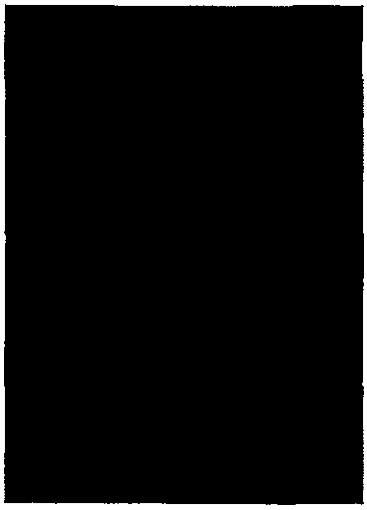

Fig. 16 Pitch locking device

To block a pitch drive the locking device is screwed into the drill hole that is protected with a red cap or a screw plug until it stops. The locking device, one per rotor hub, is stored in a bracket in the hub interior.

Certain work steps require the safe deactivation of the yaw system.

The yaw stop switch at the Topbox is used for this. Switching from *Auto* to *Stop* triggers the following:

- The "safe stop" function of the yaw drives is activated
- The electromechanical brakes of the yaw drives are disconnected so that they are applied

Manually operating the yaw drives with the manual control unit is then no longer possible.

For the safe shut-down of the yaw system, e.g. to perform work on the yaw drives, one of the yaw drives must additionally be mechanically locked. This takes place as described above, see "Locking the pitch system" on page 43.

Caution: If the green signal lamp in the nacelle or in the yaw area is not constantly lit, safe deactivation of the yaw system may be affected, see "Indicating safety-relevant situations" on page 41. In this case, the responsible employee must decide which work may have to be stopped.

8.8 Rotor hub call button

Delta4000 class wind turbines are equipped with call buttons in the rotor hub. If a call button is actuated, you can hear an acoustic signal in the nacelle. With this button, persons in the rotor hub are able to attract attention in case of emergency. This call button is located at the center box.

8.9 Rotor brake selector switch

Delta4000 class wind turbines are equipped with a "rotor brake selector switch" at the Topbox.

It is used for switching between automatic and manual operation of the rotor brake.

After switching to manual mode, the rotor brake is immediately applied and a pitch emergency run is triggered.

Now, the rotor brake can be released only with the *Release Brake* button on the manual control unit. Upon releasing the button the rotor brake is applied with the maximum braking torque.

Now the wind turbine control system can no longer access the rotor brake.

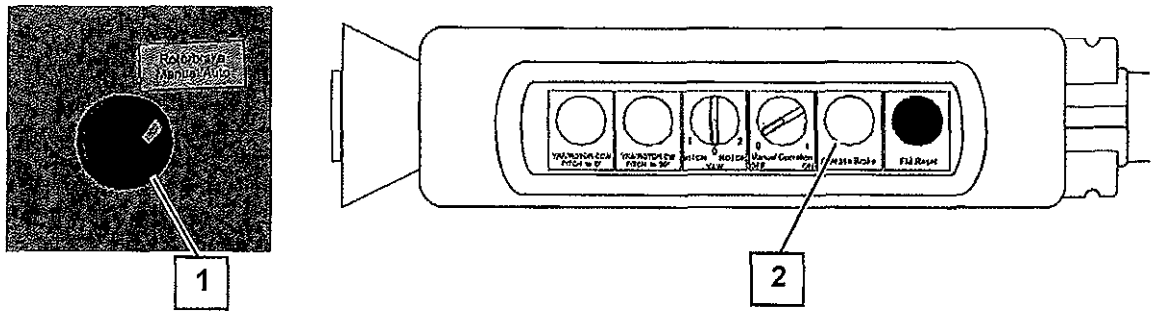

Fig. 17 Operating elements for manual rotor brake operation

1 Rotor brake selector switch on the Topbox
2 *Release brake* button on the manual control unit

Caution: If the green signal lamp in the nacelle is not constantly lit, the operation of the rotor brake may be affected, see "Indicating safety-relevant situations" on page 41 In this case, the responsible employee must decide which work may have to be stopped.

8.10 Emergency lighting

The WT is equipped with battery-powered emergency lighting in the tower and nacelle if the power supply of the WT should fail.

The emergency lighting in the tower switches on automatically after a power supply failure. The lamps flash five times at one-second intervals and then stay on for five minutes. This procedure repeats as long as the emergency lighting is activated. The status of the batteries is monitored with an LED.

The emergency lighting in the nacelle switches on automatically with a maximum delay of 15 seconds and ensures that the WT is lit for at least 30 minutes. This ensures a safe descent from the nacelle.

The emergency lighting in the nacelle can be tested with the button *Test emergency lighting* at the Topbox. The condition of the batteries in the emergency lamps in the nacelle is indicated by an LED on each light. Red means "poor" and green means "OK".

9. Behavior in specific situations

9.1 Grid failure

DANGER

Fall hazard when using the vertical ladder without sufficient lighting

After a grid failure, leave the nacelle immediately and descend to the tower base.

OBSERVE DOCUMENT

Work instructions *F010_002 Wind turbines without grid connection or with locked drive train*

In case of grid failure, the lighting in the WT is automatically switched to emergency lighting. Emergency lighting is ensured for at least 30 minutes.

If there is a grid failure during service work on the WT, and if it cannot be foreseen when the power supply will be restored, proceed as follows:

- Stop all work in the rotor hub and nacelle.
- Proceed as described in the work instructions *F010_002*.
- Descend to the tower base.
- Inform the responsible Remote Monitoring.

9.2 Thunderstorm

DANGER

Life-threatening injuries due to lightning strike

In case of an approaching thunderstorm, leave the WT or do not enter it.

Once the thunderstorm has passed, be aware of crackling noises as you approach the WT, as these are a result of electrostatic charging.

Enter the WT only when these noises have stopped.

A WT is at high risk from lightning strikes.

The WT itself is adequately protected against damage by comprehensive lightning protection measures. However, persons inside or in the proximity of a WT are still at risk.

- Stop all work in the rotor hub and nacelle.
- Descend to the tower base.
- Leave and lock the WT.

- Leave the wind farm.
- Wait in a vehicle at a safe distance from the WT – approx. 1 km – until the thunderstorm has passed.
- Wait one hour after the thunderstorm has passed before entering the WT.

9.3 Fire

⚠ DANGER

Life-threatening injuries due to falling turbine parts

In case of a fire in the tower, in the nacelle or on the rotor, parts may fall off the WT.

Keep a safety distance of 500 m around the WT.

Do not enter the WT.

⚠ DANGER

Risk of death when using the service lift in case of fire

Do not use the service lift in the event of a fire in the WT.

NOTE

The WT is equipped with fire extinguishers for fighting incipient fires.

At least one fire extinguisher is located in the tower base near the door and another in the nacelle near the Topbox.

This makes it possible to extinguish burning solids and liquids, as well as fires in electrical systems of up to 1000 V.

These fire extinguishers are not suitable for extinguishing a fire on the high-voltage elements, see chapter 9.3.2 "Fire in the nacelle".

9.3.1 Fire in the WT

- Remove any persons from the danger area.
- The burning object must be disconnected from the grid, if possible.

[redacted]

- Call the Nordex emergency phone number and describe the situation.

9.3.2 Fire in the nacelle

DANGER

Risk of death from incorrect attempts to extinguish fires

Parts of the converter and the MV transformer are under high voltage.

Where possible CO_2 extinguishers should be used with an adequate safety distance (3 m for up to 30 kV).

The use of powder extinguishers near high voltage equipment should be avoided.

- Vacate the danger area immediately.
- Immediately disconnect the WT from the grid (if possible safely).
  |In the nacelle the medium voltage isolator at the chain box of the electric chain hoist may be used for this purpose.
- If this is not possible, inform the responsible power utility that the WT is to be disconnected from the grid.
- Evacuate the WT.
- Call the fire department.
- Call the Nordex emergency phone number and describe the situation.

9.4 Accident

- Remain calm.
- Take care of your own safety.
- Take action to prevent further casualties.
- Rescue casualties from the danger area.
- Perform first-aid.
- The rescue service must be informed.
- Call the Nordex emergency phone number and describe the situation.

Electrical accidents

- Immediately disconnect the voltage in the WT.
  Note: If this is not possible, the power utility must be informed to disconnect the WT.
- Only use non-conductive devices for any rescue attempts.
- Continuously check the consciousness and breathing (circulation) of casualties.
- Always seek medical treatment, even after minor electrical accidents.

9.5 Oil spill

WARNING

Injuries due to slipping on oil-polluted surfaces

Move particularly carefully and, where possible, avoid stepping on oil-polluted surfaces.

- Stop the WT.
- Inform the responsible Remote Monitoring.

Further measures, to be carried out by service employees only

- Locate the leak.
- Where possible, seal the leaks or redirect the flow of oil.
- Professionally remove any escaped oil.
- Replace damaged parts.
- Remove any contamination.
- If oil has penetrated into the soil, inform the responsible local authorities and agree further measures with them.

9.6 Earthquake

If the WT is located in an area with earthquake hazard, the following rules of conduct must be observed.

Earthquakes during work on the WT

- Immediately leave the WT.
- Wait at a safe distance until the end of the earthquake.
- Do not re-enter the WT until it has been checked for damage and no safety risk has been identified.

After an earthquake

- Stop the WT.
- Check the WT, particularly the tower and foundation, for external damage.
- Inform the responsible remote monitoring, and agree further procedure with them.

9.7 Leaving the nacelle in hazardous situations

There are various escape routes out of the nacelle:

- Descending inside the tower via the vertical ladder
  Warning: Do not use the service lift during a fire or an earthquake.
- Descending from the nacelle roof
- Descending directly from the nacelle
- Descending from the rotor hub

These been described in the escape and rescue plan. The rescue and evacuation plan is located in the tower base and in the nacelle of the WT.

