RMT | ENERGY
construction ▲ engineering

Ice Detection and Mitigation Plan

Mason County, MI
Lake Winds® Energy Park

August 2012

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Section 1
Purpose

The purpose of this document is:

- To provide Mason County, Michigan, with detailed information regarding the planned wind turbine generator (WTG) ice detection monitoring and potential mitigation measures for operating the Lake Winds® Energy Park (Project) under icing conditions, as required by Mason County Special Land Use Permit (SLUP) Part G, Section 13.

Section 2
Background

At the time the application was submitted, the mechanics of how ice detection would be implemented were undefined. As a result, one of the conditions of the SLUP, Part G, Section 13, states:

> "(a) At least six weeks prior to the commencement of operations of the System, the Applicant shall submit to the County a written plan for detecting the accumulation of ice on turbine blades, and the measures to be taken to avoid the shedding or throwing of ice from the blades in operation.
>
> (b) The plan shall include the installation and operation of an automatic sensing device or system, for the detection of the accumulation of ice on blades and other equipment and determining the thickness thereof. The plan shall include a detailed description of such devices or equipment.
>
> (c) If ice has accumulated on turbine blades in such thickness or under such weather conditions that may cause it to fall from the blades, the Applicant shall cease operation of the turbine involved until the ice has melted or is otherwise removed, in accordance with the plan.
>
> (d) During weather conditions in which ice may accumulate on turbine blades, the Applicant shall utilize the above-stated ice-sensing system or devices, and promptly undertake measures to cause any accumulated ice to fall safely from the blades or otherwise cease turbine operations until ice is no longer present. If the Applicant proposes to determine ice conditions by means of visual inspection, in addition to the above-stated automatic sensing devices, the plan shall include the methods and procedures whereby sufficient lighting will be used to illuminate the blades for visual inspection during nighttime conditions."

Section 4 of this plan describes the mitigation strategy that will be implemented by the Project utilizing the Vestas Ice Detection System (VIDS), weather data and visual inspections in order to meet the SLUP requirement.

Section 3
Ice Detection

The SLUP requires that the Project incorporate an automated ice sensor system to detect levels of ice accumulation. The SLUP also requires a plan for addressing accumulated ice on turbine blades. In order to meet these conditions, Consumers Energy will use a system of both daytime observation and mechanical monitoring to check for and address ice formation on turbine blades. The system of ice detection is based on the use of practical and reliable real time data. Note that due to the turbine blade rotation and flexing, icing is unlikely to occur.

In addition to the automatic detection system and observation, the WTG controls are very sensitive to an imbalance on the blades (as could be created by ice formation). If an imbalance is detected, the controls will pause the WTG and a technician will be alerted to the condition before the turbine can be restarted. Accordingly, there is essentially a third layer of ice detection built into the system. The turbine control system may also indicate a reduction in power output at a given wind speed as another possible indication of ice formation.

The purpose of the ice detection system is to detect icing conditions in the vicinity of the Project. In addition to the ice detection system, qualified technicians will observe weather and precipitation conditions and perform daytime visual blade observations when conditions would likely lead to blade icing. Visual inspections triggered by ambient temperature monitoring, as well as in response to alerts from the automatic detection system, are an integral part of the ice detection program.

The ice observation system will use weather reports, meteorological station information, and field inspections to check for blade icing conditions. As potential icing conditions develop technicians will perform daylight inspections using binoculars and observations from the hatch of the nacelle to check for icing. The mechanical ice detection system will use the Vestas Ice Detection System (VIDS), which consists of two mechanical sensors, one located at each meteorological tower (refer to Figure 1 for locations), to be used to monitor for blade icing. If icing conditions are indicated at night by the mechanical ice detection system, or other operating indicators, turbines not already paused will be set to pause by the remote operations center until daylight observations for icing occur.

This mechanical system operates as summarized here:

1. The ice detection sensor includes a small metal tube that is excited to vibrate continuously at its resonant frequency (refer to Attachment A).
2. As ice forms on the tube, the tube's resonant frequency changes. The change in resonant frequency can be used to calculate how much ice is present.
3. When 0.5 mm of ice has built up, the ice detection sensor melts the ice, increments a value that records the level of accumulated ice, and starts detecting again.
4. The sensor sends the vibrational frequency of the tube to the control center computer with the accumulated ice level.
5. The sensor can log a large accumulation of ice without having a significant level of ice actually accumulate.
6. If conditions are favorable for ice to form on the turbine blades during daylight hours technicians will perform a field observation (refer to the Ice Detection System Schematic on Figure 2). If icing conditions are indicated at night, turbines not already paused will be set to pause by the remote operations center until daylight observations for icing occur.

