INTRO

Inadequate Setback, as well as Icing, Structural Failure, and Noise represent health and safety threats to humans, habitat and the environment within the proximity of wind power generators (windmills).

These elements are grossly violated in the proposed expansion of the Wachusett Wind Power Site.

Except for minor grammatical corrections and page re-numbering, the four sections that follow are the comments submitted by John P. Mollica (john@mollica.com) in response to a Massachusetts Environmental Policy Act (MEPA) required Expanded Environmental Notification Form (EENF) filing #13229 of the Princeton Municipal Light Department (PMLD), in March 2004.

PMLD seeks to expand their experimental Wachusett Wind Site (WWS) developed 20 years ago on the slopes of Wachusett Mountain into a for-profit owned commercial venture. The approximately 2000-acre mountain properties, owned by the citizens of the Massachusetts Commonwealth and managed by its Department of Conservation and Recreation (DCR) agency, surround the 16-acre wind power site – over half of its perimeter being bordered by popular state hiking trails.

The Wachusett Mountain state properties are protected under Article 97 of the Massachusetts' Constitution (included at the end of this *Introduction)* that grant its citizens specific environmental rights equivalent to those of speech, and worship.

PMLD is seeking a easement across the commonwealth properties for vehicular access utilizing the Stage Coach Trail. In addition, access through forested land is sought for transmission lines connecting the wind power site to municipal electric grid. Such grants are subject to Massachusetts' legislature approval.

On April 23, 2004, Environmental Secretary Herzfelder determined that no further study or reporting was required by PMLD, paving the way to permitting by DCR. In her multi-page *Certificate* critical matters, detailed in Mollica's comments, are inadequately addressed and footnoted with conjecture -- disregarding Environmental Office Article 97 land disposition policies and giving license for increased risk to state park visitors. See, http://www.state.ma.us/envir/mepa/secondlevelpages/currentissue.htm.

Essentially, a for-profit company (Community Energy, Inc. of Wayne, PA), who will own, operate and maintain the Wachusett Wind Site under the name of CEI Mass-Wind, LLC, will encroach and impinge upon a minimum of 100-acres of constitutionally protected state preserve and a local public road -- both commercially and dangerously.

Among those commenting on PMLD's filing, requesting more information, studies, testing and policies were Massachusetts Audubon, Sierra Club, Wachusett Mountain Advisory Council, and the U.S, Department of the Interior. The positions presented by Mollica are those principally of wind industry proponents, backed up by their research, empirical studies, papers presented at international conferences, wind site operators, consultants, standards and advocacy bodies – those whose business is wind power.

ARTICLE 97 -- CONSTITUTION OF THE COMMONWEALTH OF MASSACHUSETTS.

Article XCVII. Article XLIX of the Amendments to the Constitution is hereby annulled and the following is adopted in place thereof: -

The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose.

The general court shall have the power to enact legislation necessary or expedient to protect such rights.

In the furtherance of the foregoing powers, the general court shall have the power to provide for the taking, upon payment of just compensation therefor, or for the acquisition by purchase or otherwise, of lands and easements or such other interests therein as may be deemed necessary to accomplish these purposes.

Lands and easements taken or acquired for such purposes shall not be used for other purposes or otherwise disposed of except by laws enacted by a two thirds vote, taken by yeas and nays, of each branch of the general court.

Wachusett Mountain State Reservation

Wind power expansion site
Eenf #13229 – comments

John P. Mollica
April 16, 2004

introduction

April 15, 2004
167 Westminster Road
Princeton, MA 01541
john@mollica.com

Secretary Ellen Roy Herzfelder
EOEA - MEPA Unit
100 Cambridge Street
Suite 900
Boston, MA

RE: EENF #13229 – "Princeton Wind Farm Infrastructure Improvements"

Dear Secretary,

In EENF #13229, you have under your responsibility a most paradoxical filing. One that generates energy using renewable resources wanting to become more of a neighbor, yet without a fence, to a non-renewable resource placed in public hands.

In your certificate for the recent Florida-Munroe wind project you wrote, "It is therefore appropriate to resolve in the MEPA process the issues surrounding the use of public trust land for the generation of electricity prior to making permitting decisions on such a proposed use."

Perhaps you were intuitive about Wachusett…as beyond the scope of exchanging driveways this projects asks more -- the handling and the transfer of the rights and safety to tens and hundreds of acres.

As the science, the studies, the history, the elements of weather and the proximity of these two neighboring environments is examined, it will be hard to deny that the decision to be made is one of geometrically greater scale than is presented in EENF #13229's filing. Equally undeniable, is that the wind industry science and studies speak directly to the variables in this filing.

The Princeton wind farm was a noble experiment -- with a history of marginal power delivery, structural failures, never contributing to the studies and science of wind power, or any science.

The Wachusett Wind Site (WWS) seeks this again. It unfortunately is situated on a parcel wholly surrounded by Article 97 properties -- on a parcel too small for the technology it requires to be viable, whose requirements for siting have grown geometrically with the wind industry machines that is uses.

Although this project is "in my back yard," in my comments I speak with the justification of research produced, *not by opponents* to wind development but rather of proponents. In fact those who will own and operate this Wachusett site, as well. I speak the words of standards bodies, industry advocacy groups, equipment manufactures, developers and academics, those who have engaged in studies with regard to wind power development.

As Michael Last former DEM Board Chairman said of the Wachusett project, “This is not about green-power.” On Wachusett we are being asked to share the rights afforded to citizens to tens and hundreds of acres – and we are being asked by a private enterprise.

If the strategic goal of the commonwealth is to promote the production of power by renewable means then I will, in my comments, allow experts to show that this (WWS project) will be a failure beyond the bounds of Princeton and the Wachusett Reservation

I do believe their work powerful and able to hold its ground in any forum.

I limit my comments to four elements: setback, icing/safety, structural integrity and noise – applying industry knowledge to the Wachusett Wind Site expansion, and to its unique natural environment and the rights and safety of those who choose to avail themselves of its privilege.

I paraphrase when I say, that each incident or accident caused by un-mindful actions is an unnecessary event and will decrease the public acceptance of wind energy.

The opportunity to comment, to me, is a privilege -- that I thank you and your office for upholding this.

Wachusett Mountain has remained a beacon, through many of Massachusetts’ cultural eras from pre-colonial times to through this day. It has been active in many of America’s periods. *The* monadnock, of the 100 miles from the Atlantic Ocean to the Berkshires, Wachusett shares its notoriety with no other.

To this it was acquired, and needs to remain protected.

Sincerely

John P. Mollica

Section
1

setback

1.0 SETBACK

1.1 SUMMARY -- SETBACK

- WTGs (wind turbine generators) are evolving in height, blade size, power generated as well as land area required (per WTG) to accommodate these increases
- Putting distance (setback) between a wind turbine generator (WTG) and people (businesses, homes, public and private property, roads, etc) is a wind industry precedent – a proven solution to the safety and annoyance issues arising in wind power site developments.
- By industry standards, the proposed ~three-megawatt WTGs, on the Wachusett Wind Site (WWS) should be cited on 45-90 acres – instead they'd be on 16-acres, at the property's limits, with no room for setback.
- The proponent's two WTGs setbacks are ~145-feet and 230-feet respectively, with blades distances 10-feet and 95-feet from Wachusett Reservation properties
- Setback distances are relatively consistent among wind power developers, researchers, standards groups, regulatory agencies, consultancies, and equipment manufacturers. The proponent's WTG setbacks don't come close.
- By not meeting industry-sanctioned setbacks, the EENF proponent ignores the rights and safety of Wachusett Reservation Article 97 environment
- The proponent (PMLD) has a documented, history of ignoring setback – both in the siting of their present WTGs and in siting their wind data monitoring towers. This has, and will continue, to increase the risk of harm and danger to the state park visitors, animals and habitat.
- The proponent's *accounting* and *their assessment of the setback risks*, in the Wachusett Wind Site EENF (#13229), are ignored and inadequate.
- The proponent's *mitigation of setback risks* is, in their EENF therefore incomplete, inadequate and not based on observation, experience and industry research and wind industry standards.

On Stagecoach Trail, the present WTGs are nearly overhead

- In the Wachusett Reservation environment, these risks for casualty will exponentially increase with the proposed wind site expansion.
- PMLD has failed to research and assess, and therefore to mitigate in their EENF the impingements and the danger to the Article 97 protected Wachusett Reservation environment. Of such, they should be comprehensively required -- before any sanction of this proposal is conditionally or permanently granted by any agency of the Commonwealth – for liability sake, for the unthreatened exercise of citizen's rights and vitally for their safety.
-

1.2 WTG EVOLUTION -- SETBACK

The evolution of WTG size and capacities is well represented in this accompanying graph. Larger WTGs required more siting space for each unit.

The present WWS WTGs are represented by the "50 kW" units (1985), and the proposed by the "1,500 kW" WTG shown (to the right).

Setback -- putting distance between a WTG and people (businesses, residences, public and private property, roads, etc) -- is the wind industry's proven solution to avoid many of the issues facing developers as they attempt to site a wind power project. Setback is the mitigation umbrella for wind power project, trying to find a home for a structure that is hundreds of feet tall, hundreds of feet wide, makes noise, throws ice, cast shadows, can fail structurally, has flashing lights, etc. Other than a wind resource and capital, space is the necessity.

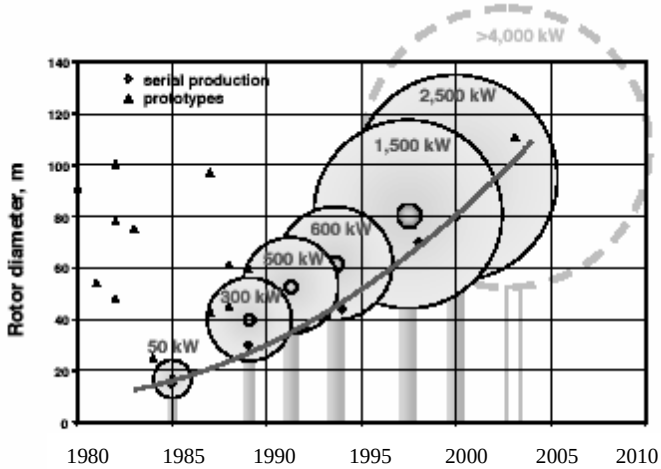


Figure 8 Development of sizes of wind turbines within the last years in Germany.

Figure 8 shows the development of sizes of commercially produced wind turbines within the last years in Germany, a tendency which can also be observed for other countries. The growing size is also accompanied by growing rotor tip heights, increasing the probability to scratch low clouds in wintertime and thus, the possibility for icing even in flat terrain. It might happen, that the ice sensors at the nacelle are not affected, but the outer part of the blades. Corresponding adaptation of the control system might avoid these effects.

