Multi-Municipal Wind Turbine Working Group

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REPORT ON ONTARIO WIND TURBINE FAILURES

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Wind Turbine Failures

Based on the number of catastrophic wind turbine failures, the Multi Municipal Wind Turbine Working Group (MMWTWG)[1] is deeply concerned about the associated implications. While the wind power industry reports that each is an isolated incident, there are now too many incidents for this response to be credible. At least 10 known turbines failures have happened in Ontario since 2007. Each of these resulted in significant portions of blades or the tower hitting the ground at some distance from the turbine base.

At the same time, there has been no public response from the provincial government that indicates these potentially serious incidents are being investigated either in the context of public and/or workplace safety. To date, there has been no information shared with MMWTWG member municipalities.

As a result, we have been working with several people that have technical experience with industrial applications of power and rotating equipment. We have developed our own assessment of the failures based on statements from project operators, pictures and other available information. This assessment of the following events points to a number of different causes:

- **Bow River** –Pictures suggest that tower collapse was linked to a bolt failure of tower sections.
- **Skyway 8** – Rotor failure occurred shortly after the installation of an experimental device.
- **Raleigh Wind** – Published information from the project owner indicates that the tower collapse is related to a single blade failure. Marks on the tower suggest that the blade struck the tower.
- **Sumac Ridge** – Blade fractures , no explanation available.
- **Kingsbridge 1** – Fire in the nacelle spread to the blades resulting in wide debris scatter.
- **Huron Wind** – Blade failure with the location of the debris thrown by this failure highlighting the inadequacy of current setbacks from property lines.

Another recent incident in New Brunswick adds to our concerns:

- **Kent Hills, NB** – Project operator linked the collapse of tower to a foundation failure.

Collectively, the assessments of these situations increased our concern that action is required to formally investigate these incidents. We believe they clearly demonstrate that the current setback distances are inadequate to protect the public and they will increase as tower heights and blade lengths increase.

Faced with continued public inaction by the provincial government, the MMWTWG decided to prepare this summary of available information relative to these failures with a goal of sharing the information with other municipalities that host wind turbine projects to enable them to better protect their citizens.

The MMWTWG recommends that the provincial government needs to:

[1] The MMWTWG formed in 2009 by member municipalities in Bruce, Grey and Huron Counties to share information on wind turbine projects being proposed or operating in our municipalities. The working group is a joint committee with elected and municipally-appointed citizen representatives from the member municipalities.

1. **Establish a formal public process for investigations of wind turbine failures** so that the cause can be firmly determined. These would involve third-party independent engineers starting with initial inspection procedures through to the public release of the final report;
2. **Complete comprehensive inspections of existing projects** to identify any project that shows signs of similar weaknesses;
3. **Establish requirements** for on-board predictive maintenance equipment for operating wind turbines to allow early identification of problems and establish protocols for information transfer to the MECP for review and sharing with the host municipality.
4. **Review the emergency response procedures** submitted by the proponents of wind turbine projects as part of the approval process to ensure that the plans are current and responsive to the types of failures being experienced; and
5. **Increase the setbacks** from property lines to a minimum of tower height plus blade length for new towers or repowering of existing sites to at least reflect the impact of a tower collapse while recognizing additional distances would be required to protect against ice throw and debris scatter like that seen in the Huron Wind failure where debris with the dimensions of a car were found 2.5 times the height of the tower plus blade length.

We suggest that Councils review these attached summaries to consider how they apply to the wind turbine project(s) in your municipality. It may be possible for the municipality to review the situations with the owner of each project to confirm that appropriate activities are underway to ensure public safety.

If you agree with the recommendations for action by the provincial government we ask that you communicate your support to David Piccini, Ontario Minister of Environment, Conservation and Parks.

When these projects were approved and built, provincial regulations limited municipal input into the projects and the supervision of their construction. This self-regulation process led to some serious problems for the municipalities. Now that further gaps in this process are becoming evident, the province needs to take responsibility for addressing the mistakes that were made.

Attachment 1: Bow Lake, Algoma Region, Ontario

Project Details:
Owners:
Batchewana First Nation – 50%
DIF Infrastructure V – 50%
BluEarth Renewables - operator
Location: Northwest of Sault Ste Marie
Capacity: 58.3 MW
Commissioned:
Phase 1: May 2015
Phase 2: April 2016
Equipment – GE Energy 1.6 MW
Height – 80 m tower; 50 metre blades
Date of Failure: August 28, 2021

Assessment of Failure:
The pictures strongly suggest that the failure mechanism was fatigue of the bolts holding the tower together. There is no evidence of buckling, tearing of the steel plate or general deformation at the adjoining section flanges.

A portion of one blade was found located on the ground near the tower base. The other two blades appear to have remained attached to the rotor as it collapsed into the adjacent trees.