A rescue concept for leaving the nacelle and for rescuing casualties in hazardous situations was developed for Nordex employees. If not already required by law, the owner/operator of the WT should develop a specific safety concept for themselves and any accompanying person in the WT, which is used particularly in cases of emergencies.

Thus, the following chapters give only some turbine-specific information on descending from the nacelle.

⚠ DANGER

Risk of life-threatening injuries from rotating rotor

Before descending, ensure that the rotor and yaw system have been locked.

9.7.1 Descending directly from the nacelle

Descending directly from the nacelle is done through the transport hatch in the nacelle rear.

⚠ DANGER

Fall hazard during descender attachment

Secure yourself to a personal attachment point near the transport hatch before attaching the descender.

Attach the descender or descent rope to a PAP above the crane hatch.

The hatch of the nacelle housing below the transport hatch is opened with the pull mechanism. To this end the railing must be closed at both ends.

9.7.2 Descending from the nacelle roof

⚠ DANGER

Fall hazard while staying on the nacelle roof

Immediately secure yourself to one of the personal attachment points after stepping onto the roof.

WARNING

Risk of injury from lightning rods

There are lightning rods on the exterior of the nacelle. Avoid these areas during descending.

The descender or descent rope can be attached directly to one of the personal attachment points on the roof with the snap hook.

Use the L-shaped edge protection from the rappelling equipment to protect the nacelle housing from the running rope. Secure the edge protection against falling down with the safety rope in a suitable location.

Fig. 18 L-shaped edge protection

9.7.3 Descending from the rotor hub

Attach the rappelling device and descender or descent rope to a personal attachment point above the rescue hatch, above the head where possible.

To open the rescue hatch, loosen the six clamping nuts by hand.

Use the U-shaped edge protection from the rappelling equipment to protect the cable if the cable runs along the spinner. Secure the edge protection against falling down with the safety rope in a suitable location.

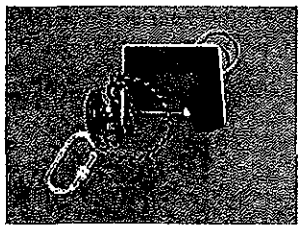

Fig. 19 U-shaped edge protection

9.7.4 Descending a casualty from the nacelle

During descent of a casualty, please observe the following instructions:

- Always call for external help such as an ambulance or emergency services via the respective emergency number.

- Descend the casualty with the rescue devices that are available on the WT only if the person can be transported whilst hanging in the safety harness. This means that the person has not suffered any serious injuries (e.g. on head or spine) or any internal injuries.

  Otherwise, a high altitude rescue team must be called who is able to transport the casualty in a lying position.

- If conscious, ask the casualty to move the legs during descent (if possible) in order to maintain blood circulation and to prevent a suspension trauma.

- Symptoms of a suspension trauma are:
  - *Numbness of the legs, similar to feet that "fell asleep"*
  - Pallor, sweating, shortness of breath
  - Dizziness, blurred vision and restriction of the blood circulation, eventually leading to fainting

- If a suspension trauma is suspected, place the casualty into a sitting position, see Fig. 20, or – if unconscious – into recovery position with extremely bent legs. Loosen the safety harness at the chest, open the leg straps only slowly.

⚠ DANGER

Risk of death from suspension trauma

Do not place the casualty in shock position if a suspension trauma is suspected.

Fig. 20 Casualty in a sitting position

- After approx. 20 minutes, slowly stretch the casualty's legs and, if possible, place him/her in a horizontal position.

- Transfer the casualty to the ambulance for medical care.

- Inform the ambulance explicitly about the suspected suspension trauma.

10. Ascending inside the tower

⚠ WARNING

Ascending into the nacelle is permitted only if the following conditions are met:

- 10-minute average wind speeds up to 20 m/s
- A second person is present

10.1 Preparing for the ascent

⚠ DANGER

Fall hazard from a faulty PFPE

A PFPE either with an invalid inspection label/inspection record, or which has been damaged or strained by a fall, must no longer be used.

Immediately replace the PFPE and have it checked by a qualified person.

- Inform the responsible Remote Monitoring about the intended ascent.
- Stop the WT.
- Disable remote access to the WT.

  Note: For this, switch the operation mode selector switch on the Bottombox to *Local mode* or to *WTG stop and lock*, see also the turbine's operating instructions.
- Test the emergency lighting in the tower.

  If two consecutive emergency lamps are defective these must be repaired before ascending into the nacelle.
- Remove any loose objects from pockets and clothing and leave them behind in the tower base or secure them from falling down during the ascent.
- Ensure that the inspection labels or records of the PFPE are valid and the PFPE has not been damaged.
- Put on the safety harness as described under "Safety equipment", see chapter 7.1.3 "Handling the safety harness".
- Visually inspect the vertical ladder and fall protection system, ensure that there is no visible damage and check that the inspection label/inspection record is valid.
- Thoroughly remove any contamination on the fall arrest system, especially oil and lubricant.
- If the inspection label/inspection record of the vertical ladder has expired or damage is visible, block the vertical ladder from any use.

DANGER

Fall hazard

Vertical ladders with invalid inspection label, invalid inspection record or visible damage must not be used.

- Owner/operator:
  - Have a qualified person rectify any damage to the vertical ladder and release the vertical ladder.

  Service employees:
  - Cancel the maintenance.
  - Inform the owner/operator.

10.2 Using the vertical ladder

DANGER

Hazard of falling from the vertical ladder in the case that the service lift is used at the same time

If a service lift is available it must always be used for ascending and descending the tower. Use the vertical ladder only if the service lift is not in operation.

10.2.1 Using the vertical ladder with a fall arrest system

DANGER

Fall hazard due to unsecured use of the vertical ladder

The vertical ladder must be used only while wearing the PFPE, while secured with the fall arrester permitted for the respective fall arrest system, and while carrying the lanyard with energy absorber.

DANGER

Fall hazard resulting from overload on the fall arrest system

Note that the number of persons allowed to use the vertical ladder at the same time may be restricted. Refer to the user manual.

DANGER

Fall hazard due to incorrect use of the vertical ladder

Do not allow your full body weight to rest in the fall arrester during the ascent. Always have at least three points in contact with the vertical ladder: two feet and one hand or two hands and one foot.

NOTE

- Wear safety gloves during the ascent.
- Always access platforms from the left side of the vertical ladder. A personal attachment point is located only here.
- The vertical ladder has a foldable rest platform about every 9 m.

- Attach the fall arrester approved for the respective fall arrest system to the front fall-arrest eyelet and secure it.
- Attach the fall arrester to the fall arrest system, see "Attaching the fall arrester" on page 37.
- Check whether the fall arrester works properly.
- Check the personal protective equipment for correct fit and perform a suspension test.
- Make sure that there is no other person on the vertical ladder in the section up to the next platform.

  Otherwise, wait until the other person has reached the next platform.
- Start the ascent.
- During the ascent, keep checking regularly if the vertical ladder and the fall arrest system are fully functional and do not show any signs of damage or contamination.

DANGER

Fall hazard due to unsecured leaving of the vertical ladder

Before detaching the fall arrester from the fall arrest rail, always attach the lanyard with fall arrester to a suitable attachment point. Before releasing the energy absorber secure yourself to a personal attachment point of the tower platform.

10.2.2 Using the vertical ladder without fall arrest system

DANGER

Fall hazard due to unsecured use of the vertical ladder

If the fall arrest system is not available, use a lanyard with energy absorber for securing.

Attach the lanyard to the ladder upright. Solely the ladder rungs are not suitable as attachment point.

If the vertical ladder must be used without the fall arrest system being available (e.g. during erection), the persons using the vertical ladder must be secured using the lanyard with energy absorber of the PFPE.

Proceed as follows:

- Start the ascent.
- At a height of about 1 m, connect one end of the lanyard with energy absorber to a ladder upright as high as possible.
- Only climb the vertical ladder so far that you can still reach the first snap hook of the lanyard.
- Attach the second snap hook of the lanyard as high as possible on the vertical ladder upright.
- Release the first snap hook of the lanyard.
- Move further up the vertical ladder, as described, and always secure yourself with at least one of the two lanyard snap hooks.

10.2.3 Leaving the vertical ladder

DANGER

Fall hazard due to unsecured leaving of the vertical ladder

To access a platform from the vertical ladder, always step off the vertical ladder to the left. A personal attachment point is available only on this side.

- Before leaving the vertical ladder, attach the lanyard with the energy absorber to the personal attachment point on the left at the tower wall.
- *Remove the fall protection from the vertical ladder.*

  If using a fall arrester, remove it from the rail and take it along.
- Step off the vertical ladder to the left-hand side, onto the platform.

10.3 Using the service lift

DANGER

Risk of death from a service lift fall

Do not use the service lift in case of technical defects.

Before using the service lift for transporting persons or material, ensure the following:

- The service lift has been fully commissioned.
- The authorized inspection agency has approved the lift for the particular country. This also applies for the erection of the WT.
- All required service lift maintenance tasks were completed on schedule and documented.
- The included logbook is reviewed and updated.

DANGER

Risk of death when using the service lift in case of fire

Do not use the service lift in the event of a fire in the WT.

DANGER

Hazard of falling from the vertical ladder in the case that the service lift is used at the same time

If a service lift is available it must always be used for ascending and descending the tower. Use the vertical ladder only if the service lift is out of order.

DANGER

Fall hazard due to unsecured use of the service lift

In the service lift cage, always secure yourself by attaching the lanyard with energy absorber to one of the personal attachment points.

WARNING

Functional failure in heavy frost

The service lift is approved for temperatures down to -20 °C and -35 °C (CCV).

WARNING

Injuries and damage to components due to incorrect operation

The service lift must be used only by persons who have successfully completed the manufacturer's training on *service lift operation.*

Always operate the service lift together with a second person or ensure that there is a person with a descender above the service lift, to carry out any necessary rescue operations.

NOTICE

Damage to components due to objects in the operating area of the service lift

Before and while using the service lift, always ensure that the operating area of the service lift is clear.