(*Large Turbines Go Into Cold Climates;* Tammelin, Finnish Meteorological Institute (FMI); Seifert, Deutsches Windenergie-Institut; paper presented at the EWEC 2001,Copenhagen; ,2001)

A clear example is California's Altamont Pass site, with approximately 4,000 windmills erected there in the 1980's. They are located on the grassy hills between Livermore and the state's Central Valley. A lot of people drive through that area but few people live, work or play for a radius of 10-miles in any direction from there.

"Windfarms typically occupy 15 to 30 acres per MW of installed capacity."
(*Wind Energy Development: A Guide for Local Authorities in New York*; New York State Energy Research & Development Authority, Albany, NY October 2002)

In the present, state and federal government subsidies for production of energy from renewable sources, increases in WTG production and people concerned about the environment have created a rush to wind power. At the same time the lack of regulations and experience [mainly in U.S.], and the geometrically increasing size of WTGs have led to siting issues with developers who are *not* using industry guidelines in this area.

"Wind turbines are normally erected far away from houses, industry, etc., as the wind conditions are not favourable in the vicinity of large obstacles. Furthermore, with regard to acoustic noise emission and shadow flicker certain distances are required by national (European country) regulations, when wind farms are planned in the neighbourhood of residential areas. Thus, wind turbines should not cause risks as far as ice throw is concerned. However, the turbines are erected close to roads or agricultural infrastructure in order to avoid long and expensive access roads for erection and maintenance. This induces a risk for persons passing by the wind turbines, cars passing the streets if ice fragments fall down from a turbine."
(*Risk Analysis of Ice Throw From Wind Turbines*; Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS, April 2003)

Setbacks are not always the same. Yet they are consistent relative to general use of the siting area (agricultural, wilderness, rural, recreation, etc) as well as its geography and weather. These consistencies tell -- that the proposed WWS expansion is not in the ballpark.

1.3 NEW YORK STATE - Setback

To the right are setback "examples" used in the New York state-*siting guide for local authorities*. The "structure height" referred to, is the distance from the ground (base of the WTG) to the blade tip fully extended vertically.

New York State Guide "Examples
Wind turbine setbacks from property lines

- Fenner/Stockbridge, NY – 1.5 x structure height plus rotor radius
- Martinsburg, NY – 300 feet (rear and side lot lines)
- Contra Costa County, CA – 3 x structure height or 500 feet, whichever is greater (from all boundaries)
- Cook County, MN – tower height
- Wasco County, OR – at least 5 rotor diameters"

(*Wind Energy Development: A Guide for Local Authorities in New York*; New York State Energy Research & Development Authority, Albany, NY October 2002)

1.4 NWCC- Setback

The National Wind Coordinating Committee (NWCC), is an industry collaborative, with a very broad base of members from across the wind industry, including federal agency representatives. Their siting examples (on the next page) use the regulations of nine California counties in their *Permitting of Wind Energy Facilities: A Handbook.*

A NWCC member is Community Energy, Inc. the owner, operator and maintainer of the proposed WWS expansion "facility." Of the nine "Principal Contributors" to this handbook is Dick Curry, of *Curry & Kerlinger, LLC* (a consulting firm to PMLD on this EENF project).

The WWS developer, Community Energy, Inc, should report as to why they choose to disregard the recommendations and examples of a collaborative in which they hold membership.

1.5 WECO – Ice Setback

WECO - *Wind Energy in Cold Climates* is an annex of the International Energy Agency, IEA R&D Wind, an international collaboration gathering and providing information about wind turbine icing and low temperature operation.

WECO's setback recommendation is cited in a Finnish Meteorological paper. "Especially when installing wind turbines close to human activities (buildings, skiing resorts, roads, ship routes etc.) a special attention to the possibility of ice throw has to be given.

"In the (Wind Energy in Cold Climates) project a distance of 1.5 (hub height + rotor diameter) between the turbines and the nearest object has been recommended if no special precaution is foreseen at ice endangered sites." **(***Large Turbines Go Into Cold Climates;* Tammelin, Finnish Meteorological Institute (FMI); Seifert, Deutsches Windenergie-Institut; paper presented at the EWEC 2001,Copenhagen; ,2001)

NWCC "Setback: Property Lines

- *Alameda* – 1.25 x total WECS [same as WTG] height from all property lines
- *Contra Costa* -- 3 x total WECS height or 500 feet (whichever is greater) from exterior project boundaries
- *Kern* – 1.5 x total WECS height from all exterior boundaries i9f adjacent to parcels of 40 acres or more
- *Merced* – 1.25 x total WECS height from any exterior property line
- *Monterey* -- 2 x total WECS height from any property line
- *Riverside* -- 1.25 x to 3 x total WECS height from any lot line
- *Solano* – Minimum 1.25 x total WECS from any property line [can be waived by abutter]
- *Palm Springs* – 1.25 x total WCES height from any lot line"

(*Permitting of Wind Energy Facilities;* NWCC Siting Subcommittee; Washington, DC; August 2002)

1.6 GREEN MOUNTAIN POWER – SEARSBURG, VT – Setback

Installed in 1997, eleven previous generation 660-kW WTGs operate in Searsburg, Vermont. These machines are about 200-feet high and located on a mountain ridge at elevations similar to the WWS.

This site is restricted from the public except by guided tour given during warmer months. The generators are turned off while the public is onsite. These cautions are based on the risk of ice throw, the general release of WTG parts, or fall-over. Setback is Searsburg's mitigation strategy for public safety.

At present this is the only online commercial venture into wind power in New England. The proponent during the development of their proposed expansion used the Searsburg site often, as a model.

The WWS proponent should report on why they have not chosen such caution as has Searsburg, in a site that is wholly more accessible.

1.7 FPL ENERGY. LLC -- Setback

An example of a typical wind industry negotiation is given using FPL Energy, LLC -- a "leading unregulated wholesale generator of clean energy." A subsidiary of FPL Group ($8 billion annual), FPL Energy, LLC is the Leader in wind power development in United States with 36 wind facilities in 14 states representing 20% of the company's portfolio.

In Addison, Wisconsin, the Town Board negotiated setback with FPL Energy. " The project developer proposed a setback of 650-feet around each turbine (approximately 2.5 x the maximum turbine height including the rotor) to address concerns about noise safety and visual aspects. The town decided to expand a minimum of 1000-feet from any residences, road right-of-ways or property boundaries."
(*Wind Energy Development: A Guide for Local Authorities in New York*; New York State Energy Research & Development Authority, Albany, NY October 2002)

Examples like this one abound in the industry news and literature, and the setback figures are consistent. The WWS proponent's setbacks are a fraction of those requested by the leader in wind energy development in the U.S.

1.8 GENERAL ELECTRIC (MANUFACTURER) – Setback

Exhibit 1.8 is an email exchange between a person that I asked to write and General Electric. GE is one of two turbine manufacturers that the proponent considered. Their 1.5 mW machines are equivalent to the NEG Micon WTGs specified in the EENF.

The email was passed on to GE's Lorraine Friedland (lorraine.friedland@ps.ge.com) of "our Land and Permits department."

The exchange highlights that this manufacturer recommends that "the standard (average) setback should be 1000 feet from any inhabited structure, road, or other type of access." The reason stated by GE for this is, "for performance and above all - safety reasons."

The proponent should report on what the specifications of NEG Micon are in this regard. A letter from proponent should request that the manufacturer document what their recommended setback is, and if they'd sanction their turbines placed less than 150-feet from a well traveled state park trails – in an ice zone.

As well, I've included in **Exhibit 1.8a**, and exchange between a person (John Bomba, innkeepr@aol.com) seeking set back recommendations from NEG Micon (proposed EENF proponent WTG choice). Their minimum setback , not accounting for ice and noise, is the WTG height (365-feet).

-----Original Message-----
From: yahoo.com]
Sent: Tuesday, February 04, 2003 11:54 AM
To: PS Wind Energy US (PS, Wind)
Subject: Tower Setbacks

To whom it may concern:

I'm currently investigating the feasibility of one or more of the 1.5MW turbines on my property with a private wind developer. One concern I have is the setback from any houses or property lines. Does GE have recommendations I can use as a rule of thumb for my house and my neighbors house or property.

To:
Subject: *RE: Tower Setbacks*
Date: Tue, 18 Mar 2003 12:07:31 -0500

Mr. Clark:

Depending which state your property is located, the standard (average) setback should be 1000 feet from any inhabited structure, road, or other type of access. Please check with your State or County with regards to any noise regulations for wind turbines, as each State and County is different. Our website has technical data on our 1.5 machine that you can view or download that describes the noise levels.

Sorry for the delay and thank you again for your interest in renewable energy.

Lorraine Friedland

EXHIBIT 1.8
GENERAL ELECTRIC
(TURBINE MANUFACTURER)
EMAILS ON WTG SETBACK

From: yahoo.com]
Sent: Tuesday, March 25, 2003 1:48 PM
To: *Friedland, Lorraine J (PS, Wind)*
Subject: RE: Tower Setbacks

Dear Ms. Frieland

Thank you for your letter regarding the setback recommendations for the 1.5 units. This recommendation would limit the number of units I would be able to install by 2. What is the reasoning for this 1000' setback? and is there any way around it. If its noise or safety is there any mitigation steps I can take to get around the 1000' setback so I can get the two additional units on the plan.

Please reply as soon as possible. Time is of the essence.

Sincerely,

Robert Clark

From: lorraine.friedland@ps.ge.com | **This is Spam** | **Add to Address Book**
To: ahoo.com
Subject: RE: Tower Setbacks
Date: Tue, 25 Mar 2003 17:48:12 -0500

Ms. Clark:

The setbacks are established by the county in your area, as well as, for performance and above all - safety reasons. The noise standards are what we have to follow as decreed by your state or county. You will need to check with them directly.

Tue, Apr 20, 2004 4:13 PM

Date: Mon, 19 Apr 2004 11:51:02 -0700
To: <innkeepr@aol.com>
Subject: RE: Turbines in New England

Dear John,

In response to your email, the minimum requirement for safety would be the height of the tower plus blade at 12 o'clock position. Other things to consider would be noise levels and potential for icing.

Regards,
Cynthia Wong, P.E.
Vestas-Americas
tel: 416 466 6684
fax: 416 352 6075

----- Forwarded by Birgitte Beck Larsen/RADK/NEG Micon on 13-04-2004 14:06 -----

InnKeepr@aol.com
11-04-2004 04:55

To: purchase@neg-micon.com
cc:
Subject: Turbines in New England

I'm looking at the 1.5 Mw turbine for a site in New England. As you know, like Europe, New England has a large population density. What would your companies (manufacturer) recommendation be as far as any type of a property setback for safety?

Thank you for your assistance in this matter.

John Bomba

Exhibit 1.8a NEG Micon (Manufacturer) – Setback

Emails to/from NEG Micon with respect to turbine Setback

1.9 PROPONENT (WWS) – PROPOSED SETBACKS

This table gives the distances from the proposed WTGs to the property boundaries – which in all cases in is the Commonwealth's Wachusett Reservation.