Section 4
Mitigation

If icing is likely based on indicated data and/or weather conditions, technicians will make a visual inspection and evaluate the site conditions while they are on site. Paused turbines resulting from overnight icing conditions will remain paused until daylight observations for icing by technicians have occurred. When a WTG is in pause mode following icing conditions (whether automatically or because technicians are in the vicinity of a WTG), the WTG nacelle will be remotely yawed to face west to protect workers from the potential for any falling ice from the paused turbine while entering and exiting the WTG (access doors are located on the east side of the tower).

Once a WTG is paused, a qualified technician will perform an inspection of the WTG blades and determine if the equipment may be safely returned to service. Methods of removing ice from the blades will include manually starting and stopping the turbine for a partial rotation to allow ice to fall near the base of the turbine, or yawing the WTG nacelle and stationary blades to face south so that the sun can help to melt and / or sublimate the ice layer. If ice that has a risk of falling cannot be removed from a turbine, operation of that turbine will cease until the event has passed and the ice has melted or has fallen from the blades in accordance with this plan.

Attachment A
Vestas Ice Detection System (VIDS)

GOODRICH

SENSOR SYSTEMS

MODEL 0871LH1
ICE DETECTOR

- **Designed Specifically for Ground-based Freezing Rain Sensing**
  - **Small Size, Weighs Less than 1 Pound**
  - **Nondeiced Strut Lowers Power Consumption**
  - **Simplified Design Lowers Cost**
- **RS-422 and Discrete Output Signals**
- **Commanded and Continuous Built-In Test (BIT)**

DESCRIPTION

Model 0871LH1 is a small, low power sensor designed specifically for light ground based freezing rain conditions. Compared to our other freezing rain sensors that are used in moderate and severe icing environments, this design has been simplified with a low-cost nonheated strut. Only the ice detection probe has deicing capability.

To detect the presence of an icing condition, the ice detection probe vibrates ultrasonically at a nominal resonant frequency of 40 kHz. As ice accretes on the probe, the added mass causes the resonant frequency to decrease. When a frequency decrease equivalent to 0.020" ice thickness is detected, the ice signals (RS-422 and discrete outputs) are activated for a period of 60 seconds and the ice detector initiates a self-deicing cycle that removes all accumulated ice from the probe. If another icing encounter is detected within that 60 second period, the annunciator timer is reset to zero and the ice signals remain activated for an additional 60 seconds.

The 0871LH1 should be mounted at a slight inclination angle of 20 to 30 degrees into the prevailing wind. This will allow for the proper drainage of water at the base of the sensor.

SPECIFICATIONS

Set Point

The ice signal activates when probe ice thickness exceeds 0.020 ±0.005 inches.

Operating Modes

Sensing

Operating with no ice or with probe ice thickness below the set point.

Deicing

Operating with probe ice thickness exceeding the set point.

Discrete Output Signals

Ice Signal:	– No icing: Open – Icing detected: Ground
Status Signal:	– Operating correctly: Ground – Failure detected: Open
Output Signal Notes:	• "Open" - impedance is ≥200k ohms • "Ground" - maximum current sink is 50 mA

RS-422 Output Signals

Ice State:	1 = Ice, 0 = No Ice
Fail State:	1 = Fail, 0 = No Fail (OK)

Commanded Built-In-Test (BIT)

Commanded BIT is performed at initial power-up. If a failure is detected and verified, the ice detector stops detecting and annunciating icing conditions, the heaters are disabled, and a failure is annunciated.

Continuous Built-In-Test (BIT)

Hardware and software BIT verifies that internal electronics are functioning properly.

Output Format

RS-422 output operates @ 9600 baud. (Request our document D9420161-1 for string definition.)