To use the service lift, proceed as follows:

- If not already done, perform and document the daily checks of the service lift.
  Note: The inspection plan and report are in the service lift.
- Check the support structure of the lift cabin for damage.
- If irregularities were detected during the above checks.
  - Immediately block the service lift from use.
  - **Service employees:** Prepare a non-conformity report.
    Customer: Inform the wind farm management. Indicate the serial number of the service lift.
- Before using the service lift, familiarize yourself once more with its operation, particularly in the event of a fault, using the operating instructions that are provided on site.
- If the service lift is found correct enter the lift cage. Take along a fall arrester that is approved for the respective fall arrest system of the vertical ladder.
- Attach the lanyard with energy absorber to one of the personal attachment points in the service lift cage.
- Start the service lift.

10.4 Entering the nacelle

The service lift and vertical ladder end at the tower platform below the top tower platform, on the lift platform. The top tower platform can be reached by climbing another short vertical ladder.

- When the service lift reaches the *service lift platform*, open the door and attach yourself to the personal attachment point at the tower wall.

- Release yourself from the personal attachment point in the service lift and then open the railing door.
- Exit the service lift.
- Climb the vertical ladder to the top tower platform with the aid of the fall arrest system.

  For using the vertical ladder with fall arrest system see "Using the vertical ladder" on page 54.
- Secure yourself to the personal attachment point (PAP) near the hatch and release the fall arrester from the fall arrest system.
- Exit the vertical ladder.
- Close the hatch.
- Release yourself from the PAP.
- Ascend into the nacelle.

11. Revision index

Rev.	Date	Reason for revision	AST	Author
[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	[redacted]	[redacted]		[redacted]

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Release Page:

Document title:	**Rules of conduct on, in and around wind turbines**

[redacted]

This page is part of the document Rules of conduct on, in and around wind turbines, Rev. 1/2018-08-20 with 63 pages.
Document has been electronically created and released.

Developer Package SG 4.5-145

Application of the Developer Package
The Developer Package serves the purpose of informing customers about the latest planned product development from Siemens Gamesa Renewable Energy (SGRE). By sharing information about coming developments, SGRE can ensure that customers are provided with necessary information to make decisions.

Furthermore, the Developer Package can assist in guiding prospective customers with the indicated technical footprint of the SG 4.5-145 in cases where financial institutes, governing bodies, or permitting entities require product specific information in their decision processes.

All technical data contained in the Developer Package is subject to change owing to ongoing technical developments. Information contained within the Developer Package may not be treated separately or out of the context of the Developer Package.

The information contained in the Developer Package may not be used as legally binding documentation and cannot be used in contracts between SGRE and any other parties. This Developer Package contains preliminary technical data on SGRE turbines currently under development and can be used in an indicative capacity only.

All technical data is subject to change according to the technical development of the wind turbine.

SGRE and its affiliates reserve the right to change the below specifications without prior notice.

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Developer Package
SG 4.5-145

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Introduction

The SG 4.5-145 is the first wind turbine of the new Siemens Gamesa 4.X Platform, the next generation Siemens Gamesa Onshore Geared product series, which builds on the Siemens & Gamesa design and operational experience in the wind energy market.

With a brand new 71m blade, a 4.5 MW generator and a tower portfolio with hub heights ranging from 107.5m to 157.5m, the SG 4.5-145 aims at becoming a new benchmark in the market for efficiency and profitability.

This Developer Package describes the turbine technical specifications and provides preliminary information for the main components and subsystems.

For further information, please contact your regional SGRE Sales Manager.

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Technical Description

Rotor-Nacelle
The rotor is a three-bladed construction, mounted upwind of the tower. The power output is controlled by pitch and torque demand regulation. The rotor speed is variable and is designed to maximize the power output while maintaining loads and noise level.

The nacelle has been designed for safe access to all service points during scheduled service. In addition the nacelle has been designed for safe presence of service technicians in the nacelle during Service Test Runs with the wind turbine in full operation. This allows a high quality service of the wind turbine and provides optimum troubleshooting conditions.

Blades
The SG 4.5–145 Siemens Gamesa blade is made up of fiberglass infusion-molded components. The blade structure uses aerodynamic shells containing embedded spar-caps, bonded to two main epoxy-fiberglass-balsa/foam-core shear webs. The SG 4.5–145 SGRE blade uses a blade design based on SGRE proprietary airfoils.

Rotor Hub
The rotor hub is cast in nodular cast iron and is fitted to the drive train low speed shaft with a flange connection. The hub is sufficiently large to provide room for service technicians during maintenance of blade roots and pitch bearings from inside the structure.

Drive train
The drive train is a 4-points suspension concept: main shaft with two main bearings and the gearbox with two torque arms assembled to the main frame.
The gearbox is in cantilever position; the gearbox planet carrier is assembled to the main shaft by means of a flange bolted joint and supports the gearbox.

Main Shaft
A forged main shaft ensures a comfortable access from the nacelle cover to the hub.

Main Bearings
The low speed shaft of the wind turbine is supported by two spherical roller bearings. The bearings are grease lubricated.

Gearbox
The gearbox is 3 stages high speed type (2 planetary + 1 parallel).

Generator
The generator is a doubly-fed asynchronous three phase generator with a wound rotor, connected to a frequency PWM converter. Generator stator and rotor are both made of stacked magnetic laminations and formed windings. Generator is cooled by air which is cooled with a liquid/air cooling system.

Mechanical Brake
The mechanical brake is fitted to the non-drive end of the gearbox.

Yaw System
A cast bed frame connects the drive train to the tower. The yaw bearing is an externally geared ring with a friction and sliding plain bearing. A series of electric planetary gear motors drives the yawing.

Nacelle Cover
The weather screen and housing around the machinery in the nacelle is made of fiberglass-reinforced laminated panels.

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Tower
The wind turbine is as standard mounted on a tapered tubular steel tower. Other tower technologies will be available for higher hub heights. The tower has internal ascent and direct access to the yaw system and nacelle. It is equipped with platforms and internal electric lighting.

Controller
The wind turbine controller is a microprocessor-based industrial controller. The controller is complete with switchgear and protection devices. It is self-diagnosing and has a touch panel and display for easy readout of status and for adjustment of settings.

Converter
Connected directly with the Rotor, the Frequency Converter is a back to back 4Q conversion system with 2 VSC in a common DC-link. The Frequency Converter allows generator operation at variable speed and voltage, while supplying power at constant frequency and voltage to the MV transformer. The power conversion system is water cooled and has a modular arrangement for easy maintenance.

SCADA
The wind turbine provides connection to the SGRE SCADA system. This system offers remote control and a variety of status views and useful reports from a standard internet web browser. The status views present information including electrical and mechanical data, operation and fault status, meteorological data and grid station data.

Turbine Condition Monitoring
In addition to the SGRE SCADA system, the wind turbine is equipped with the unique SGRE condition monitoring setup. This system monitors the vibration level of the main components and compares the actual vibration spectra with a set of established reference spectra. Review of results, detailed analysis and reprogramming can all be carried out using a standard web browser.

Operation Systems
The wind turbine operates automatically. It is self-starting when the aerodynamic torque is enough. Below rated wind speed, the wind turbine controller fixes the pitch and torque references for operating in the optimum aerodynamic point (maximum production) taking into account the generator capability. Once rated wind speed is surpassed, the pitch position demand is adjusted to keep a stable power production equal to the nominal value. If high wind derated mode is enabled, the power production is limited once the wind speed exceeds a threshold value defined by design, until cut-out wind speed is reached and the wind turbine stops producing power. If the average wind speed exceeds the maximum operational limit, the wind turbine is shut down by pitching of the blades. When the average wind speed drops back below the restart average wind speed, the systems reset automatically.

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Technical Specifications

[redacted]

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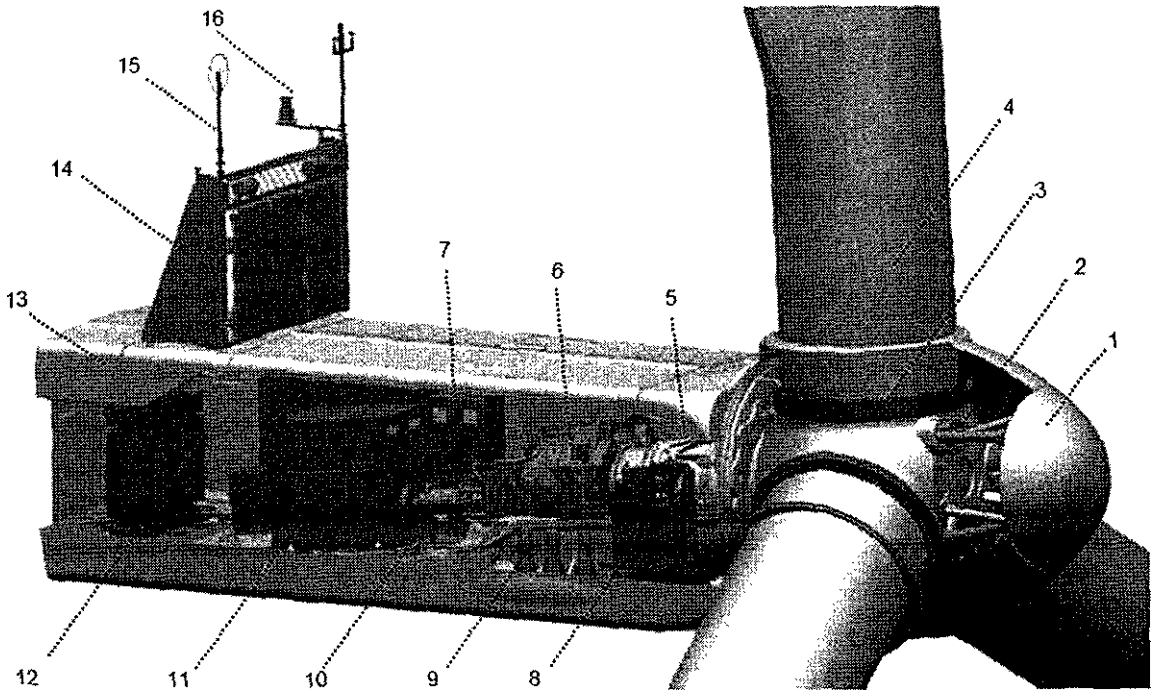
Nacelle Arrangement

The design and layout of the nacelle are preliminary and may be subject to changes during the development of the product.