WTG SETBACKS – To Commonwealth Boundaries

	Boundary	Distance - Blade to Boundary	Setback - Distance Tower to Boundary	WWS Setback Distance - % of WECO Setback
Turbine #1	North	10-feet	145-feet	19%
	East	10-feet	145-feet	19%
Turbine #2	South	95-feet	230-feet	31%
	West	185-feet	320-feet	43%

Note: distances are estimates per EENF maps.

None – of these setbacks – come close to industry recommendations. Turbine #1 actually couldn't get any closer lest its blades edge over the Reservation's boundary lines.

See **Exhibit 1.9**, a WWS site layout included in the EENF. It compliments the table of setback distances within this section.

Turbine #1 is located in the northwest corner of the WWS.
Turbine #2 is located in the southwest side of the WWS.

The EENF, Section 3.2.3, is revealing. It refers to noise impacts relative to "the nearest private property." Perhaps this is the issue – the proponent is clueless of the rights granted under Article 97? Either that or they may figure if they don't bring setback up – and its accompanying issues, it might go un-noticed?

1.10 WACHUSETT SETBACK – BOTTOM LINE

The messages from all of the above is that:

- Wind industry uses setback to mitigate annoyances and safety risks
- Industry setbacks are consistent
- Setback is disregarded at WWS
- Due to proximity of the WWS (proposed turbine locations) and the Wachusett State Reservation *lack of setback* of proponent's WTGs will cause annoyance and threaten the safety of the Commonwealth's citizens
- Of rights and safety sake, PMLD (the project proponent) should be comprehensively required to report on its research, assessments of risk and mitigations for the impingements and the danger, to the Article 97 protected Wachusett Reservation environment that their chosen WTG setback distances will present -- before any sanction of this proposal is conditionally or permanently granted by any agency of the Commonwealth.

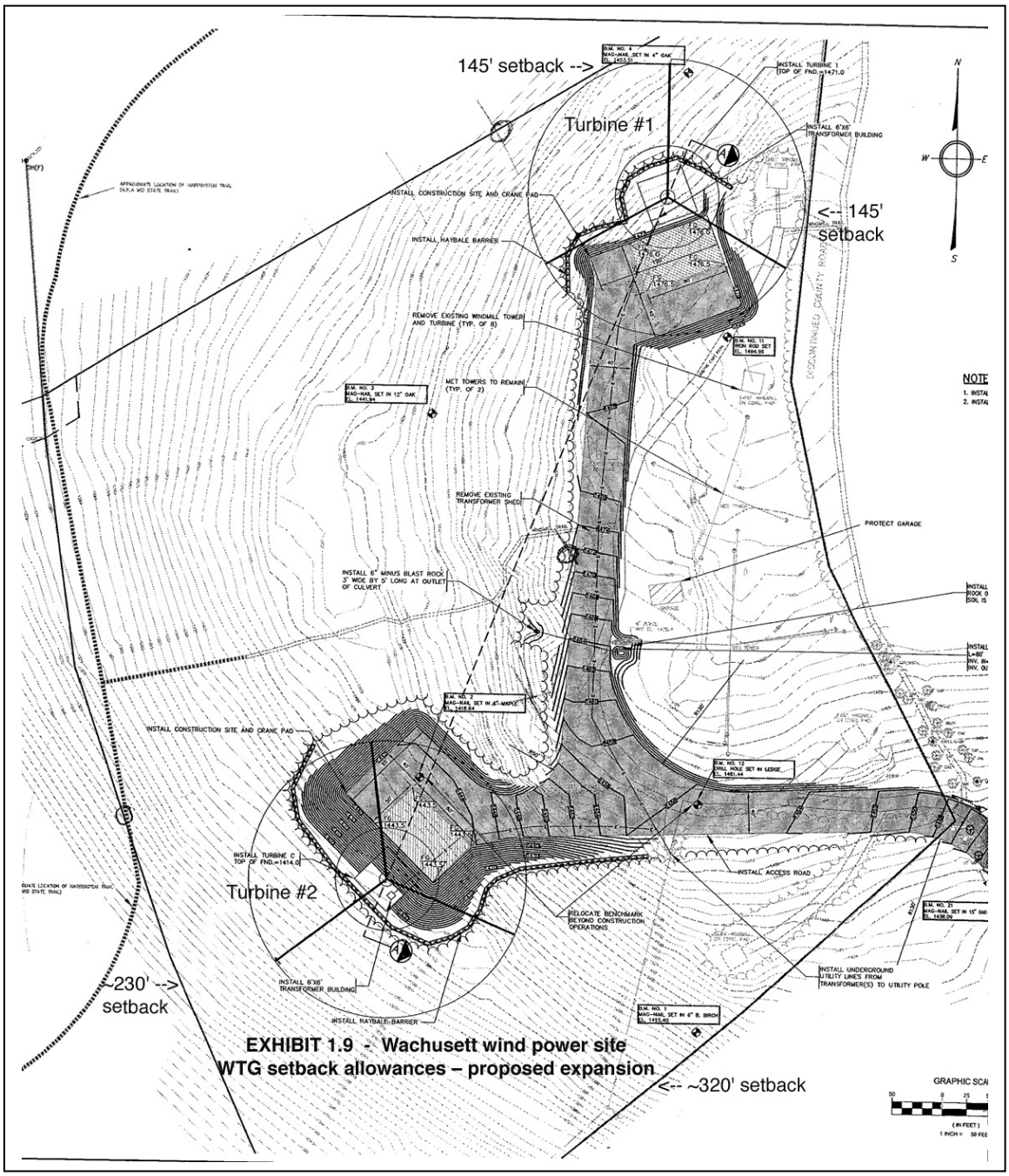


EXHIBIT 1.9 - Wachusett wind power site
WTG setback allowances – proposed expansion

Section
2

Icing – safety

2.0 <u>ICING / SAFETY</u>

2.1 SUMMARY -- ICING / SAFETY

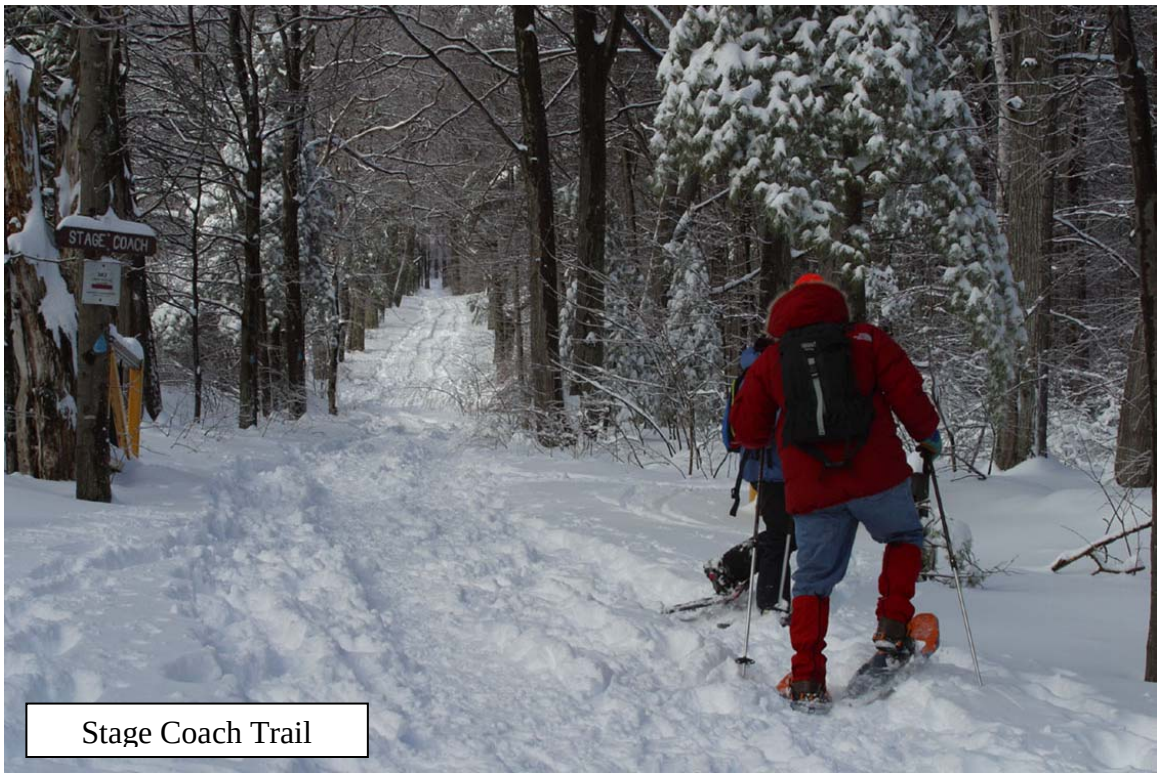
- The proponent's *accounting* and *their assessment of the risks* due to WTG (wind turbine generator) icing at the Wachusett Wind Site (WWS) in their EENF (#13229) is understated and non-quantitative
- The proponent's *mitigation of icing risks* is, in their EENF, incomplete, inadequate and lacking a strategy based on observation, experience and industry research and wind industry standards
- Wachusett has a documented, history of ice related incidents and damage. This continues to this day and has been observed by myself and by others. At the WWS, this has been recently documented in photos, videos and ice samples.
- From moving and stationary blades, ice is thrown or released (falls and is blown away). It is also accreted on the nacelle (generator housing) and towers – all a potentially lethal present threat to the Wachusett Reservation environment (visitors, wildlife and habitat). Risks for casualty will exponentially increase with the proposed expansion. From a 1/2-inch ice storm, 40-tons of ice perWTG (wind turbine generator) will fall.
- The WWS ice zone encroaches *now* on the state park lands. Conservatively, and based on industry research and studies, the proposed expansion will intrude onto an ~100-acre area of the Wachusett Reservation. It will blatantly violate rights to the natural environment granted, ensured and protected by Massachusetts Constitution Article 97.
- Beyond ice throw, wind industry research shows that current WTG design and the operations of such in cold climates are not standardized, classified or even engineered. This can result in unbalanced loading of blades raising serious questions about WTG structural integrity, equipment over-powering and safety. The proponent should provide evidence of having had the proposed WWS expansion engineered and approved -- under verified and quantified conditions.
- Proponent shows no evidence of understanding wind industry cold climate science including research, studies, findings and recommendations in their EENF.
- Proponent shows no evidence of having performed any cold climate studies at their site over the last 20 years – never contributing to this body of science or recognizing its value.
- THE SOLUTION to ice safety is setback -- of the WTG towers from property lines, roads, trails, residences, conservation lands, etc. This alone is recommended and relied upon by the wind power industry. All else is unproven.
- Risk-filled ice mitigation studies or experiments, in intimate proximity to a protected environment (such as Wachusett), should not be permitted.
- PMLD (the project proponent) has failed to research and assess icing, and therefore to mitigate in their EENF the impingements and the danger, to the Article 97 protected Wachusett Reservation environment, their proposed WTGs will present. Of such, the proponent should be comprehensively required – before any sanction of this filing is conditionally or permanently granted, by any agency of the Commonwealth – for liability sake, for the unthreatened exercise of its citizen's rights and vitally for their safety.