SPECIFICATIONS (continued)

Electrical

Input Voltage: 22 to 29.5 VDC

Power Consumption:
- Sensing mode: 15 Watts maximum
- De-Icing mode: 50 Watts maximum

Connector Pinout: See configuration drawing

Environmental

Operating Temperature Range: –55°C to +71°C

Storage Temperature Range: –65°C to +90°C

Random Vibration: 7.9 Grms (DO-160D, Category R)

Shock: MIL 810D METHOD 516

Mechanical

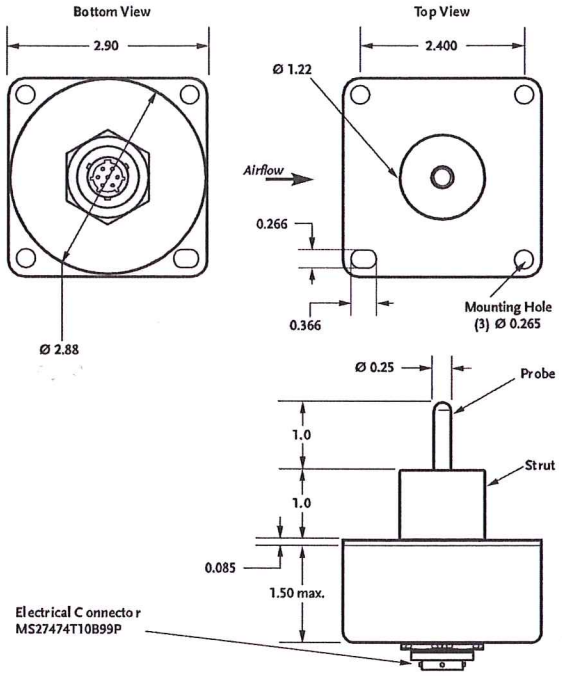
Electrical Connector: MS27474T10B99PN

Mating Electrical Connector: MS27473T10B99SN

Weight: 0.7 lbs maximum

CONFIGURATION DRAWING

CONNECTOR PINOUTS	
Pins	Function
A	28 VDC
B	28 VDC return
C	Case ground
D	RS-422 high
E	RS-422 low
F	Ice signal
G	Status signal



All dimensions in inches

GOODRICH

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Tel: 952 892 4000
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www.aerospace.goodrich.com

ORDERING INFORMATION

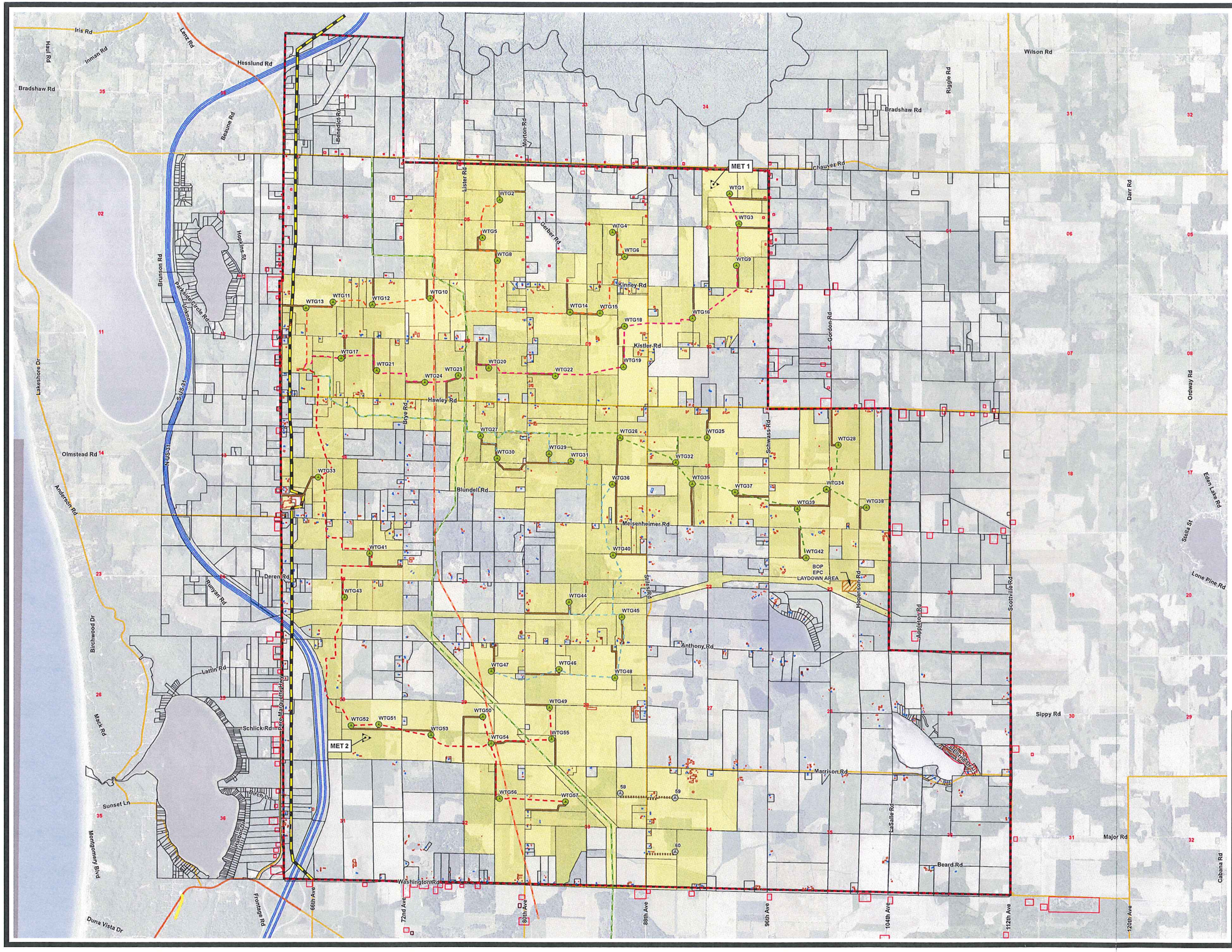
Order Model Number...0871LH1 Ice Detector