1	Rotor cover	**9**	Yaw system
2	Pitch system	**10**	High speed shaft
3	Blade bearings	**11**	Generator
4	Blades	**12**	Transformer
5	Low speed shaft	**13**	Nacelle cover
6	Gearbox	**14**	Cooling system
7	Electrical cabinets	**15**	Wind sensors
8	Hydraulic group	**16**	Beacon system

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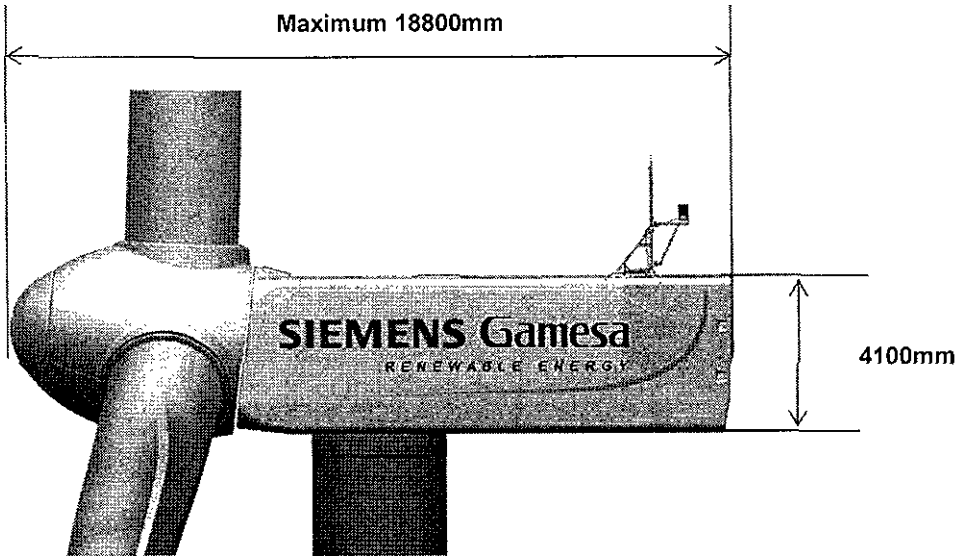
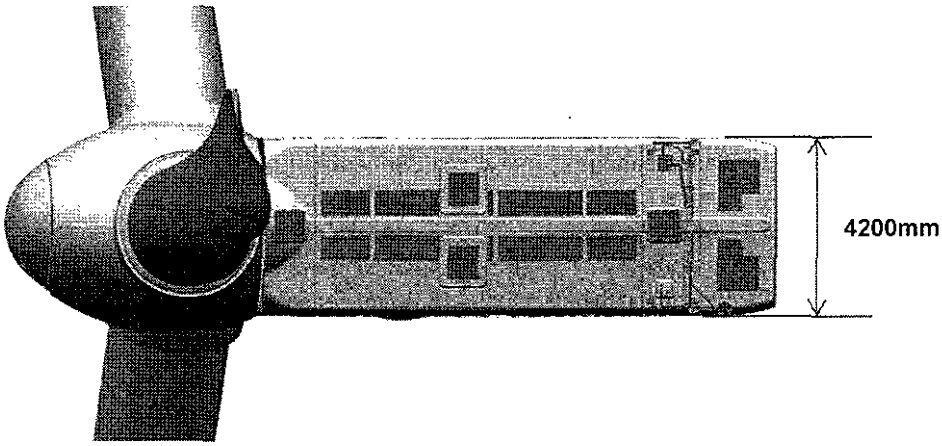
Nacelle Dimensions

The design and dimensions of the nacelle are preliminary and may be subject to changes during the development phases of the product.





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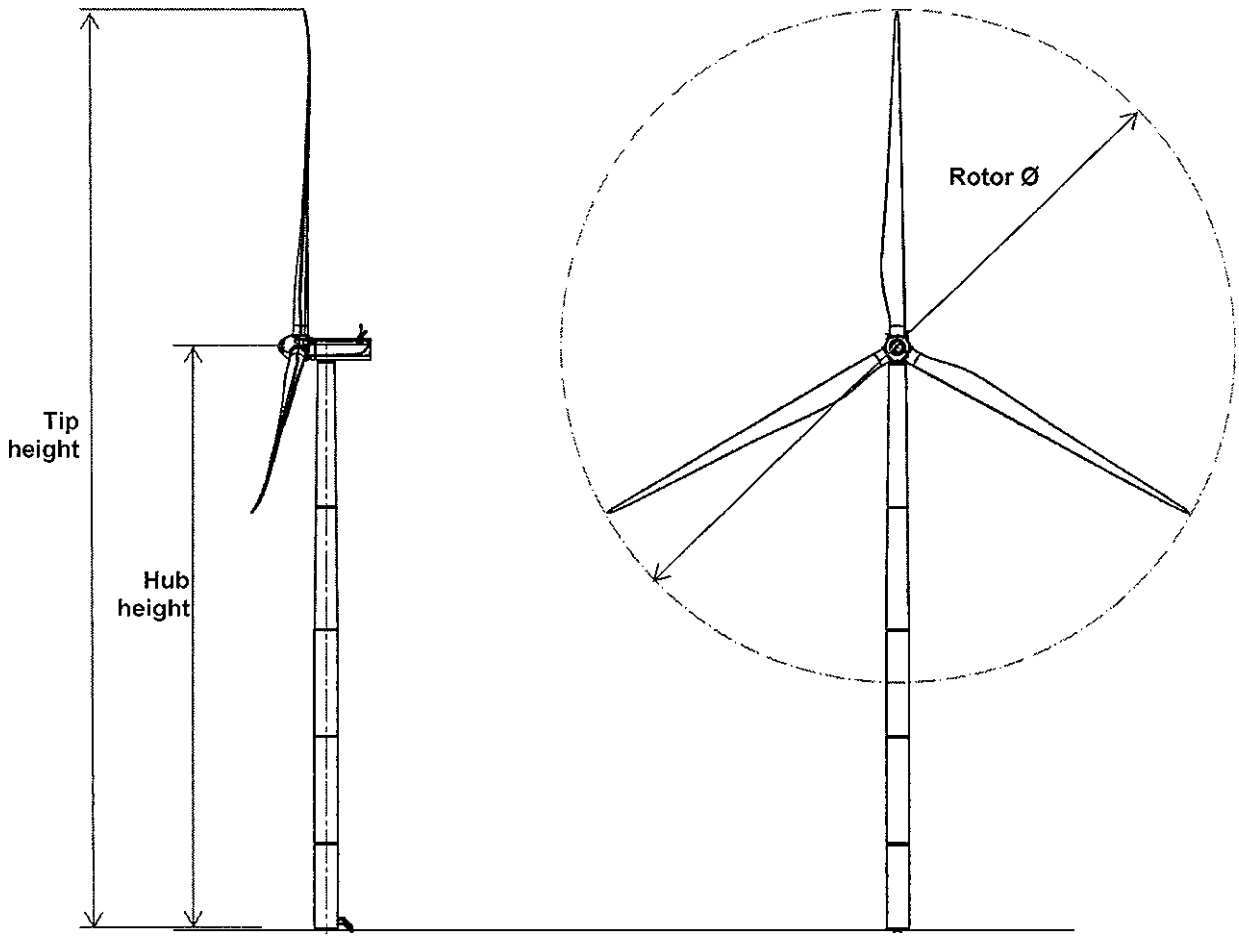
Elevation Drawing



Tip height	180m, 200m, 230m
Hub height	107.5m, 127.5m, 157.5m
Rotor diameter	145m

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[redacted]

[redacted]

Dimensions in millimeters.

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Design Climatic Conditions

The design climatic conditions are the boundary conditions at which the turbine can be applied without supplementary design review. Applications of the wind turbine in more severe conditions may be possible, depending upon the overall circumstances. A project site-specific review requires the completion by the Client of the "Project Climatic Conditions" form.

[redacted]

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[redacted]

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Standard Power Curve, Standard power operational mode

[redacted]

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[redacted]

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Standard Ct Curve, Standard power operational mode

[redacted]

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Power Curve, Air density, Standard power operational mode

[redacted]

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[redacted]

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Ct Curve, Air Density, Standard power operational mode

[redacted]

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Standard Acoustic Emission

Noise Level (LW): Values reported correspond to the average estimated Sound Power Level emitted by the WTG at hub height, called LW in TS IEC-61400-14. LW values are expressed in dB(A). To obtain LWd value, as defined in IEC-61400-14, it must be applied a 2 dB increase to LW.

dB(A): LW is expressed in decibels applying the "A" filter as required by IEC.

Noise generated at standard power operation mode LW is **107.8 dB(A).**

Noise values included in the present document correspond to the wind turbine configuration equipped with noise reduction add-ons attached to the blade.

SG 4.5-145	
Wind Speed [m/s]	LW [dB(A)]
3	95.1
3.5	95.1
4	95.1
4.5	95.1
5	95.5
5.5	97.6
6	99.7
6.5	101.5
7	103.2
7.5	104.7
8	106.2
8.5	107.6
9	107.8
9.5	107.8
10	107.8
10.5	107.8
11	107.8
11.5	107.8
12	107.8
12.5	107.8
13	107.8
13.5	107.8
14	107.8
14.5	107.8
15	107.8

Noise values included in the present document correspond to the wind turbine configuration equipped with noise reduction add-ons attached to the blade.