2.2 ICE SAFETY – ASSESSMENT & COMMENT - BRIEF

"The safety of the wind turbine as well as the vicinity of the site will be also affected by icing or in general by cold climate operation. Ice fragments thrown away or even large ice pieces falling down from the rotor can harm persons or animals or damage objects." (*Technical Requirements for Rotor Blades Operating in Cold Climate,* by Henry Seifert, DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, 2003)

Wachusett Mountain it is often mentioned as having 3/4 – 1 million visitors each year, mainly skiers and autos traveling to the summit. The Machis Pond area is perhaps the most frequented, on-foot, trailhead – and is the beginning of Stage Coach Trail which serves as the access to the present WWS. The trail continues as a pathway for the entirety of the WWS's east side boundary. One-half of the WWS west boundary and its northern boundary is traced by the combination Harrington and Mid-state Trails. **Exhibit 2.2** shows cars parked on Westminster Road at Machis Pond the morning after a mid-winter snowstorm. The amount of cars and the Stage Coach Trail packed snow reveals its popularity even in winter.

Comment-Section	EENF ASSESSMENT	COMMENT
2.6.1	Being hit by ice from trees is a greater risk than from windmills.	Moot - thousands of trees, just two windmills. Forces of ice from WTGs are exponentially greater than trees. OSHA and insurance company actuaries need evaluate these risks.
2.6.2	Five ice accretion days at WWS annually.	More ice days than five documented in each of the last two winters. UMASS cites ice at WWS for missing wind speed data. PMLD consultant –Dr. Manwell (UMASS) cites ten-year study map shows that on Wachusett – ice happens much more than five days.
2.6.3	Large tower diameter deceases ice accretion.	Basis? Industry photos show dangerous accretion on large monopole towers.
2.6.4	Slower blade speed [rpm] and reduced turbine number reduces risk of ice throw and accretion.	Blade tip speed (throw velocity) is the critical factor. This will double in the proposed WTGs over the existing WTGs. Surface area determines accretion – the total blade area of proposed WTGs (~1/4 acre) is 5 times that of present blades.



Stage Coach Trail

Westminster Road

EXHIBIT 2.2 -- Wachusett reservation
Stage coach trail – administration road – morning after snowfall

2.3 ICE SAFETY – MITIGATION & COMMENT - BRIEF

"Developers and owners of wind turbines have a duty to ensure the safety of the general public and their own staff. However there are no guidelines for dealing with potential dangers arising from ice thrown off of wind turbines. This puts developers, owners, planning authorities and insurers in a difficult position."
(*Assessment of Safety Risks Arising From Wind Turbine Icing*; by Morgan, Bossanyi, Grand Hassan and Partners Ltd. Bristol BS18 9JB and Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS IV, April 1998)

Comment-Section	**EENF MITIGATION**	**COMMENT**
2.7.1	Sensors will monitor ice accretion and signal a turbine shutdown	Industry studies show that reliable sensors "do not exist." Design standards for ice sensors? They have yet to even be defined.
2.7.2	Ice sensor installed on nacelle roof.	Industry study shows that ice can accrete in amounts of up to seven times in elevation differences of just 22 meters (72 feet). Blade tips can accrete ice while the sensor, on nacelle, is oblivious. WWS experience/photos show such an observable fact.
2.7.3	PMLD will use SCADA (computer system) to monitor site conditions and control WTGs.	SCADA dependent on *unreliable* onsite sensor data to control WTGs.
2.7.4	Monitor power curve to to control (stop) ice accreting WTGs.	Power curve determination relies on an anemometer which industry studies have determined are inconsistent, "give faulty information" and "should be used cautiously" as an ice indicator.
2.7.5	Vibration Sensing	Rime ice – which accretes at WWS – evades this incomplete procedure.
2.7.6	Blade jogging to clear ice	An economic practice, to ensure a return to power production. An ice shower – dangerous to wind site staff, state park habitat and visitors. Remaining ice is thrown or blown.
2.7.7	WARNING signs on wind site perimeter	You've wandered into the DANGER ZONE – please leave your state park.
2.7.8	Five free acres	For the Commonwealth…no charge for the liability

2.4 ICE RELEASE – TWO PROPOSED WTGs (1/2-INCH ACCRETION)

	Surface Area - sq. ft.	Volume – cu. Ft.	Weight – lbs.	Weight – tons
6 Blades	11,004	451	27,962	13.98
2 Nacelles	2,180	90	5,580	2.79
2 Towers	17,658	733	45,446	22.72
TOTALS	**30,842**	**1,274**	**78,988**	**39.5**

Note: Based on WTG dimensions within EENF.
Proposed WTG blade is 10-foot wide maximum. A width used for calculations is 7-feet (average based on "Rotor Solidity" specification of 5% in EENF).
Surface area of nacelle bottom was not included in determining surface area.
Ice weight is ~62-lbs. Per cubic foot. An accretion of 1/2-inch is used for calculations, although at the WWS up to 2-inches have been documented in the last two winters.
For one-inch of ice – its volumes and weights double, etc.

2.5 PHYSICAL COMPARISON – Present WTGs vs. Proposed WTGs

	WTG – present	WTG – proposed	Proposed Increase
Single Blade (area)	44 sq. ft.	917 sq., ft.	20 times
All Blades (area)	1,056 sq. ft.	5,502 sq. ft.	5 times
Swept Area -- one WTG (circle created by blades as they rotate)	1,502 sq. ft. (.034 acres)	56,410 sq. ft. (1.3 acres)	37 times
Swept Area – all WTGs	12,016 sq. ft. (.28 acres)	107,825 sq. ft. (2.6 acres)	9 times
Blade Tip Speed	110 mph	204 mph	~ 2 times
Tower height	100 ft.	230 ft.	2.3 times
Structure Height	122 feet	364 ft.	3 times

Note: blade areas given one side only (visual impact). Increase ratios remain the same.
The tallest building in Worcester, MA is 24-stories, 288-feet. The proposed WTGs at 364-feet could be considered the equivalent of a 30-story building.

The proposed WTGs will be based on a 250-foot sharp rise above the surrounding Westminster Road portion of the state park. This will add another 20-stories to their effective height for a total appearance of 50-stories (the size of Boston's Prudential Building) when viewed from a variety of locations within the Wachusett Reservation

EXHIBIT 2.6.1 - Wachusett Wind Power Site
Rime ice (White in center) – from 120-foot wtg – soaring over state park

2.6 PROPONENT ASSESSMENT of IMPACTS OF ICE RISKS
(EENF SECTION *3.2.7 PUBLIC SAFETY*)

The proponent's EENF assessment of impacts of icing risks is inadequate, non-quantitative, ignores the wind industry's recommended practices and is limited to the following:

1. ***EENF Assessment:*** "The risk of a hiker being hit by ice is less than from trees."

   Comment: Certainly this is true, but moot…as there are *hundreds* of trees but there are *only two* proposed WTGs on the Wachusett Reservation that visitors can walk under. Ice thrown or released from trees at the WWS is in size, weight, distance and resulting forces fractional compared to that of the ice from the WTGs -- as shown in the pictures below and verified by DCR personnel in an onsite visit in 2003.

   Comparative to ice released by trees, the present WTGs release much larger pieces of ice (up to 8.5-feet long by 2-feet wide documented at WWS -- verified by DCR personnel) and the proposed WTGs (with 131-foot by 10-foot blades) will release geometrically larger pieces of ice (full sheet of plywood size or greater is certainly possible), from higher heights, resulting in forces that are exponentially greater than those of trees. Trees in the vicinity of the WWS release ice from heights up to 50-60 feet tall verses the proposed 364-feet tall WTGs. Trees do not throw ice from blades moving at speeds of 61 meters per second (204 mph per EENF).

WWS nub size ice pieces released from trees (2003)

WWS 4-foot ice piece leaning off 165-foot data tower (same date as nubs)

   After an icing event, state reservation visitors will often believe that there is no ice risk, because the trees where they walk will be free of ice. We show the dangerous situation created in this assumption. **Exhibit 2.6.1** show release of ice from the present WTGs, soaring the Wachusett Reservation, after the rest of the environment's ice in the has melted and fallen off.

A 5 x 5 x 2-inch chunk of ice weighs about 2-pounds. Thrown from a windmill blade traveling 200 mph (tip speed per EENF) or 293-feet/second, **the ice will have energy of 2,667 foot-pounds**.

$$\text{Energy} = \frac{\text{weight x speed}^2}{\text{2 x specific gravity (32.185)}}$$

Comparatively, a bullet fired from a rifle has 2,145 foot- pounds of energy at 100 yards. (rifle type: 30-06; bullet: 125-grain (1/4 ounce))

2. *EENF Assessment:* "Up to five ice events may be expected at the present wind site."
Comment: There is much evidence of more than five ice events occurring annually on Wachusett Mountain. I have personally documented seven icing events at the WWS during *each* of the last two winters. My visits were non-exhaustive – meaning that it is likely that more events occurred.

WWS gathers enough ice so that the UMASS Renewable Energy Research Lab in its *Wind Turbine Project* report for PMLD cited that in studying a two-year period of WWS winds speeds "The tower data had several gaps in it due to lightning damage and icing events including one of over a months duration." Note: these issues were with the wind data towers at 100 and 130-foot high, verses the proposed 364-foot WTGs. Studies, such as the one done on Finland's Pori Wind Farm, show that ice will accrete proportionately greater with elevation.

The following map depicts the New England, including Wachusett Mountain, freezing rain and drizzle over a 10-year period. It is included in a presentation by Professor Manwell of UMASS's Renewable Energy Research Laboratory, who has produced *Wind Energy: Cold Weather Issues* in June 2000 -- a consultant to the PMLD in this WWS expansion and quoted in the EENF. On site experience and studies show icing is minimally double PMLD assessments.