Even though the tower contained 60 gallons of flammable petrochemical lubricants, the MECP Environmental Officer did not visit the site until 3 days after the accident took place.

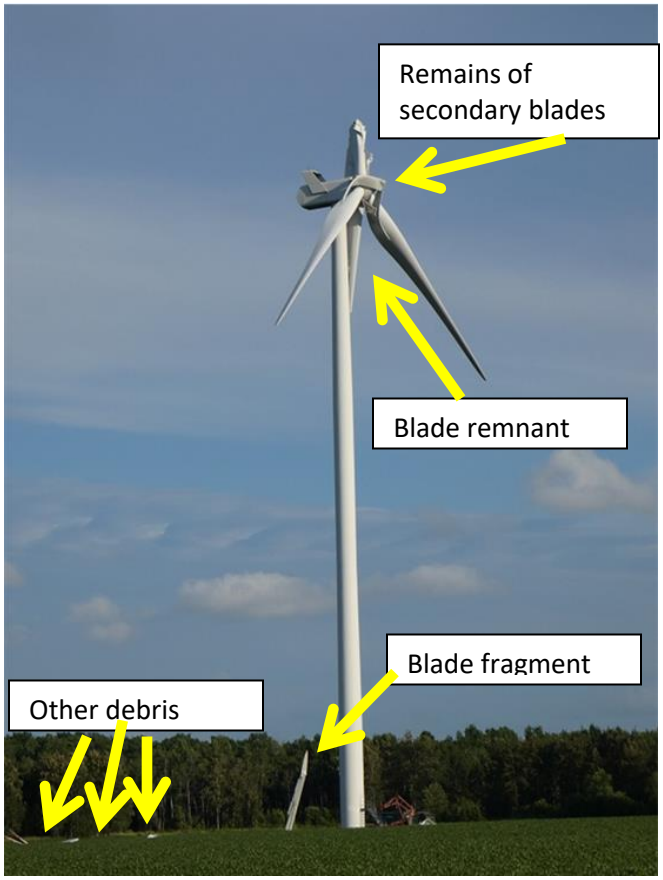
Potential Learnings:
Tower bolt failures can have many potential causes; i.e. wrong bolts, excessive cyclical loading beyond design criteria, improper installation method regarding torque application, inadequate bolt maintenance checks during regular maintenance etc.

Fatigue damage cannot be seen until a crack develops. Since all aspects of the other towers seem to be identical, it would seem necessary to replace all their tower section bolts.

Attachment 2: Skyway 8, Grey County, Ontario

Project Details:
Owner: Capstone Infrastructure
Location: South west of Dundalk
Capacity: 9.5 MW
Commissioned: August 2014
Equipment
3 - Vestas V100- 1.8 MW
2 - Vestas V100- 2.0 MW
Height – 80 m tower; 50 metre blades
Modification – Biome Renewables secondary blades installed on this turbine in early 2021.
Date of Failure: June 30, 2021

Assessment of Failure:
This turbine was retrofitted approximately 3 months prior to the failure with a secondary rotor of three curved blades that fastened to the hub between the existing blades. This experimental device was not part of the original design and was added to increase power output. The failure resulted in the separation of one of the secondary blades and one of the existing blades. Although the exact sequence of the failure is not known, the most likely scenario is that the experimental blade partly separated, impacting the main blade which then failed.
MECP approved the change but there is no public information confirming that the turbine could handle the additional static and dynamic loads imposed by the secondary rotor.



Blade fragment

Learnings:
This turbine was located only 195m from the road, Grey Rd. 8. The road closure that was immediately put in place for public safety confirms that existing setback requirements are insufficient. The failure raises many questions concerning how this project was executed and the engineering safety margins for the original wind turbine design.

Attachment 3: Raleigh Wind, Chatham-Kent

Project Details:
Owner:
2018 – Terraform Power
2020 – Brookfield Renewables
Location: South of Chatham
Capacity: 78 MW
Commissioned: January, 2011
Equipment: 52 - GE 1.5 MW
Height – 80 m tower;
42 metre blades
Date of Failure: Jan. 19, 2018

Assessment of Failure:

The company reported that their investigations indicated that the failure was caused by a single faulty blade.
This tower at Chatham-Kent buckled at approximately its midpoint and fell toward the wind. It was found with one blade wrapped around the tower base and markings on the tower that were above the fold line.
Based on the evidence of publicly available pictures, it seems that the most likely scenario for this catastrophic failure was that the tower was struck by a blade which weakened it such that it collapsed.

Learnings:
If the failure was indeed caused by a blade strike on the tower, this raises questions as to how this occurred. This suggests that the clearance may not have been adequate for the conditions encountered during operation. Alternately the blade may have started to separate and this caused it to get so close to the tower that it made contact with it. There may be other possibilities and variations as well.