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Noise Reduction System (NRS) operational modes

[redacted]

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[redacted]

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[redacted]

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[redacted]

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[redacted]

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Electrical Specifications

[redacted]

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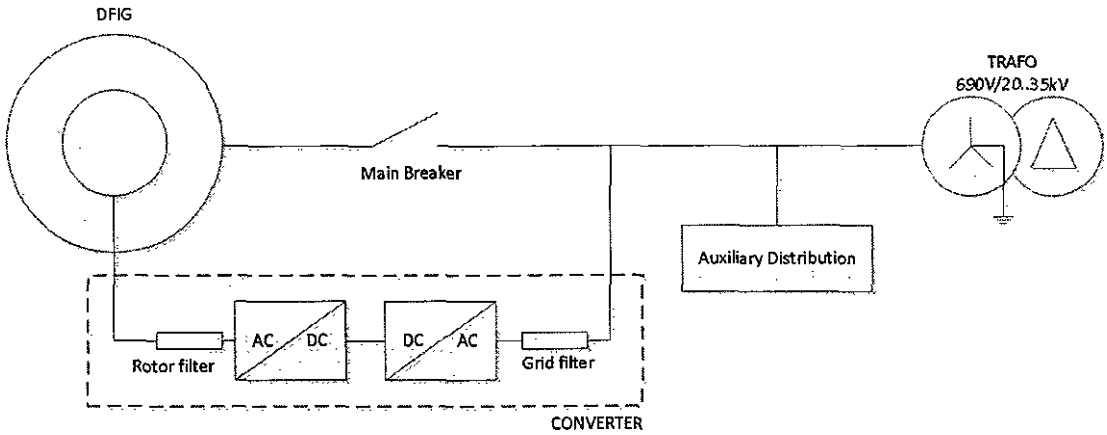
Simplified Single Line Diagram



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Transformer Specifications ECO 30 kV*

[redacted]

Transformer Specifications 34.5 kV*

[redacted]

All data are subject to tolerances in accordance with IEC.
***Example for an ECO 30kV and 34.5kV transformers. For other Medium Voltage transformers, consult with SGRE**

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Switchgear Specifications

The installation of a switchgear is an option available upon request. The minimum requirements that must be compliance, from the point of view of electrical protection, are:

Switchgear Specification (38 kV)

[redacted]

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Preliminary Foundation Loads

[redacted]

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Tower Dimensions

[redacted]

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Estimated Foundation Design

[redacted]

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Codes and Standards For Design, Manufacturing, and Testing

The wind turbine is designed, manufactured, and tested to Siemens Gamesa Renewable Energy's technical drawings, procedures, and processes that are generally in compliance with the applicable sections of the codes and standards listed herein. This list of codes and standards for design, manufacturing, and testing forms a part of the design basis documentation for the certification of the wind turbine. The edition of the codes and standards is the version used for the certification process which was conducted by an external certifying body.

General

- IEC 61400-22:2010 Ed.1, Wind turbines – Part 22: Conformity testing and certification
- EN 61400-1:2006, Wind turbine generator systems, Part 1: Safety requirements, (IEC 61400-1:2005, modified).
- IEC 61400-1:2005 Ed.3, incl. Amendment. Wind turbine generator systems, Part 1: Safety requirements.
- DIBt – Richtlinie für Windenergieanlagen – Fassung September 2013.
- IEC 61400-11:2012 ed.3: Wind turbine generator systems. Part 11: Acoustic noise measurement techniques.
- IEC 61400-12:2005, Wind turbine generator systems. Part 12: Wind turbines power performance testing.
- IEC/TS 61400-13 Ed.1, Wind turbine generator systems, Part 13: Measurement of mechanical loads.
- IEC/TS 61400-23:2001, Wind turbine generator systems, Part 23: Full-scale structural testing of rotor blades.
- VDI 2230 Blatt 1, February 2003, Systematic calculation of high duty bolted joints – Joints with one cylindrical bolt (Bolt calculations)
- EN ISO 898-1(2009-08), Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.
- EN 10029:2010, Hot rolled steel plates 3 mm thick or above – Tolerances on dimensions, shape and mass
- EN 10083:2006, Quenched and tempered steels – Part 1: Technical delivery conditions for special steels (Main shaft)
- EN 1563 +A1:2004, Founding – Spheroidal graphite cast irons
- EN 10025-1:2004, Hot rolled products of structural steels – Part 1: General technical delivery conditions
- EN 10025-2:2004, Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels
- EN 10025-3:2004, Hot rolled products of structural steels – Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
- 97/23/EC Pressure Equipment Directive
- EN 1993 – Design of steel structures
- EN 1999 – Design of aluminum structures
- ISO/TS 16281:2008 Rolling bearings – Methods for calculating the modified reference rating life for universally loaded bearings
- DIN ISO 281 Rolling bearings - Dynamic load ratings and rating life
- DIN ISO 76:2006 Rolling bearings - Static load ratings
- ISO/TS 16281:2008 + Cor. 1:2009 Rolling bearings - Methods for calculating the modified reference rating life for universally loaded bearings
- DNV-DS-J102:2010, Design and Manufacture of Wind Turbine Blades, Offshore and Onshore Wind Turbines

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Electrical

- *EN 61000-6-2:2005 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for*
- industrial environments
- EN 61000-6-4:2007 Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
- *EN 60204-1:2006 Safety of machinery – Electrical equipment of machines – Part 1: General* requirements
- IEC 61400-24:2010, Wind turbine generator systems – Part 24: Lightning protection
- DS/EN 60076–16:2012 - Power transformers – Part 16: Transformers for wind turbine applications
- *IEC 61400-21:2008, Wind turbine generator systems – Part 21: Measurement and assessment of power* quality characteristics of grid connected wind turbines
- Directive 2014/35/EU on Electrical Low Voltage Equipment (LV)
- Directive 2014/30/EU on Electromagnetic Compatibility (EMC)

Quality

- ISO 9001:2015, Quality management systems – Requirements.

Personal Safety

- OSHA 2005 Requirements for clearances at doorways, hatches, and caged.
    - OSHA's Subpart D Walking-Working Surfaces Section 1910.27v
- 2006/42/EC Machinery Directive

Corrosion

- DS/EN ISO 12944-1:2000, Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 1: General introduction (class C3 to C4).

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[redacted]

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LR 3A

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC, for a Certificate to Site Wind-Powered Electric Generation Facilities in Seneca and Sandusky Counties, Ohio.	)))))	Case No. 17-2295-EL-BGN

REPUBLIC WIND, LLC'S AMENDED RESPONSES TO LOCAL RESIDENTS' THIRD SET OF INTERROGATORIES AND REQUESTS FOR PRODUCTION OF DOCUMENTS

Republic Wind, LLC ("Republic Wind") submits the following amended responses to the Intervening Local Residents (the "Local Residents") third set of interrogatories and requests for production of documents. These responses amend certain responses initially produced on October 28, 2019. These responses reflect Republic Wind's present knowledge of the matters covered by the discovery requests and its best efforts to respond thereto. Republic Wind's efforts, however, are continuing, and it reserves the right to amend and/or supplement the responses contained herein as may be necessary or appropriate in the future.

GENERAL OBJECTIONS AND RESERVATIONS

1. Republic Wind objects to the discovery requests to the extent they require disclosure of information beyond the permissible scope of discovery. Republic Wind's responses and any identification of documents included in said responses shall not waive or prejudice any objection Republic Wind may later assert, including, but not limited to, objections to the admissibility of any of the answers or responses hereto, or to the admissibility of documents or categories of documents at trial.

2. Republic Wind objects to each request and part thereof to the extent that they call for information protected by: (a) the attorney-client privilege; (b) the attorney work product

doctrine; (c) any privilege relating to confidential trade secrets or confidential communications; (d) the right of privacy; or (e) any other privilege. Republic Wind reserves the right to redact from

the documents it produces or information it provides any confidential or proprietary business information or trade secrets not relevant to the subject matter of this proceeding. Any inadvertent identification subject to such privilege shall not waive those privileges.

3. Republic Wind objects to the discovery requests to the extent they are not relevant to the subject matter of this action nor proportional to the needs of the case.

4. Republic Wind objects to the discovery requests to the extent that are not reasonably calculated to lead to the discovery of admissible evidence.

5. Republic Wind does not waive any objection to the admissibility, competency, relevancy, materiality, confidentiality or privilege attaching to any document, communication or information, supplied, nor to the right to object to additional discovery relating to the subject matter of the discovery requests herein.

6. Republic Wind objects to the discovery requests to the extent they request that Republic Wind produce information in the possession and control of individuals or entities over whom Republic Wind has no control or right of control. The following responses are made on behalf of Republic Wind and not on behalf of any other entities or persons.

7. Republic Wind objects to the discovery requests to the extent they request information that is otherwise available through public documents to which the Local Residents have access.

8. Republic Wind reserves the right to object to any additional discovery procedures initiated by the Local Residents and/or to file a Motion for Protective Order to the extent that any

such subsequent discovery proceedings involve the subject matter or substantially the same areas of inquiry covered by these discovery requests.

9. Republic Wind reserves the right to add to, subtract from, or clarify any objections or responses which they give in response to the discovery requests. Republic Wind further notes that investigation of the areas of inquiry touched upon by the discovery requests shall continue through the time of trial, all of which may necessitate further action as described above.

10. Republic Wind objects to all discovery requests that are objectionable as to form.

11. Republic Wind objects to the discovery requests to the extent that they purport to call for information not known to Republic Wind and that is not reasonably ascertainable by Republic Wind.

12. Republic Wind objects to the discovery requests to the extent that they purport to call for legal conclusions or expert opinions or require Republic Wind to perform legal research for the Local Residents.

13. Republic Wind objects to the discovery requests to the extent that they are overly broad, unduly and unreasonably burdensome and oppressive in that the burden of obtaining the information purportedly called for substantially outweighs any probative value to the information it has.

14. Republic Wind objects to the discovery requests to the extent that they purport to call for answers that are dependent in whole or in part on information to be obtained by Republic Wind from the Local Residents or another person in the course of discovery.