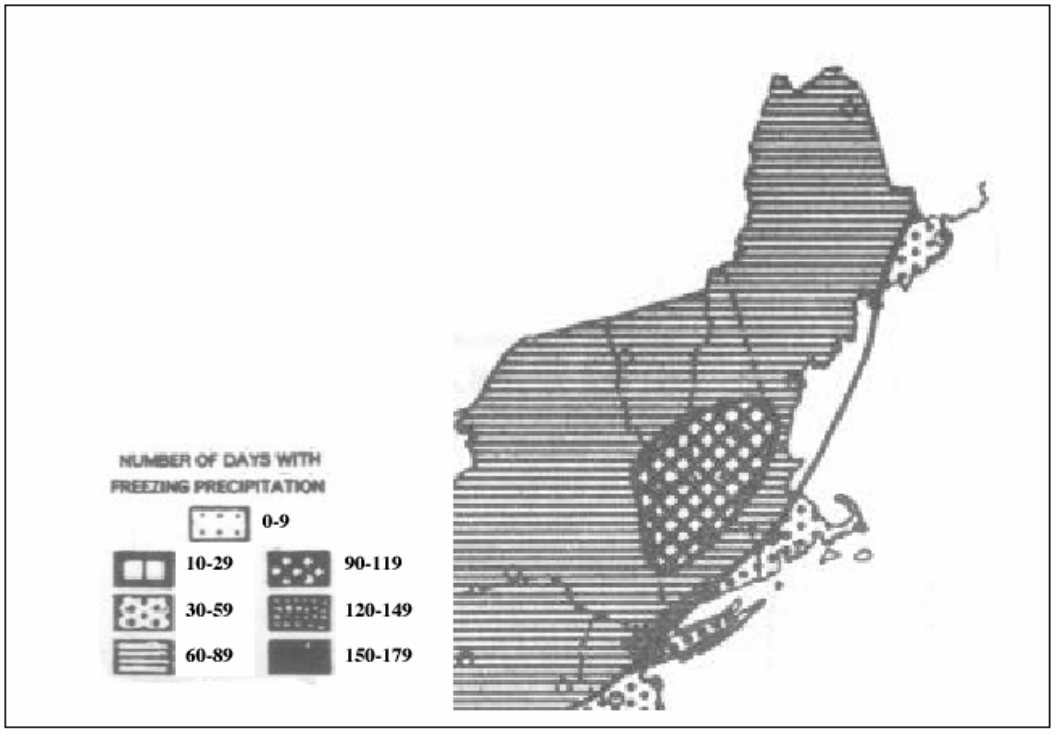


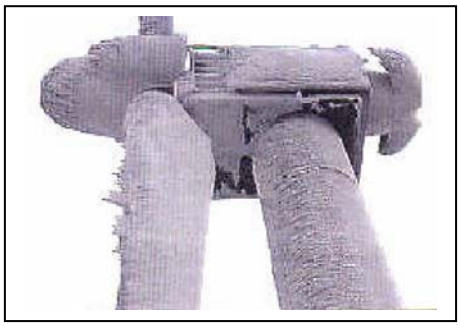
Figure 4. Total number of days with freezing rain or drizzle in the 10-year period from 1939 to 1948. Based on data from 95 Weather Bureau stations (Adapted from Bennett, 1959)

"New England and especially Massachusetts is an area of high occurrence for

glaze storms as confirmed in Figure 3 [not shown]. A study covering a period of fifty years of glaze precipitation in the United States conducted by Tattelman and Gringorten supports this claim."
(New England ice graphic and quote taken from *Wind Energy: Cold Weather Issue;* Dr. James F. Manwell **and** Antoine Lacroix; UMASS- Amherst, Renewable Energy Research Laboratory, June 2000)

"Ice thrown off the blade may also pose a safety risk even in areas where icing is infrequent, specifically when the turbines are situated close to the public, such as road and skiing resorts."
(*State-of-the-Art of Wind Energy in Cold Climates*; T. Laakso, H. Holttinen, G. Ronsten, L.Tallhaug, R. Horbaty, I. Baring-Gould, A. Lacroix, E. Peltola, B. Tammelin, WECO, April, 2003)

3.EENF Assessment: [speaking of WTG towers] "The larger diameter and surface area decreases the likelihood of ice accretion as compared to the existing lattice style towers small diameter blades."
Comment: [assume the above EENF word "blades" is misplaced?] What is the basis that a larger diameter tower reduces ice accretion? In fact, in the industry literature as shown below, there is much evidence of large monopole towers (as are proposed in WWS expansion) covered with ice.



WTG – With Large Diameter Tower Completely Masked With Rime Ice

(*Assessment of Safety Risks Arising From Wind Turbine Icing*; Figure 1; by Morgan, Bossanyi, Grand Hassan and Partners Ltd. Bristol BS18 9JB and Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS IV, April 1998)

As the proposed towers warm up, from temperature increase or solar heating, ice adhering to the 230-foot tower surfaces will come off in sheets. Each ice piece will be carried from the towers a distance relative to its height on the tower, its size and shape, and the speed of the wind.

Ice from the present windmill towers and data monitoring towers is blown onto the Wachusett Reservation. At twice their height, and in close proximity to the Stage Coach and Harrington / Midstate Trails, ice from the new towers will be deposited in part upon these pathways and other commonwealth properties.

2.4 ***EENF Assessment:*** "The slower blade speed and reduced number of turbines from the existing eight to only two, also reduces the risk of ice accretion and throw."

Comment: Ice accretion is based on surface area, after all that is what ice adheres to. The proposed WTGs possess more surface area of blades (and towers and nacelle), so proportionally more ice will be accreted and released per icing incident. Total *blade* surface area and accreted ice will increase over 5 times from the present WTG to the proposed WTGs.

Present total WTG blade area is 2,112 square feet.
(blades are 22' by 2', two-sided, three per machine, eight WTG)
Proposed total WTG blade area is 11,004 square feet (1/4 acre).
(blades are 131' by an average 7' wide, two-sided, three per machine, two WTGs)

The speed (of the blade tip) at which ice will be whipped off will double from approximately 110 mph to 204 mph (based on the present 22-foot long WTGs blades moving at 70 rpm verses the proposed 131-foot WTGs blades with "Tip Speed 61.8 m/s", per EENF, Appendix C, Table 3,

2.7 PROPONENT MITIGATION OF ICE RISKS
(EENF *SECTION 3.2.7 PUBLIC SAFETY*)

The proponent's EENF mitigation of icing risks is incomplete, neither references nor is based on wind industry research and violates such research's findings and recommendations

1. ***EENF Mitigation:*** "PMLD will install sensors that monitor ice accretion, which will shut the turbines down during significant ice events."
   Comment: Industry studies show ice sensors are an immature technology.
   "The EUMETNET SWS [Severe Weather Sensor] II project proved that at present reliable equipment to measure atmospheric icing (freezing rain and in-cloud icing) do not exist. There are currently few detectors available to detect icing, but there is a need to improve them, to inform manufacturers about requirements for icing measurements as well as the occurrence and distribution of icing intensity."
   "It is important to produce definitions and specifications for measurement of icing and for ice sensors. This information is also required for safety standards for wind turbines."
   (both from *Measurement and Forecasting Atmospheric Icing on Structures,* page 4, European Concerted Research Action, COST 727, 2003)
   "However, practical experience at the Tauerwind [wind power study site] showed that all sensing systems tested reported different "ice information.""
   (*Technical Requirements for Rotor Blades Operating in Cold Climate,* by Henry Seifert, DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, 2003)

2. ***EENF Mitigation:*** "The ice sensor is installed in the roof of the nacelle (generator enclosure)."
Comment: The ice sensor on the roof of the nacelle will not always (nor even regularly) be able to detect ice that is being formed on the outer portions of the blades. Result will be that the blades will continue to rotate -- collecting ice and releasing ice (due to the lack of aherence from the simultaneous sub-freezing and above-freezing temperatures that the blades will encounter) even as no icing is being sensed.

On Wachusett cloud cover/ fogging of the upper elevations and not the lower is a regular event. This results in warm weather fog and icing during the colder months at elevations above 1200-feet approximately. For example during the week of March 28- April 3, 2004 this happened four times—where the lower elevations (and that height varies) are not iced up, yet the upper ones are ice covered. This is very noticeable and the mountain appears to have a "frosting" like cap. See **Exhibit 2.7.2.**

We have photographed the present 50-meter data collection tower on the WWS with the upper anemometers frozen in ice while the lower ones are spinning. These heights vary by no more than 15 meters (~50-feet).

This phenomenon is included in various wind industry studies, for example at the *Pori Wind Farm* in Finland:
"In-cloud icing was seven times more frequent at the level of 84m than at the 62m level [73-foot difference] during the winter 99/00. Together with the earlier research this study indicates, that in-cloud icing will be more frequent at higher elevations. This has to be taken into account, when bigger and higher wind turbines are to be built at sites where icing conditions may prevail. Already, multimegawatt size turbines have been planned. It seems that the highest tip position of a wind turbine blade is about to increase in the future, and therefore it is more than likely that the tips of blades are going to undergo icing in near future at surprising sites."

"If the ice detection instrument is mounted on the roof of the nacelle, blade tips can undergo in-cloud icing without detection of icing and alert to the ice prevention system."
(both from *Results of Pori Wind Farm Measurements*, pages 80 and 81; VTT Energy Reports 42/2001, ISSN 1457-3350 by Marjaniemi, Laakso, Makkonen, Wright of VTT Energy, November 2001)

3. ***EENF Mitigation:*** "During weather conditions that may lead to icing, PMLD will supervise the site more closely. The turbine SCADA system will monitor the site 24 hours a day. The controls of the turbine will automatically perform the

EXHIBIT 2.7.2 Wachusett Mountain State Reservation
Ice cloud & icing at higher elevations

following functions in order to shut down the units and minimize the risk of ice throw during an icing event."
Comment: SCADA does not perform magic. It is the computer based observation system for the WTGs. It uses specific information (delivered from wind site sensors) to make control decisions and then telecommunicate them to the WTGs. SCADA's reliability is limited to the accuracy and availability of data it receives from the site sensors. It is also dependent on the host PC being available, and electrical power and telephone lines being intact. All are dubious during Wachusett area ice storms.

"Reliable prediction of energy production and fatigue loads on the wind turbine's components at inland sites can only be done if ice detectors deliver exact information about icing. Also the control of the turbines has to rely on sound information on icing conditions in order to shut the turbine down or react in another way to prevent the surrounding[s] or the turbine itself from harm or damage. The reliable detection of ice is an indispensable requirement for the operation of wind turbines in cold climates. These ice detectors and ice free wind sensors need standardized conditions according to which they can be designed and calibrated. These standard conditions are not available yet and have to be defined."
"Frozen or iced control instruments give faulty information to the supervisory system of the turbine."
(both from *Technical Requirements for Rotor Blades Operating in Cold Climate*, by Henry Seifert, DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, 2003)

4. ***EENF Mitigation:*** "The power curve is programmed into the control system and is always compared with the actual power output. When the mean (average) of the power is continuously out of the power curve for two minutes, it is an indication that ice has accumulated on the blades and the WTG will be stopped automatically."

Comment: What is not mentioned and hopefully understood about this scheme is that the programmed power curve determines what its electrical output should be based on wind speed data – coming from the onsite anemometers.

Industry studies based on site experiences show:
"..long term measurements with two types of anemometers – a heated and an unheated one – at the Tauernwindpark showed ambiguous results during icing events or snow fall at very low temperatures…"
(*Technical Requirements for Rotor Blades Operating in Cold Climate*, by Henry Seifert, DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, 2003)

"Ice sensors and also ice detection by using power curve plausibilisation or two anemometers – one heated, one unheated – is not reliable enough at the moment and needs to be improved."