Chatham-Kent Ward 2 Councillor Frank Vercouteren told CBC News at the time that he believed that the setback from roads was insufficient to protect public safety.

Attachment 4: Sumac Ridge, Kawartha Lakes

Project Details:
Owner:
2016: wpd
2021: Capstone Infrastructure
Location: Southwest of Peterborough
Capacity: 10.5 MW
Commissioned: November, 2017
Equipment: 5 - Senvion MM92 2.05 MW
Height – 80 m tower;
46 metre blades
Date of Failure: April 20, 2019

Assessment of Failure:

Residents reported hearing a grinding sound followed by a loud explosion at 9 a.m. on the morning of the incident.

It was found that one of the blades of the turbine had shattered. Parts of the blade fell to the ground while other pieces were still dangling off of the remaining sections of the blade. The nearby road was closed to ensure public safety.

Initial speculation was that the failure may have been related to the strong winds associated with the storm that moved through the area on the previous weekend.

The investigation and follow up on this incident was hampered as Senvion had filed for bankruptcy protection on April 9 – just before incident.

Learnings:

The blade that failed was relatively new having been in operation for only 1.5 years. This highlights the fact that failures can occur at any time during the life of a wind turbine.

If the failure was related to the strong winds, it raises questions concerning the design safety margins.

Attachment 5: Kingsbridge 1, Ashfield-Colborne-Wawanosh

Project Details:

Owner: Capital Power
Location: North of Goderich
Capacity: 40 MW
Commissioned: 2006
Equipment: Initially 21 – Vestas V80 with the failed turbine being replace with a Vestas V 90.
Height – 80 m tower; 45m blades
Date of Failure: April, 2013

Assessment of Failure:

The fire started at about 1 am and burned for about two hours. Most of the nacelle was completely destroyed. The intensity of the fire also ignited the blades.

The fire department was called to the site but there was not much that they could do given the elevation of the fire and risks posed by burning pieces of the nacelle and the blades that were falling off of the towers.

Blades continued to rotate and could not be stopped due to the fire in control mechanisms.

A representative of the operator addressed ACW Council the following day and indicated that elements of the turbine were found over 200 metres from the tower.

As the fire occurred in early spring, the ground was wet and there were no crops to be set on fire when burning elements fell off of the tower.

Learnings:

This failure highlights the need for fire identification and suppression systems to be installed within the nacelles of all wind turbines.

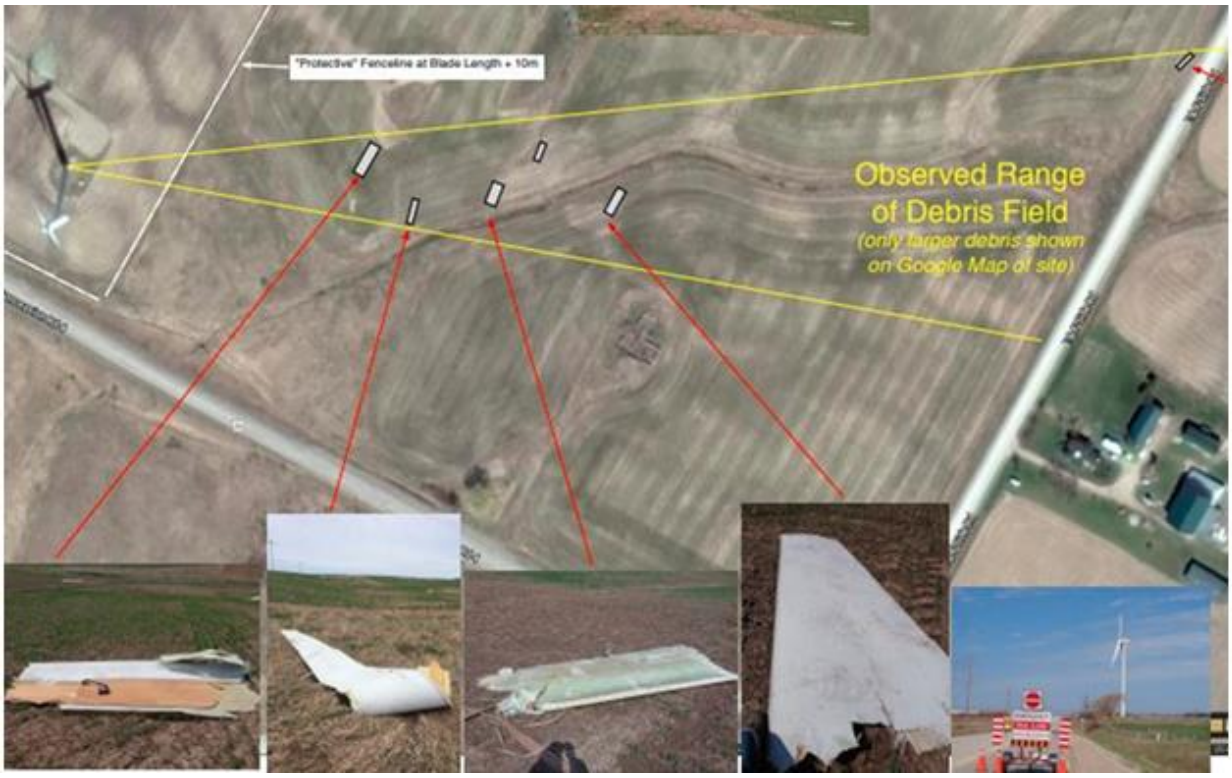
Had this fire occurred when dry crops were in the field below the turbine, the fire progression would have been more serious.