15. Republic Wind objects to each of the discovery requests to the extent such are not reasonably limited in scope and time.

16. Republic Wind objects to each discovery request that seeks the production of documents or information that is confidential, proprietary, financially sensitive, or of a confidential nature that outweighs any arguable relevance the information could have to this proceeding.

17. These general objections are incorporated by reference into each specific answer made by Republic Wind to the Local Residents' discovery requests answered below.

INTERROGATORIES

INTERROGATORY 1: Provide the following information with respect to the sound monitoring station designed as the "Busy Roadway" site in the background sound study contained in the Application:

a. The name of all owners of the land on which the monitoring station was placed;

b. The county parcel number for the parcel of land on which the monitoring station was placed;

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: Objection. Republic Wind restates and incorporates herein the foregoing General Objections. Republic Wind also objects to this Request to the extent it seeks information that is protected from discovery by the attorney-client privilege, work-product doctrine, or other applicable privileges or immunities. In addition, the request is vague and ambiguous because it fails to define terms such as "setbacks" and "base of the nearest proposed turbine." As such, it

unclear what information is being sought. Further, Republic Wind objects to requests that would require Republic Wind to perform new studies and conduct additional analysis that has not already been performed in support of the application. Republic Wind objects to this Request to the extent it seeks discovery in a manner or at time inconsistent with applicable rules and orders. Subject to and without waiving its objections, Republic Wind states the following:

a. The name of all owners of the land on which the monitoring station was placed;

ANSWER: Kilbourne Lew Farms LLC ~~Flat Rock Homes~~

Answer by: Isaac Old
Objection by: Counsel

b. The county parcel number for the parcel of land on which the monitoring station was placed;

ANSWER: Parcel No. N46000762320000 ~~N46005766180000~~

Answer by: Isaac Old
Objection by: Counsel

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

ANSWER: Assuming that Republic Wind understands what is meant by "component of the Facility" and assuming that the response herein applies, Republic Wind states that collection (essentially, underground cabling) is sited on Parcel No. N46000762320000.

~~**ANSWER:** No turbine or component Facility, assuming that Republic Wind understands what is meant by "component of the Facility," has been planned to be sited on Parcel No. N46005766180000.~~

Answer by: Dalton Carr
Objection by: Counsel

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

ANSWER: It is unclear what information is being sought in this request. Further, based upon its understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

INTERROGATORY 2: Provide the following information with respect to the sound monitoring station designed as the "Mixed Residential" site in the background sound study contained in the Application:

a. The name of all owners of the land on which the monitoring station was placed;

b. The county parcel number for the parcel of land on which the monitoring station was placed;

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: Objection. Republic Wind restates and incorporates herein the foregoing General Objections. Republic Wind also objects to this Request to the extent it seeks information that is protected from discovery by the attorney-client privilege, work-product doctrine, or other applicable privileges or immunities. In addition, the request is vague and ambiguous because it fails to define terms such as "setbacks" and "base of the nearest proposed turbine." As such, it unclear what information is being sought. Further, Republic Wind objects to requests that would require Republic Wind to perform new studies and conduct additional analysis that has not already been performed in support of the application. Republic Wind objects to this Request to the extent it seeks discovery in a manner or at time inconsistent with applicable rules and orders. Subject to and without waiving its objections, Republic Wind states the following:

a. The name of all owners of the land on which the monitoring station was placed;

ANSWER: Flat Rock Homes ~~Kilbourne Lew Farms LLC~~

Answer by: Isaac Old
Objection by: Counsel

b. The county parcel number for the parcel of land on which the monitoring station was placed;

ANSWER: Parcel No. N46005766180000 ~~N46000762320000~~

Answer by: Isaac Old
Objection by: Counsel

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

~~**ANSWER:** Assuming that Republic Wind understands what is meant by "component of the Facility" and assuming that the response herein applies, Republic Wind states that collection (essentially, underground cabling) is sited on Parcel No. N46000762320000.~~

ANSWER: No turbine or component Facility, assuming that Republic Wind understands what is meant by "component of the Facility," has been planned to be sited on Parcel No. N46005766180000.

Answer by: Dalton Carr
Objection by: Counsel

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

ANSWER: It is unclear what information is being sought in this request. Further, based upon its understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

INTERROGATORY 3: Provide the following information with respect to the sound monitoring station designed as the "North Boundary" site in the background sound study contained in the Application:

a. The name of all owners of the land on which the monitoring station was placed;

b. The county parcel number for the parcel of land on which the monitoring station was placed;

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: Objection. Republic Wind restates and incorporates herein the foregoing General Objections. Republic Wind also objects to this Request to the extent it seeks information that is protected from discovery by the attorney-client privilege, work-product doctrine, or other applicable privileges or immunities. In addition, the request is vague and ambiguous because it fails to define terms such as "setbacks" and "base of the nearest proposed turbine." As such, it unclear what information is being sought. Further, Republic Wind objects to requests that would require Republic Wind to perform new studies and conduct additional analysis that has not already been performed in support of the application. Republic Wind objects to this Request to the extent it seeks discovery in a manner or at time inconsistent with applicable rules and orders. Subject to and without waiving its objections, Republic Wind states the following:

a. The name of all owners of the land on which the monitoring station was placed;

ANSWER: Kuhn Family Farm

Answer by: Isaac Old
Objection by: Counsel

b. The county parcel number for the parcel of land on which the monitoring station was placed;

ANSWER: Parcel No. N46000751520000

Answer by: Isaac Old
Objection by: Counsel

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

ANSWER: No turbine or Facility component, assuming that Republic Wind understands what is meant by "component of the Facility," has been planned to be sited on Parcel No. N46000751520000.

Answer by: Dalton Carr
Objection by: Counsel

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

ANSWER: It is unclear what information is being sought in this request. Further, based upon its understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

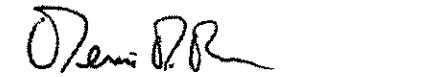
Objection by: Counsel

REQUEST FOR PRODUCTION OF DOCUMENTS: Produce all records that contain the information requested by this set of interrogatories.

ANSWER: Republic Wind is producing, along with these responses, responsive, non-privileged documents, by electronic file.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Response has been served upon the following parties listed below by electronic mail, this ~~3rd~~ 14th day of November 2019.



Devin D. Parram

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tdougherty@theoec.org

dwd@senecapros.org

jodi.bair@ohioattorneygeneral.gov

Dennyh7@frontier.com

mkessler7@gmail.com

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Republic Wind, LLC, for a Certificate to Site Wind-Powered Electric Generation Facilities in Seneca and Sandusky Counties, Ohio.	)))))	Case No. 17-2295-EL-BGN

REPUBLIC WIND, LLC'S AMENDED RESPONSES TO LOCAL RESIDENTS' THIRD SET OF INTERROGATORIES AND REQUESTS FOR PRODUCTION OF DOCUMENTS

Republic Wind, LLC ("Republic Wind") submits the following amended responses to the Intervening Local Residents (the "Local Residents") third set of interrogatories and requests for production of documents. These responses amend certain responses initially produced on October 28, 2019. These responses reflect Republic Wind's present knowledge of the matters covered by the discovery requests and its best efforts to respond thereto. Republic Wind's efforts, however, are continuing, and it reserves the right to amend and/or supplement the responses contained herein as may be necessary or appropriate in the future.

GENERAL OBJECTIONS AND RESERVATIONS

1. Republic Wind objects to the discovery requests to the extent they require disclosure of information beyond the permissible scope of discovery. Republic Wind's responses and any identification of documents included in said responses shall not waive or prejudice any objection Republic Wind may later assert, including, but not limited to, objections to the admissibility of any of the answers or responses hereto, or to the admissibility of documents or categories of documents at trial.

2. Republic Wind objects to each request and part thereof to the extent that they call for information protected by: (a) the attorney-client privilege; (b) the attorney work product

doctrine; (c) any privilege relating to confidential trade secrets or confidential communications; (d) the right of privacy; or (e) any other privilege. Republic Wind reserves the right to redact from

the documents it produces or information it provides any confidential or proprietary business information or trade secrets not relevant to the subject matter of this proceeding. Any inadvertent identification subject to such privilege shall not waive those privileges.

3. Republic Wind objects to the discovery requests to the extent they are not relevant to the subject matter of this action nor proportional to the needs of the case.

4. Republic Wind objects to the discovery requests to the extent that are not reasonably calculated to lead to the discovery of admissible evidence.

5. Republic Wind does not waive any objection to the admissibility, competency, relevancy, materiality, confidentiality or privilege attaching to any document, communication or information, supplied, nor to the right to object to additional discovery relating to the subject matter of the discovery requests herein.

6. Republic Wind objects to the discovery requests to the extent they request that Republic Wind produce information in the possession and control of individuals or entities over whom Republic Wind has no control or right of control. The following responses are made on behalf of Republic Wind and not on behalf of any other entities or persons.

7. Republic Wind objects to the discovery requests to the extent they request information that is otherwise available through public documents to which the Local Residents have access.

8. Republic Wind reserves the right to object to any additional discovery procedures initiated by the Local Residents and/or to file a Motion for Protective Order to the extent that any

such subsequent discovery proceedings involve the subject matter or substantially the same areas of inquiry covered by these discovery requests.

9. Republic Wind reserves the right to add to, subtract from, or clarify any objections or responses which they give in response to the discovery requests. Republic Wind further notes that investigation of the areas of inquiry touched upon by the discovery requests shall continue through the time of trial, all of which may necessitate further action as described above.

10. Republic Wind objects to all discovery requests that are objectionable as to form.

11. Republic Wind objects to the discovery requests to the extent that they purport to call for information not known to Republic Wind and that is not reasonably ascertainable by Republic Wind.

12. Republic Wind objects to the discovery requests to the extent that they purport to call for legal conclusions or expert opinions or require Republic Wind to perform legal research for the Local Residents.

13. Republic Wind objects to the discovery requests to the extent that they are overly broad, unduly and unreasonably burdensome and oppressive in that the burden of obtaining the information purportedly called for substantially outweighs any probative value to the information it has.