(*Risk Analysis of Ice Throw From Wind Turbines*; Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS, April 2003)

5. ***EENF Mitigation:*** "Additional loads resulting from iced blades cause vibrations which are monitored by the control system. When the vibrations exceed the adjusted limits, the turbines will be stopped."
   Comment: Studies show that this is not always the case with different ice types. "Also, rime ice formation appears to occur with remarkable symmetry on all turbine blades with the result that no imbalance occurs and the turbine continues to operate."
   (*Assessment of Safety Risks Arising From Wind Turbine Icing*; by Morgan, Bossanyi, Grand Hassan and Partners Ltd. Bristol BS18 9JB and Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS IV, April 1998)

   See **Exhibit 2.7.5** of rime ice accretion at WWS.

6. ***EENF Mitigation:*** "Once the turbines are shut down and the warning sent, PMLD's staff must visibly check the site for ice accretion. The turbines will not be restarted until the ice melts away or is removed by jogging the turbine blades (jogging is a quick start and stop operation that flex's the fiberglass turbine blades enough to cause the ice to break off and fall to the ground."
   Comment: This methodology is inadequate and dangerous (for staff and bystander). Approaching a wind site that is throwing or falling ice is unnerving. I have shown people pictures of WWS icing…but it is not until they visit the site during an ice shedding that the imminent danger makes its point.

   Icing doesn't just accrete and the fall off or cling waiting to be jogged off. It has a natural life of its own – regarding the time of day, the time of winter, how thick it becomes, what type(s) it is, when it falls or is blown off, when it *does not* fall off…and stays for weeks.

   Jogging methodologies are never described in industry literature as a methodology for safely releasing ice from WTGs. It is an economic practice. It leads to questions unanswered in the EENF, such as:
   - What happens when the maintenance staff, because of the continual showering of WTG ice, cannot approach the WTGs? I have personal documentation of such conditions.
   - What happens when the ice sensors (located on the nacelle roof) are iced up? Does staff thaw them artificially – override their function so the blades can turn again? And will staff be in danger from ice falling off of the blades above the nacelle during the thawing procedure?

EXHIBIT 2.7.5 Wachusett Wind Power Site
Rime Ice formation on WTG blade

- What happens at night or the when the view of much of the entirety of the WTGs is obscured in fog (a cloud) that prevents observation of the ice either attached or falling off?
- What happens when the icing period is several days long, and visitors want to enjoy the beauty of the reservation's crystallized habitat? Will they have to wait for a blade jogging? Will there be several jogs?
- What happens to the ice that is jogged off? Will it fall into neat pile at the base of the tower? That's not what happens. I personally have seen thousands of pieces of ice be cast or released from windmills on the WWS. Given the proposed WTG's dimensions, ice will be flung and carried by the wind from its heights of up to 364-feet. It will shower not only the wind site but also a sizeable perimeter of the state reservation (as blades of one WTG set back a mere 10-feet from the reservation property line). Ice, the size and thickness of sheets of plywood and larger, will impact the reservation visitors, animals, habitat, stonewalls, etc. Thirty-one tons shed (~62,000 pounds) per 1/2-inch ice storm.
- What happens to the ice that will remain on the blades? – the entirety of the blade is not flexible, nor does it flex entirely in the direction of the jogging. Remaining ice will drop off or be thrown from the blades when it melts off or the machines are started.
- Nacelles and the towers do not flex - what happens to the tons of ice that remain on those WTG sections? Should visitors plan their visits around the eventual (day later, week later?) release or the blowing of ice onto Wachusett Reservation properties, including hiking trails – as it presently does. From the proposed higher structures ice will travel greater distances than the hundreds of feet I have presently documented (and has been witnessed by DCR personnel). It will land with geometrically greater forces.
- When the wind site staff performs the blade jogging procedure, protected in the safety of their in a steel WTG tower, how can they possibly see or warn state park visitors that may be anywhere within the tens of acres of forest that are exposed to the frozen, descending shower?
- Is jogging an OSHA or insurance approved activity?

"The rime [ice] build-up is quite hard but it is also less brittle than might be expected and remains attached to the rotor under significant flexure of the blades."
"However it is common practice for the [WTG] operator to accelerate the process by thawing the sensors and restarting the turbine with ice still on the rotor. This circumstance has been observed to lead to the heavy shedding of ice."
"There is significant evidence that rime ice continues to form when the turbine is operating and is not shaken off by blade flexing, even though this may be the case for other types of ice formation."
(all from *Assessment of Safety Risks Arising From Wind Turbine Icing*; by Morgan, Bossanyi, Grand Hassan and Partners Ltd. Bristol BS18 9JB and Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS IV, April 1998)

"During the winter time it may occur that – depending on the shape of the nacelle housing – snow and ice adds up on the top. Due to the heating of the generator and gearbox, the ice on the surface melts and results in a water film enabling the amount of ice or snow to slip down." "…close to the turbine high masses of possibly falling large and heavy ice fragments may be extremely dangerous…" (*Risk Analysis of Ice Throw From Wind Turbines*; Seifert, page 4; Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS, April 2003)

7. ***EENF mitigation:*** "Signage will be fixed on the turbine and site perimeter to warning [sp] passing pedestrians of the risk."

   Comment: Just what is the "risk"? The applicant needs to qualify what the risk is. The applicant needs to quantify the risk.

   The applicant needs to mitigate hazards – instead of choosing to warn park visitors with signs and to restrict them in their constitutional rights. Their lack of rigor in characterizing the context of icing on this site, and in using industry research and experience to understand it, trivializes the Article 97 experience, as well as the safety of those who exercise that right.

   Analogously… if your home and yard was 10-feet from your *neighbor's* 360-foot machine that threw or released tons of ice… would you allow for such damage to personal property, buildings, automobiles and the terror of your family trying to dodge the lethal ice shards? Suppose, your neighbor posted a sign -- warning you of the "risk" -- would it be ok then?

   Perhaps it would be informative to have a series of signs, which progressively quantify the increasing risks that state park visitors take as they approach the wind site? Or will the signs tell of how large a perimeter a visitor should keep to insure a specific level of safety?

   How about "If you can read this sign, you have a one-in-a-thousand chance of being struck by ice." Or maybe the *Wizard of OZ* sign "I'd turn back if I were you."

   What if a visitor didn't choose to pass by the wind site, but instead wanted to sit and eat their lunch on the bordering stonewall…under an ice shedding windmill…in a state park.

   Why is the constitutionally protected Wachusett environment - property, wildlife and visitors even being asked to consider such a proposal – laden with disrespect and risk? I fail to see the "higher public standard" that applicant (PMLD) refers to itself as meeting.

PROPONENT *SUPPLEMENTAL* MITIGATION
(EENF *SECTION 3.3.1 Enhanced Recreation*)

8. ***EENF: "***PMLD will give DCR approximately 5 acres of land not developed at the wind farm."
   Comment: This proposal considers transferring the northwest corner of the WWS property to the Commonwealth. This ~5 acre tract is merely feet away from both proposed WTGs -- an area of extreme risk for visitors and high liability for DCR during and following icing events *and* otherwise – an invitation for the state park guests to become even more intimate with the proposed ground-zero ice jogging routine.

2.8 WACHUSETT– ICE HISTORY

Icing is not a condition unfamiliar to the 2,006-foot Wachusett Mountain. Being part of its history, it is beautiful to see and increases in frequency and severity with elevation.

On Wachusett's southwest side, the two proposed WTGs will stretch to elevations approximately 1,775 and 1,835-feet respectively. Sitting beyond natural protection, they will experience the lion's share of intensity of Wachusett icing events.

2.8.1 Report of the Commissioners – Wachusett Mountain State Reservation

On July 5, 1899 Wachusett Mountain State Reservation Commission was created and submitted their first *Report of the Commissioners* in the year 1900. The initial 533 acres taken t o create the reservation included the properties now adjacent to the WWS and containing Stage Coach Trail – an easement for which this EENF is filed.

Within their initial reporting the commissioner's cite, "Much damage was caused by the ice storm in November of the present year…" In the same paragraph, they write, "annual wind and ice storms and other natural forces are operating…"

Nearly 100 years later in the *Resource Management Protection Plan* for the Wachusett Mountain State Reservation, the Commonwealth's Department of Environmental Management refers to the same – ice storms.
"Wachusett mountain is also particularly susceptible to winter ice storms (freezing rain) due to its elevations, as well as rain and fog. Deposition of ice is usually limited to the area above 1,500-feet (457 meters). Tree damage at this elevation 9is particularly substantial."
(*Resource Management Protection Plan, Wachusett Mountain State Reservation;* Massachusetts Commonwealth: DEM, prepared by Epsilon Asosciates; page 2-2; June 1999)

In the 1990's, an extraordinary uncommon natural resource was discovered on Wachusett. This *Old Growth Forest* is a rarity that has been studied, classified, and protected. The promise of even more acres of such has been identified and awaits verification. *Old growth* is here today because these trees represented neglible economic value in the 1700's and 1800's – they were too small, too twisted, gnarled and too hard to harvest – so today this treasure remains, a result of Wachusett's ice storms.

"Wachusett Mountain is the highest peak east of the Connecticut River and is the second oldest reservation in the state. It has the oldest red oak (328 years) in the world and some of the oldest known yellow birch at 374 years old. A long history of ice, snow and wind damage, as well as porcupine browse, has resulted in trees that are stunted with gnarled canopies, making them less desirable over the years for cutting, according to Orwig. "Wachusett contains a wealth of information and should be afforded the strictest protection before it's too late," he said."
(*Old Oaks and big lizards unique to Mt. Wachusett*; Phyllis Booth; The Landmark. Page 1, April 2004)

2.8.2 WWS Icing Experience of Former PMLD Employees

When interviewed by myself former PMLD employess:

- Recalled that during prolong windmill periods of icing PMLD employees would climb the present towers to "chip ice" off the blades, to get the windmills operational again
- Recalled ice falling from the WTGs and:
    - going through the windshield of the PMLD pickup truck,
    - going through the roof of the present windmill control shack, requiring the addition of a double roof made of thick wood
    - damaging an onsite transformer enough to require 1/4" plate steel welded to its top for prevention of further harm
    - piercing the roof of the wind site equipment barn

See **Exhibits for 2.8.2**.

"Is there an Icing Problem? We should not experience any icing problems at our site."
(*PMLD Powerpoint slide*; Q&A in a presentation before the *Wachusett Mountain Advisory Council* (WMAC); by PMLD; July 2002)

"Is There an Icing Problem? No. We should not experience any icing problems at our site. The existing lattice tower and units are more prone to icing and PMLD has not experienced icing problems in 18 years."
(*PMLD's Wind Farm Project, Frequently Asked Questions*; PMLD; December 2002)

2.8.3 WWS Icing Experience of John P. Mollica

During the past two winters seasons 2003- 03 and 2003-04, I have personally, with help, monitored the WWS documenting seven icing events in each winters. There were more icing events, but I have documented this number with details, pictures, and video recordings. I have spent over one hundred hours in an effort to comprehensively understand these cold weather icing events and the present eight WWS turbine's interaction with them.