FOR ADDITIONAL INFORMATION

To learn more about the Model 0871LH1 Ice Detector, call Goodrich at 952 892 4000.

4095 LIT 03/02

Figure 1
Meteorological Tower Locations



LEGEND

- ALTERNATE WIND TURBINE LOCATION
- PROPOSED WIND TURBINE LOCATION
- HVD LINE LOCATION FROM LIDAR SURVEY
- PROJECT BOUNDARY
- PARCEL BOUNDARY
- POOLED PARCELS
- AREAS CONTAINING BARN OR GARAGE
- AREAS CONTAINING OCCUPIED STRUCTURES
- AREAS CONTAINING A BUSINESS
- AREAS CONTAINING A CHURCH
- HOUSE
- OTHER BUILDING
- DTE 10" NATURAL GAS PIPELINE
- OMIMEX BASIN SOUR GAS PIPELINE ROUTE
- PROPOSED ACCESS ROAD
- ACCESS ROAD TO ALTERNATE TURBINE LOCATIONS

PROPOSED COLLECTOR CIRCUIT

1 2 3 4 5

NOTES:

1. AERIAL IMAGE FROM U.S. DEPARTMENT OF AGRICULTURE, NATIONAL AGRICU IMAGERY PROGRAM 2006.
2. ROAD INFORMATION FROM ENVIRONMENTAL SYSTEMS RESEARCH INSTITUT
3. NOT FOR CONSTRUCTION OR INFORMATION ONLY.
4. EASEMENT STATUS DATED DECEMBER 1, 2010.
5. PARCEL BOUNDARIES APPROXIMATE BASED ON PLANIMETRIC PARCEL MAPS
6. SOUR GAS PIPELINE LOCATION BASE ON COORDINATES FROM OMIMEX GRO 2011.
7. TURBINE 7 HAS BEEN REMOVED FROM THE SITE PLAN AND REPLACED WITH TURBINE 57A

N

0 2,000 4,000 FEET

1" = 2,000'
1:24,000

NOT FOR CONSTRUCTION

NO.	BY	DATE	REVISION	APP'D.
12	CH	8/3/2012	ADDED MET TOWERS	JCK
11	CH	3/1/2012	UPDATED WTG, COLLECTOR, AND TRANSPORTATION ROUTE LOCATIONS	JCK
10	JM	2/22/2012	UPDATED WTG AND COLLECTOR LOCATIONS	JCK
9	JM	9/29/2011	REMOVED COLLECTION SYSTEM SUBSTATION	JCK
8	JM	7/6/2011	RELOCATED ACCESS ROAD FOR WTG 25	PRL
7	JM	6/16/2011	ADDED 3 RECENTLY BUILT OCCUPIED STRUCTURES IDENTIFIED BY COUNTY	PRL
6	JM	6/6/2011	RELOCATED WTG 41 AWAY FROM OCCIDENTAL EASEMENT, RELOCATED WTG 23 AWAY FROM OMIMEX SOUR GAS LINE, RELOCATED WTG 16 AWAY FROM DTE GAS LINE	PRL
5	JM	4/11/2011	REMOVED TURBINE 7	PRL
0	JM	9/15/2010	DRAFT ISSUANCE	JLB

PROJECT:

LAKE WINDS ENERGY PARK
MASON COUNTY, MICHIGAN

SHEET TITLE:

SITE PLAN OVERVIEW

DRAWN BY:	HANKLEY C	SCALE:	PROJ. NO. 00-08405.01
CHECKED BY:		AS NOTED	FILE NO. 840501140.mxd
APPROVED BY:	KUCHER J	DATE PRINTED:	**FIGURE 1**
DATE:	AUGUST 2012	8/3/2012	

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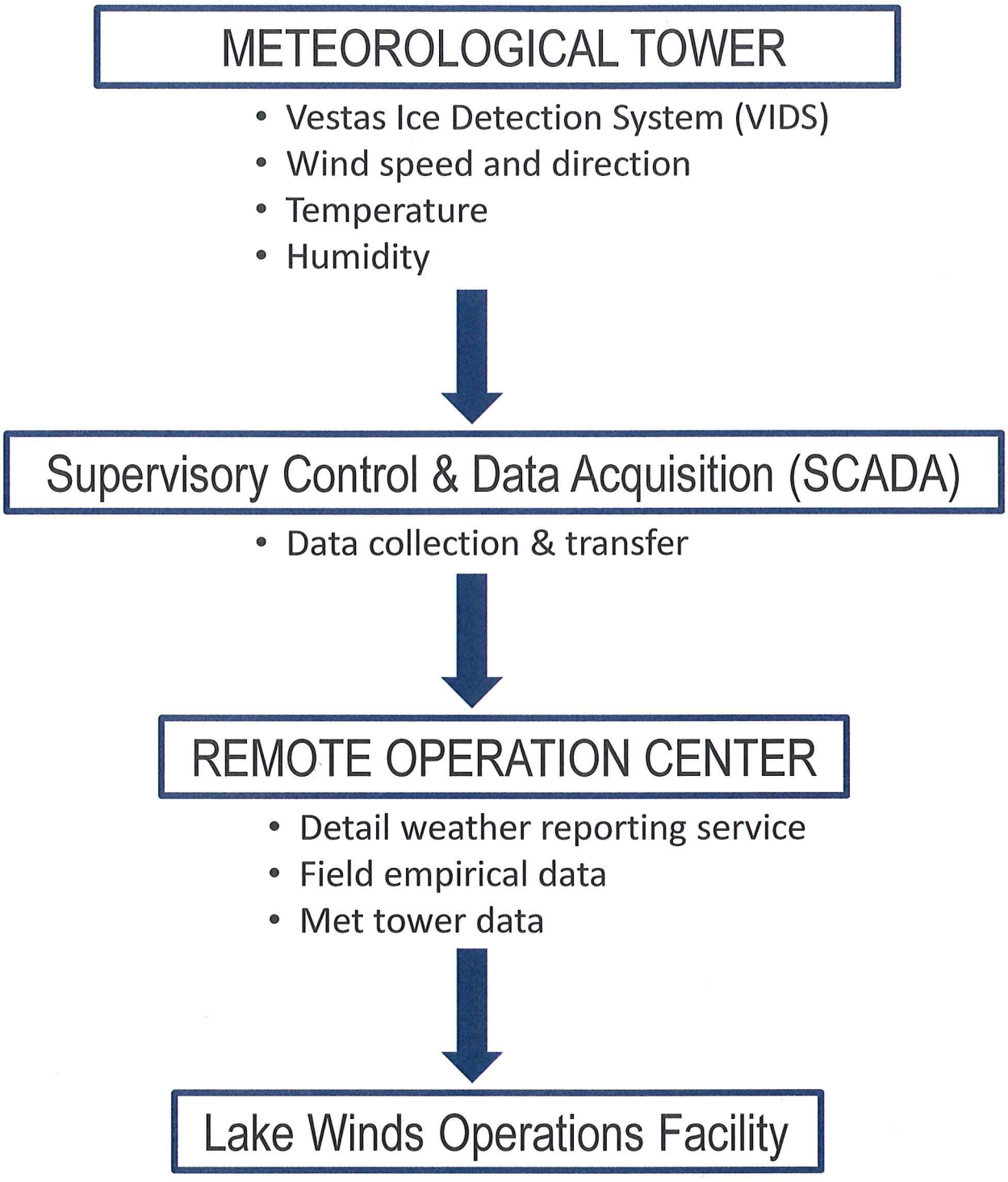
Figure 2
Ice Detachment System Schematic



Ice Detection System Schematic

Figure 2