14. Republic Wind objects to the discovery requests to the extent that they purport to call for answers that are dependent in whole or in part on information to be obtained by Republic Wind from the Local Residents or another person in the course of discovery.

15. Republic Wind objects to each of the discovery requests to the extent such are not reasonably limited in scope and time.

16. Republic Wind objects to each discovery request that seeks the production of documents or information that is confidential, proprietary, financially sensitive, or of a confidential nature that outweighs any arguable relevance the information could have to this proceeding.

17. These general objections are incorporated by reference into each specific answer made by Republic Wind to the Local Residents' discovery requests answered below.

INTERROGATORIES

INTERROGATORY 1: Provide the following information with respect to the sound monitoring station designed as the "Busy Roadway" site in the background sound study contained in the Application:

a. The name of all owners of the land on which the monitoring station was placed;

b. The county parcel number for the parcel of land on which the monitoring station was placed;

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: Objection. Republic Wind restates and incorporates herein the foregoing General Objections. Republic Wind also objects to this Request to the extent it seeks information that is protected from discovery by the attorney-client privilege, work-product doctrine, or other applicable privileges or immunities. In addition, the request is vague and ambiguous because it fails to define terms such as "setbacks" and "base of the nearest proposed turbine." As such, it

unclear what information is being sought. Further, Republic Wind objects to requests that would require Republic Wind to perform new studies and conduct additional analysis that has not already been performed in support of the application. Republic Wind objects to this Request to the extent it seeks discovery in a manner or at time inconsistent with applicable rules and orders. Subject to and without waiving its objections, Republic Wind states the following:

a. The name of all owners of the land on which the monitoring station was placed;

   ANSWER: *Kilbourne Lew Farms LLC*

   Answer by: Isaac Old
   Objection by: Counsel

b. The county parcel number for the parcel of land on which the monitoring station was placed;

   ANSWER: *Parcel No. N46000762320000*

   Answer by: Isaac Old
   Objection by: Counsel

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

   ANSWER: *Assuming that Republic Wind understands what is meant by* "component of the Facility" and assuming that the response herein applies, Republic Wind states that collection (essentially, underground cabling) is sited on Parcel No. N46000762320000.

   Answer by: Dalton Carr
   Objection by: Counsel

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

   ANSWER: It is unclear what information is being sought in this request. Further, based upon its understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

   Objection by: Counsel

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

INTERROGATORY 2: Provide the following information with respect to the sound monitoring station designed as the "Mixed Residential" site in the background sound study contained in the Application:

a. The name of all owners of the land on which the monitoring station was placed;

b. The county parcel number for the parcel of land on which the monitoring station was placed;

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: Objection. Republic Wind restates and incorporates herein the foregoing General Objections. Republic Wind also objects to this Request to the extent it seeks information that is

protected from discovery by the attorney-client privilege, work-product doctrine, or other applicable privileges or immunities. In addition, the request is vague and ambiguous because it fails to define terms such as "setbacks" and "base of the nearest proposed turbine." As such, it unclear what information is being sought. Further, Republic Wind objects to requests that would require Republic Wind to perform new studies and conduct additional analysis that has not already been performed in support of the application. Republic Wind objects to this Request to the extent it seeks discovery in a manner or at time inconsistent with applicable rules and orders. Subject to and without waiving its objections, Republic Wind states the following:

a. The name of all owners of the land on which the monitoring station was placed;

   ANSWER: Flat Rock Homes

   Answer by: Isaac Old
   Objection by: Counsel

b. The county parcel number for the parcel of land on which the monitoring station was placed;

   ANSWER: Parcel No. N46005766180000

   Answer by: Isaac Old
   Objection by: Counsel

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

   ANSWER: No turbine or component Facility, assuming that Republic Wind understands what is meant by "component of the Facility," has been planned to be sited on Parcel No. N46005766180000.

   Answer by: Dalton Carr
   Objection by: Counsel

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

   ANSWER: It is unclear what information is being sought in this request. Further, based upon its understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

   Objection by: Counsel

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Objection by: Counsel

f. The distance between the microphone of the monitoring station and the proposed location for the base of the ncarest proposed turbine in the Republic Facility.

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

INTERROGATORY 3: Provide the following information with respect to the sound monitoring station designed as the "North Boundary" site in the background sound study contained in the Application:

a. The name of all owners of the land on which the monitoring station was placed;

b. The county parcel number for the parcel of land on which the monitoring station was placed;

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: **Objection.** Republic Wind restates and incorporates herein the foregoing General Objections. Republic Wind also objects to this Request to the extent it seeks information that is protected from discovery by the attorney-client privilege, work-product doctrine, or other applicable privileges or immunities. In addition, the request is vague and ambiguous because it fails to define terms such as "setbacks" and "base of the nearest proposed turbine." As such, it unclear what information is being sought. Further, Republic Wind objects to requests that would require Republic Wind to perform new studies and conduct additional analysis that has not already been performed in support of the application. Republic Wind objects to this Request to the extent it seeks discovery in a manner or at time inconsistent with applicable rules and orders. Subject to and without waiving its objections, Republic Wind states the following:

a. The name of all owners of the land on which the monitoring station was placed;

   ANSWER: Kuhn Family Farm

   Answer by: Isaac Old
   Objection by: Counsel

b. The county parcel number for the parcel of land on which the monitoring station was placed;

   ANSWER: Parcel No. N46000751520000

   Answer by: Isaac Old
   Objection by: Counsel

c. State whether or not a turbine or any other component of the Facility is proposed by the Application to be placed on that parcel of land;

   ANSWER: No turbine or Facility component, assuming that Republic Wind understands what is meant by "component of the Facility," has been planned to be sited on Parcel No. N46000751520000.

   Answer by: Dalton Carr
   Objection by: Counsel

d. State whether or not the location on which the microphone of the monitoring station was placed is located within any setback for the Facility;

   ANSWER: It is unclear what information is being sought in this request. Further, based upon its understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

   Objection by: Counsel

e. If it is, identify the setback (e.g., the setback between the turbine and the property line of the nearest adjacent property;

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

f. The distance between the microphone of the monitoring station and the proposed location for the base of the nearest proposed turbine in the Republic Facility.

ANSWER: It is unclear what information is being sought in this request. Further, based upon it understanding of this request, Republic Wind does not maintain this information in the manner requested. Assuming Republic Wind understands the type of information being requested, this answer can be determined by the Intervening Landowners based upon review of the Republic Wind Modeling and GIS Files which are being produced along with these responses by electronic file email attachment.

Objection by: Counsel

REQUEST FOR PRODUCTION OF DOCUMENTS: Produce all records that contain the information requested by this set of interrogatories.

ANSWER: Republic Wind is producing, along with these responses, responsive, non-privileged documents, by electronic file.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Response has been served upon the following parties listed below by electronic mail, this 18th day of November 2019.

Devin D. Parram

jvankley@vankleywalker.com

cwalker@vankleywalker.com

jclark@senecapros.org

lcurtis@ofbf.org

cendsley@ofbf.org

mleppla@theoec.org

amilam@ofbf.org

mulligan_mark@co.sandusky.oh.us

ctavenor@theoec.org

tdougherty@theoec.org

dwd@senecapros.org

jodi.bair@ohioattorneygeneral.gov

Dennyh7@frontier.com

mkessler7@gmail.com

VERFICIATION

STATE OF VERMONT)
) ss
COUNTY OF WINDSOR)

I, Isaac Old, being first duly sworn and cautioned, deposes and states that I have read the foregoing Answers to Interrogatories and to the best of my knowledge, information and belief the same are true.

Isaac Old

Sworn to before and signed in my presence this 15th day of November 2019.

Notary Public

[SEAL]

Stephanie L. Jarrait
Notary Public State of Vermont
Commission #157.0008520

VERIFICATION

STATE OF OHIO)
) ss:
COUNTY OF FRANKLIN)

DALTON CARR, being first duly sworn according to law states and deposes that the foregoing Answers to Interrogatories are true and accurate as he believes.

By: _____
Dalton Carr, Apex Clean Energy

Sworn to and subscribed in my presence by Dalton Carr on this 4th day of November, 2019.

_____
Notary Public

SUMMER L. SHEELY
ATTORNEY AT LAW
Notary Public, State of Ohio
My Commission Has No Expiration
Section 147.03 R.C.

14424807v1

App Ex. 40

Ohio Department of Natural Resources

JOHN R. KASICH, GOVERNOR | JAMES ZEHRINGER, DIRECTOR

Office of Real Estate
Paul R. Baldridge, Chief
2045 Morse Road – Bldg. E-2
Columbus, OH 43229
Phone: (614) 265-6649
Fax: (614) 267-4764

April 27, 2018

Ray Strom
Ohio Power Siting Board
180 East Broad Street
Columbus, Ohio 43215-3793

Re: 18-464; OPSB - 17-2295-EL-BGN Republic Wind Farm

Project: The proposed project involves the construction of 58 wind turbine generators, along with access roads, electric collection cables, a Facility substation, a laydown yard for construction staging, an operations and maintenance (O&M) facility, and up to two meteorological towers.

Location: The proposed project is located in Seneca and Sandusky Counties, Ohio.

The Ohio Department of Natural Resources (ODNR) has completed a review of the above referenced project. These comments were generated by an inter-disciplinary review within the Department. These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the National Environmental Policy Act, the Coastal Zone Management Act, Ohio Revised Code and other applicable laws and regulations. These comments are also based on ODNR's experience as the state natural resource management agency and do not supersede or replace the regulatory authority of any local, state or federal agency nor relieve the applicant of the obligation to comply with any local, state or federal laws or regulations.