I've witnessed thousands of pieces of ice, from fraction of an inch size, to pieces 8.5-feet long by 2–feet wide (the largest size I've documented). Up to two-inches thick, I've seen ice fall off, be blown off, and be thrown from the present 120-foot WTGs. I've seen the windmills spin with the blades ice covered -- without loosing any of it, and have seen ice being blown off the windmills and onto the reservation property whose trees were ice free.

Although cautious, I have been nearly hit by ice a few times over the past two winters. This year, I saw one group of three park visitors nearly hit by a five-foot by one-foot ice chunk flying off the WTG near the WWS entrance. It hit the ground about 20-feet from them – as they walked on Stage Coach Trail unaware of this.

EXHIBIT 2.8.2 Wachusett wind Power Site
Approximately 2-inch Glaze Ice on 22-foot Blades

EXHIBIT 2.82 WACHUSETT WIND POWER SITE (2003)
3-FOOT HOLES -- CONTROL SHED ROOF – ICE FROM 120-FOOT

This winter the turbines have been idle, prevented from running. Last winter, it varied but usually four windmills were active.

I have seen the ice piled in the vicinity of the turbines like a thousand broken glasses. I've found it thrown onto the Wachusett Reservation over 300-feet away.

These icing events have been witnessed at least on two occasions by a DCR Wachusett Reservation ranger and supervisor who accompanied me. The ranger found a piece of ice, just off of the present Stage Coach Trail access road, thrown ~300-feet from a WTG, nearly the longest throw I've recorded. The DCR supervisor witnessed a foot long piece of ice driven wholly into a crusted snow that we could walk upon. This piece landed beside the reservation's Stage Coach Trail, beyond where the access road enters the WWS.

In two winters, I have seen PMLD personnel onsite at WWS only once during icing conditions. I have seen their footprints in the snow twice. In January 2003, I presented the dangers of ice at the WWS to the PMLD Light Board. After promising to look into it, ice was never mentioned again at their public meetings. I never received any word from them.

See **Exhibits 2.8.3** to view few -- of the hundreds of pictures taken of these experiences.

2.9 WIND INDUSTRY – ICING STUDIES, ASSESSMENTS AND MITIGATIONS

2.9.1 COLD WEATHER & ICING RESEARCH

For the last ten years, the European wind industry has seen a serious need to characterize and extend wind power into cold climates. There, ice research and on-site studies are proliferating, although there are pleas for many more site studies and for manufacturers meeting the demands for cold climate equipment. Although making strides, consistent power production and safety issues are far from solved, as the literature will testify

In the U.S., wind sites are being installed in three general cold weather climatic regimes. In the north central region, such as Minnesota, turbine icing is uncommon due to the low humidity. In the northeast, such as Searsburg, Vermont, turbines are located on low altitude mountain ridges or in coastal regimes where icing is frequent. The last area of cold climate sites is along the arctic coast, such as Kotzebue, Alaska. These sites experience icing, cold temperatures and high density air flows.

With, to date, relatively few cold weather wind sites in the U.S., research in cold weather wind power issues is near non-existent. Professor Manwell of UMASS's Renewable Energy Research Laboratory (a consultant to the PMLD in this WWS expansion) has produced *Wind Energy: Cold Weather Issues* in June 2000.

International scientific activities on wind power in cold climates and icing include studies, research, characterizations, calculations, etc. As well, there are European- based

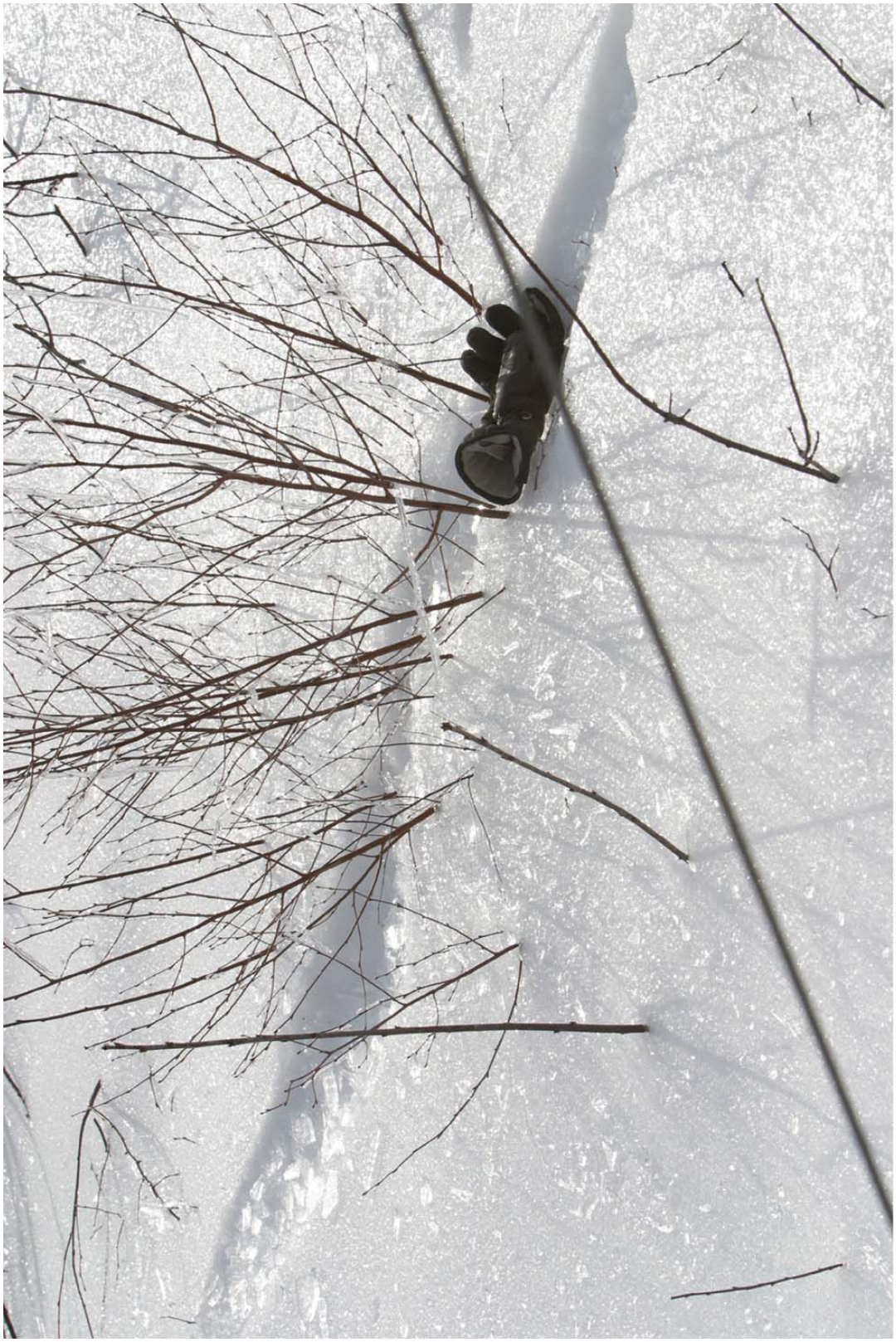


EXHIBIT 2.8.3 WACHUSETT WIND POWER SITE (2004)
8-FOOT GLAZE ICE JUST FALLEN FROM 165-FOOT WIND DATA TOWER

EXHIBIT 2.8.3 WACHUSETT WIND POWER SITE (2004)
UP TO 5-FT. GLAZE ICE – 150-FT FROM WTG – OVER WACHUSETT RESERVATION

EXHIBIT 2.8.3 WACHUSETT WIND POWER SITE (2002)
1-FOOT RIME ICE – JUST RELEASED FROM BLADE OF 120-FOOT WTG

conferences with presentations and papers where much of the findings are presented, published, subject to peer review and are resulting in international standards.

A brief of the WIND INDUSTRY ICE ASSESSMENTS AND MITIGATION MEASURES follows. International, national and northeast regional experience is presented -- chosen for their relevance to the WWS proposed expansion

2.9.2 DESIGN & FATIGUE LOADING – ICE

Ice is not only a important consideration with regards to ice throw, but WTG operation and ultimately public safety become an issue when huge machines are subjected to elements of "extreme" weather or even marginal weather over periods of time. They can fail, malfunction or literally break apart (as in flying blades).

Researchers are concerned with the increasing size of WTGs and their introduction into environments that they are not design to withstand. One assumes that these huge machines are rugged – they are, but the industry hasn't designed or defined them beyond certain limits.

Ice, for example at 1/2" thickness adds two tons of weight to a blade. At 131-feet, this huge lever has tremendous torque. If there are low-density winter winds and some turbulence, as well as cold to affect the structural strength of the bolts holding the blades to the hub of the rotor -- what happens? Unknown under certain conditions.

The industry agrees that load cases in this "special class S", "have to be agreed upon between the customer and the manufacturer." They are not necessarily, off-the-shelf solutions.

These extreme conditions also leave little room for any simultaneous faults in sensors, or computer controllers, etc. Wrong or missing data, misinform or fail to inform about conditions of stress.

> "…never combine extreme external conditions with faults…"
> (*Risk Analysis of Ice Throw From Wind Turbines*; Seifert) *Risk Analysis of Ice Throw From Wind Turbines*; Seifert

Does proposed owner/ operator Community Energy, Inc. have *any* experience with wind site operations under Wachusett's weather conditions. Do they give evidence of having characterized it? There is little correlation between the proposed site and the present technology, elevations, blade length, loading, etc. So PMLD's past experience, even if they were documented and studied, would be of marginal value.

The proponent with the manufacturer and facility owner and operator should "have to ensure that the product is adequate for the site conditions", and provide engineered evidence of such.

"The potential for icing on structures is an important design parameter…It has also recently become a relevant issue in activities related to wind energy production, where

icing of blades and control wind gauges significantly reduces power production and causes a severe environmental safety problem."
(*Measurement and Forecasting Atmospheric Icing on Structures;* European Concerted Research Action, COST 727, p. 2, 2003)

"In the IEC Standard icing is defined as an extreme external condition. Following the philosophy of this Standard a design load case, combining external and operation conditions, never combines extreme external conditions with faults. Regarding icing as an extreme external condition, only situations at normal operation are to be considered. This is important for the assumption how the control system is reacting under icing conditions."
(*Risk Analysis of Ice Throw From Wind Turbines*; Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS, April 2003)

"The standard defines operating conditions as "normal" for temperatures down to -10 º C and extreme" down to -20 º C [equivalent to -5º F, which is repeatedly experienced on Wachusett during the winter months]. Clearly, temperatures get lower in northern Europe and mountainous areas, not to mention more remote regions at high latitudes or elevations.

The standard also introduces a set of wind turbine classes according to mean (or reference) wind speeds and turbulence levels. All extraordinary sites, including offshore and icing conditions, belong to the special class S, in which load cases have to be agreed upon between the customer and the manufacturer. Thus the project developer and turbine buyer have to ensure that the product is adequate for the site conditions.

Further, it also presents partial safety factors and material factors to be used in the load and fatigue calculations. As there still is little knowledge of precisely the turbine is loaded under icing conditions the partial safety factors should probably be higher due to uncertainty.