Attachment 6: Huron Wind, Bruce County

Project Details:
Owners:
TC Energy
OMERS
Location: North of Kincardine
Capacity: 9.0 MW
Operational: November 2002
Equipment – 5 Vestas V80 - 1.8 MW
Height – 65 m tower; 40 metre blades
Date of Failure: May 4, 2018

Assessment of Failure:
Immediate access to the site allowed full documentation of the debris created by this blade failure.

The map below compares the limit of the protected area of 50 m with the actual locations of debris from the blade failure. Large pieces of debris found 280 m from the tower.



Debris at 150m from tower - 1.3m X 3.6m

Debris at 170m from tower

Debris at 210 m from tower 1.2m X 3.0m

Debris at 280m from tower 1.2m X 3.0m

Concession 4 closed to danger

Attachment 7: Kent Hills, New Brunswick

Project Details:
Owner: Trans Alta Renewables
Location: Southwest of Moncton, NB
Site shared with ATV/snowmobile trails
Capacity: 167 MW
Commissioned in Phases:
Dec 2008 – 25 turbines; Nov 2010 – 24 turbines; Oct 2018 – 5 turbines
Equipment – Vestas V90 3 MW
Height – 80 m tower; 45 metre blades
Date of Failure: October 14, 2021

Assessment of Failure:
As confirmed by the operator, this tower collapse was linked to a foundation failure (sub-surface crack propagation). The tower itself seems to have all the sections intact and bolted together. Basically, the pictures indicate that the top part of the foundation directly below the tower base was no longer adequately supporting the tower.

A close-up picture of the foundation shows the failed surfaces consists of concrete rubble and rebar. There does not seem to be evidence of the long primary anchor bolts that should fasten to the flange at the base of the tower and then be embedded deep into the concrete foundation.

Earlier pictures taken of wind turbines in this project indicate that numerous anchor bolts had been installed in the concrete bases. This is highly unusual and suggests that they were added when problems with the foundations became evident.

Potential Learnings:
The foundation problem(s) that caused the failure are very likely not an isolated case. Foundation failures can result from many factors i.e., faulty design, quality control, construction techniques, procedures etc.

This failure raises many questions that relate to how likely it is that the other foundations have the same problems. As well, it raises the question of public safety and the need for safe separation distances.

Attachment 8: History of Turbine Failures in Ontario

The following table documents the known equipment failures at Ontario wind turbine projects. that resulted in wind turbine blades hitting the ground so that members of the public may have been harmed if present in locations outside any protective exclusion zone. While the industry response to each failure is that the situation is unique and an exception, the table confirms that this is not the case.

#	Date	Project	Type	Equipment	Age at Failure
1	April 2007	Port Burwell	Blade Failure	GE 1.5	11 months
2	January 2008	Prince Wind	Blade Failure	GE 1.5	2.1 years
3	April 2013	Kingsbridge 1	Fire	Vestas V80	7 years
4	August 2015	Goshen	Blade Failure	GE 1.62	6 months
5	April 2017	Bornish	Blade Failure	GE 1.62	3 years
6	January 2018	Raleigh	Tower Collapse	GE 1.62	7 years
7	May 2018	Huron Wind	Blade Failure	Vestas V80	15.4 years
8	April 2019	Sumac Ridge	Blade Failure	Senvion MM92	1.3 years
9	June 2021	Skyway 8	Blade Failure	Vestas V100	6.9 years*
10	August 2021	Bow Lake	Tower Collapse	GE 1.62	6 years

*100 days after secondary blades installed.

These situations are similar to the operating experience with wind turbines in other jurisdictions. It suggests that the positioning of wind turbines relative to other adjacent activities needs to anticipate the potential for failure either the blades or the tower and other dangers such as ice throws or fires. Analysis of these failures indicates that the current Ontario setback of blade length plus 10 metres is not sufficient to protect the wider public.

The failures also indicate that there needs to be a program of ongoing monitoring of operation of these wind turbines with public reporting of the results of inspections and remedial actions ordered to address faults identified.