Natural Heritage Database: The Natural Heritage Database has the following records at or within a one-mile radius of the project area:

River redhorse (*Moxostoma carinatum*), SC
Greater redhorse (*Moxostoma valenciennesi*), T, FSC
Northern shoveler (*Anas clypeata*), SI
Gadwall (*Anas strepera*), SI
Redhead (*Aythya Americana*), SI
Upland sandpiper (*Bartramia longicauda*), E
Bald eagle (*Haliaeetus leucocephalus*), FSC
Loggerhead shrike (*Lanius ludovicianus*), E, FSC
Western meadowlark (*Sturnella neglecta*), SI
Waterfowl rest area (animal assemblage)
Great blue heron rookery (animal assemblage)
Cave or cavern (geologic feature)
Sandusky State Scenic River
Knobbys Prairie Wildlife Area – ODNR Division of Wildlife
Sugar Creek Wildlife Area – ODNR Division of Wildlife

Sandusky Scenic River Abbotts Bridge Scenic River Lands – ODNR Scenic Rivers Program
Scenic River easements – ODNR Scenic Rivers Program
Bowen Nature Preserve – Seneca Co. Park District

The review was performed on the project area you specified in your request as well as an additional one-mile radius. Records searched date from 1980. This information is provided to inform you of features present within your project area and vicinity. Additional comments on some of the features may be found in pertinent sections below.

Please note that Ohio has not been completely surveyed and we rely on receiving information from many sources. Therefore, a lack of records for any particular area is not a statement that rare species or unique features are absent from that area. Although all types of plant communities have been surveyed, we only maintain records on the highest quality areas.

Statuses are defined as: E = state endangered; T = state threatened; P = state potentially threatened; SC = state species of concern; SI = state special interest; A = species recently added to state inventory, status not yet determined; X = presumed extirpated in Ohio; FE = federal endangered, FT = federal threatened, FSC = federal species of concern, FC = federal candidate species.

Fish and Wildlife: The Division of Wildlife (DOW) has the following comments.

The DOW recommends that impacts to streams, wetlands and other water resources be avoided and minimized to the fullest extent possible, and that best management practices be utilized to minimize erosion and sedimentation.

The Republic project site and adjacent parcels encompass habitat with confirmed use by state-listed species, including the endangered Indiana bat (*Myotis sodalis*), threatened northern long-eared bat *(Myotis septentrionalis)*, and bat species of concern (little brown bat *(Myotis lucifugus)*, red bat *(Lasiurus borealis)*, big brown bat *(Eptesicus fuscus)* and the tri-colored bat *(Perimyotis subflavus)*). The Applicant expects "collision risk to bats in the Project area is likely to be consistent with other wind energy projects in agricultural landscapes in the mid-west" and estimates 980-2200 bat deaths per year (4.9-11 fatalities/MW/year). The DOW anticipates the mortality rate may be greater as this site has approximately five to eight times the amount of forested area as other operating projects in agricultural landscapes in Ohio. Specifically, active roost trees for the Indiana bat (state-listed as endangered) and northern long-eared bat (state-listed as threatened) have been documented both in and immediately adjacent to the project area during the most recent surveys by Copperhead Environmental Consulting in 2015 and 2016. Pursuant to Ohio Revised Codes §§ 1531, and 1533.08, the Division of Wildlife, under its jurisdiction, has the authority to protect, propagate, manage and preserve the game or wildlife of this State and to enforce, by proper actions and proceedings, the laws of the State of Ohio. While the placement and operation of turbines has been modified to reduce risk to the endangered Indiana bat, no such placement or operational modifications were described for the state-threatened northern long-eared bat. *The DOW recommends locating turbines away from known northern long-eared bat tree roosts and a curtailment regime in order to avoid take of this threatened species. If construction is delayed beyond the initial 5-year term of the OPSB certificate, DOW may recommend certain wildlife surveys to be updated prior to construction in order to characterize pre-construction site conditions.*

As mentioned above, the project is within the vicinity of records for multiple state-listed bat species. The following species of trees have relatively high value as potential bat roost trees:

shagbark hickory (*Carya ovata*), shellbark hickory (*Carya laciniosa*), bitternut hickory (*Carya cordiformis*), black ash (*Fraxinus nigra*), green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), shingle oak (*Quercus imbricaria*), northern red oak (*Quercus rubra*), slippery elm (*Ulmus rubra*), American elm (*Ulmus americana*), eastern cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), sassafras (*Sassafras albidum*), post oak (*Quercus stellata*), and white oak (*Quercus alba*). Bat roost trees consists of trees that include dead and dying trees with exfoliating bark, crevices, or cavities in upland areas or riparian corridors and living trees with exfoliating bark, cavities, or hollow areas formed from broken branches or tops. However, bats are also dependent on the forest structure surrounding roost trees. If suitable habitat occurs within the project area, the DOW recommends trees be conserved. If suitable habitat occurs within the project area and trees must be cut, the DOW recommends cutting occur between October 1 and March 31.

The project is within the range of the black sandshell (*Ligumia recta*), a state threatened mussel. This project must not have an impact on freshwater native mussels at the project site. This applies to both listed and non-listed species. Per the Ohio Mussel Survey Protocol (2016), all Group 2, 3, and 4 streams (Appendix A) require a mussel survey. Per the Ohio Mussel Survey Protocol, Group 1 streams (Appendix A) and unlisted streams with a watershed of 10 square miles or larger above the point of impact should be assessed using the Reconnaissance Survey for Unionid Mussels (Appendix B) to determine if mussels are present. Mussel surveys may be recommended for these streams as well. This is further explained within the Ohio Mussel Survey Protocol. Therefore, if in-water work is planned in any stream that meets any of the above criteria, the DOW recommends the applicant provide information to indicate no mussel impacts will occur. If this is not possible, the DOW recommends a professional malacologist conduct a mussel survey in the project area. If mussels that cannot be avoided are found in the project area, as a last resort, the DOW recommends a professional malacologist collect and relocate the mussels to suitable and similar habitat upstream of the project site. Mussel surveys and any subsequent mussel relocation should be done in accordance with the Ohio Mussel Survey Protocol. The Ohio Mussel Survey Protocol (2016) can be found at:

http://wildlife.ohiodnr.gov/portals/wildlife/pdfs/licenses%20&%20permits/OH%20Mussel%20Survey%20Protocol.pdf

The project is within the range of the greater redhorse (*Moxostoma valenciennesi*), a state threatened fish. The DOW recommends no in-water work in perennial streams from April 15 through June 30 to reduce impacts to indigenous aquatic species and their habitat. If no in-water work is proposed in a perennial stream, this project is not likely to impact this or other aquatic species.

The project is within the range of the Blanding's turtle (*Emydoidea blandingii*), a state threatened species. This species inhabits marshes, ponds, lakes, streams, wet meadows, and swampy forests. Although essentially aquatic, the Blanding's turtle will travel over land as it moves from one wetland to the next. If wetlands, or uplands adjacent to wetlands are expected to be impacted, the DOW recommends a habitat suitability survey be conducted to determine if suitable Blanding's turtle habitat exists within the area. If suitable habitat is determined to be present, the DOW recommends that presence/absence survey be conducted.

The project is within the range of the spotted turtle (*Clemmys guttata*), a state threatened species. This species prefers fens, bogs and marshes, but also is known to inhabit wet prairies, meadows, pond edges, wet woods, and the shallow sluggish waters of small streams and ditches. If wetlands, or uplands adjacent to wetlands are expected to be impacted, the DOW recommends a

habitat suitability survey be conducted to determine if suitable spotted turtle habitat exists within the area. If suitable habitat is determined to be present, the DOW recommends that presence/absence survey be conducted.

Records exist within the project area for the upland sandpiper (*Bartramia longicauda*), a state endangered bird. Nesting upland sandpipers utilize dry grasslands including native grasslands, seeded grasslands, grazed and ungrazed pasture, hayfields, and grasslands established through the Conservation Reserve Program (CRP). If this type of habitat will be impacted, construction should be avoided in this habitat during the species' nesting period of April 15 to July 31. If this type of habitat will not be impacted, this project is not likely to impact this species.

Records exist within the project area for the northern harrier (*Circus cyaneus*), a state endangered bird. This is a common migrant and winter species. Nesters are much rarer, although they occasionally breed in large marshes and grasslands. Harriers often nest in loose colonies. The female builds a nest out of sticks on the ground, often on top of a mound. Harriers hunt over grasslands. If this type of habitat will be impacted, construction should be avoided in this habitat during the species' nesting period of May 15 to August 1. If this habitat will not be impacted, the project is not likely to impact this species.

Records exist within the project area for the loggerhead shrike (*Lanius ludovicianus*), a state endangered bird. The loggerhead shrike nests in hedgerows, thickets and fencerows. They hunt over hayfields, pastures, and other grasslands. If thickets or other types of dense shrubbery habitat will be impacted, construction should be avoided in this habitat during the species' nesting period of April 1 to August 1. If this habitat will not be impacted, this project is not likely to impact this species.

Due to the potential of impacts to federally listed species, as well as to state listed species, we recommend that this project be coordinated with the U.S. Fish & Wildlife Service.

Natural Areas: The Division of Natural Areas and Preserves has the following comment.

An Ohio endangered plant species, Engleman's Spike Rush (*Eleocharis engelmannii),* has been documented near Flat Rock in the proposed project area. This species grows in ephemeral wetlands that contain exposed mud or muck flats in the summer months. Due to the possible disruption of this species, it is recommended that a pre-construction survey of the proposed project site be conducted to ensure that the plant is not impacted. If there are any questions about the species listed above or if survey assistance is requested, please contact the Division of Natural Areas and Preserves' Chief Botanist, Rick Gardner, at rick.gardner@dnr.state.oh.us or (614) 265-6419.

Water Resources: The Division of Water Resources has the following comment.

The local floodplain administrator should be contacted concerning the possible need for any floodplain permits or approvals for this project. Your local floodplain administrator contact information can be found at the website below.

http://water.ohiodnr.gov/portals/soilwater/pdf/floodplain/Floodplain%20Manager%20Community%20Contact%20List_8_16.pdf

Please contact John Kessler at (614) 265-6621 if you have questions about these comments or need additional information.

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