Some special load cases for icing conditions should be developed. There should be a variety to the amount, distribution properties of accreted ice as some principal load imbalance cases."
(*Icing in Standards;* Jonas Wolff, VTT Energy, P.O. Box 1606, FIN-02044 VTT, Finland; presented at BOREAS V 29 November - 1 December 2000, Levi, Finland)

2.9.3 HEATED BLADES

Heated blades are mentioned in my comments, not because the proponent offers them as an icing mitigation measure, but as they may be an option the proponent will cite in the future.

A variety of methods of WTG blade anti- and de-icing methods are being experimented with. Many are reviewed and their level of success is reported on in the industry literature and studies.
"The increasing size of wind turbines up to multi-Megawatt turbines and the increasing numbers of turbines being installed at inland sites even in complex terrain in

mountainous areas require special equipment of the rotor blades. However, a commercial serial-produced anti-icing or de-icing system has not yet proved reliable over many years. Just the opposite is the case."
(*Technical Requirements for Rotor Blades Operating in Cold Climate*, by Henry Seifert, DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, 2003)

*

2.9.4 BLADE COATINGS

Blade coatings are mentioned in my comments, not because the proponent did offer them as a mitigation measure for ice. However they are a measure and, like heated blades, in the future might be seen as an option by the proponent.

With *some* similarity in function to the coatings used in the aviation industry, WTG blade coating science is in its infancy with wind power applications.

"Also, special coatings which shall reduce the shear forces between the ice and the blades surface are put to the test at one of the Tauernwind turbines. Tests of different coatings have been performed in the Kanagawa climactic wind tunnel and reported in the BOREAS 6 conference."
"Disadvantages are ice throw during operation. It is expected that the ice fragments will break off regularly and be thrown away from the rotor. At heavy icing conditions and low wind speeds due to low shear forces due to idling, there will also be large ice accretion at the leading edge. Also asymmetrical ice accretion can be possible leading to unbalance."
(*Technical Requirements for Rotor Blades Operating in Cold Climate*, by Henry Seifert, DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, 2003)

2.9.5 RUTGERS UNIVERSITY

Professor Terry Matilsky, of Physics at Rutgers, has characterized ice throw using simple equations. Not accounting for air resistance, under ideal and still conditions, ice could be *theoretically* tossed off of windmills similar (blade speed, height of hub and blade radius) to those proposed at the WWS, a distance of about 2,655 feet (~800 meters).

Professor Matilsky has created a customized ice throw distance calculations, specifically using the WWS elevations relative to its surroundings. For example, in the southern direction ice could be *theoretically* be tossed 2,855 feet under ideal conditions due to the drop in elevation from wind site to the Westminster Road direction.

This is the theory – if taken with the research and studies available, they are as well part of the icing mitigation considerations for the WWS – that need be undertaken by the proponent.

See **Exhibit 2.9.5** – Professor Matilsky's WWS calculations

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Department of Physics and Astronomy
Rutgers, The State University of New Jersey
136 Frelinghuysen Road • Piscataway • New Jersey 08854-8019
FAX: 732/445-4343

This document has been prepared by Terry Matilsky, Professor of Physics at Rutgers University. He has several decades of experience in applying the laws of physics to various environmental and commercial isuues, and has served and testified as an expert witness in several venues, including United States Federal Courts.

CALCULATION OF ICE THROW DISTANCES FOR WACHUSETT WIND POWER SITE

WHAT WE KNOW: blade radius is about 130'

hub height is about 230'

rotational speed at rated capacity is 1 rev/ 3 seconds or 20 rev/min

RESULTS:

1) Rotor tip speed: In one revolution, the blade sweeps out a circle whose circumference is $2\pi r$ (Here r=134 feet) or about 800 feet. Since it does this in 3 seconds, the speed is $2\pi r / t \approx 280$ feet/sec or about 190 mph!

2) Range: The range of any projectile at a given initial velocity is maximized when launched at a $45°$ angle from the vertical. At this point, with the above turbine parameters, the projectile will be a horizontal distance $x = 134\cos 45° = 95$ feet from the hub. This will later be subtracted from the total distance traveled to yield the distance traveled from the base of the tower. Also, at this point, it will be 95 feet higher (vertically) from the hub, or at a total vertical distance from (level) ground of 230+95=325 feet.

   $R=v^2/g$, where v=initial velocity of the projectile, and g=gravitational acceleration or 32 ft/sec/sec. This is the horizontal distance to come back down to the *original* vertical height. I.e. after this distance, it is *back* to being 325 feet from the ground. Thus, $R=280^2/32=2450$ feet.

   At this position (neglecting air resistance), its vertical velocity is the same as when it was launched (except now it's going down, instead of up). Thus, $v_v=v\cos 45^o= 280 \times .707 \approx 200$ ft/sec. The extra time it takes to fall to the ground from this height can be found from solving for t in the equation: $s= v\bullet t+1/2gt^2$. With s=325 ft g=32 ft/sec/sec and v=200 ft/sec, we get $t\approx 1.5$ sec. Since the

horizontal velocity is constant in the absence of air resistance, the increase in the range over the 1.5 extra seconds that it takes to fall to the ground is: $d=v_h \bullet t$, where v_h is the initial horizontal velocity, which for a launch angle of 45° is also 200 ft/sec. Thus, $d=200 \bullet 1.5=300$ feet. Therefore, the total range of the projectile is 2450 feet + 300 feet = 2750 feet. Now, we subtract the 95 feet that the projectile was behind the hub when it was launched, and we get the maximum range of the projectile being 2655 feet, or slightly OVER ONE HALF A MILE.

3) Speed of the projectile at impact: $v_h=200$ ft/sec and $v_{vi}=v_{vo}+g \bullet t$, where v_{vi} is the vertical velocity at impact, having $v_{vo}=200$ ft/sec originally, and being subject to the gravitational acceleration of 32 ft/sec/sec for an additional 1.5 seconds (t). Thus, $v_{vi}=200 + 32 \bullet 1.5 \approx 250$ ft/sec. The final velocity upon impact is therefore: $v=\sqrt{(v_h^2 + v_{vi}^2)} = \sqrt{(200^2 + 250^2)} \approx$ 320 ft/sec or OVER 200 MPH.

4) To account for the change in elevation at the proposed sites, we can use the site maps, According to which, at a distance of one half a mile from the tower (which is the theoretical maximum range on level ground), the falloff from the north tower is from approximately 445 m. to 345 m. From the south tower, the elevation change is from about 430 m. to 345 m. Thus, there is approximately an extra 100 meters of drop, or about 300 feet. So, if the blades of the turbines were oriented in a plane along the average gradient of the mountain (which would make the ice throw occur in that direction as well), you would get an extra 300 vertical feet that the projectile would fall before it impacted the ground. At $v_v=250$ ft/sec, this would add about 1 sec to the impact time, which translates into an additional 200 feet of horizontal range. Note that this is a slight underestimate, since in that 200 additional feet, the ground would drop off further, yielding a further (small) vertical falloff over which the projectile would move. But for all practical purposes, the theoretical maximum ice throw, in the absence of air resistance, would be about 2855 feet.

EXHIBIT 2.9.5
Rutgers university – Professor terry matilsky
Theoretical Calculations of ice throw distances
for wachusett wind power site

Note that the presence of air resistance, and wind, can modify these values somewhat. For example, an aerodynamically blunt chunk of ice could reduce the range in the absence of wind, but if there were substantial crosswinds, the maximum range could be increased. These considerations are of necessity beyond the scope of this document. But it seems like it would be quite reasonable to take about ONE HALF MILE as the canonical number for the maximum range of a projectile launched with the above wind turbine parameters.

Respectfully submitted,

Professor Terry Matilsky
Department of Physics and Astronomy
Rutgers University
Piscataway, N. J. 08854

EXHIBIT 2.9.5
Rutgers university – Professor terry matilsky
Theoretical Calculations of ice throw distances
for wachusett wind power site

2.9.6 JOHN ZIMMERMAN & AMERICAN WIND ENERGY ASSOCIATION RECOMMENDATIONS

"Since 1974 the American Wind Energy Association (AWEA) has advocated the development of wind energy as reliable, environmentally superior energy alternative in the United States and around the world." (http://www.awea.org/aboutawea.html). Randall (Randy) Swisher has been the Executive Director of AWEA since 1989.

Founded in 1999, for-profit *Community Energy, Inc.*, is the, developer, operator and the owner of the power generated at the WWS. Community Energy, Inc. is an AWEA member.

John Zimmerman, founded *Vermont Energy Resource Associates* (VERA) in 1978 and serves as its president. VERA provides "wind power and program management services to electric utility companies." Mr. Zimmerman was presented with a Special Recognition Award from AWEA for the "critical role he played in bringing wind energy development to the Northeast."

Katie and Don Anderson of East Burke, Vermont, had concerns about icing at a proposed wind site near the Canadian border. The site is surrounded by public property purchased by the citizens of Vermont. Katie telephoned Randy Swisher, of the AWEA for recommendations. Swisher promised to send Anderson information on the topic.

The following is a direct copy of Swisher's reply to the Andersons, in which he forwards a contribution of John Zimmerman, from AWEA's online discussion threads and part of their archives.

AWEA offers the following icing recommendations from a member and AWEA award recipient Zimmerman – shouldn't AWEA member Community Energy offer some explanation as to why they see such caution not worth heeding?

See Swisher / Zimmerman emails in **Exhibit 2.9.6.**

donanderson2

From: Randy Swisher <rswisher@awea.org>
To: <donanderson2@charter.net>
Sent: Thursday, February 26, 2004 6:37 PM
Subject: Fwd: [a-w] Re: Ice shedding from turbines and public

Katie,

Here is a comment from John Zimmerman. He states that wind turbines don't belong at ski areas, but I think it is really just a question of what is the appropriate setback. John describes some of the ice they've seen at the Searsburg site and it sounds pretty intimidating but manageable with proper setbacks.

I think that is the last of the information I have on the topic. It isn't a lot, but I hope you find it helpful. Please let me know if you need anything else, and feel free to consult our web site at <www.awea.org> as well.

Thanks again for your interest. I hope next time I'm riding my bike in the Northeast Kingdom I will actually have a chance to see a few wind turbines!

Randy Swisher

>X-MindSpring-Loop: randy_swisher@awea.org
>X-eGroups-Return:
>awea-windnet-return-1189-randy_swisher=awea.org@returns.egroups.com
>Delivered-To: listsaver-egroups-awea-windnet@egroups.com
>From: "John Zimmerman" <johnz@northeastwind.com>
>To: <awea-windnet@egroups.com>
>Date: Thu, 20 Jan 2000 10:51:43 -0500
>Organization: VERA
>X-Mailer: Microsoft Outlook Express 5.00.2314.1300
>Mailing-List: contact awea-windnet-owner@egroups.com
>X-Mailing-List: awea-windnet@egroups.com
>List-Help: <http://www.egroups.com/group/awea-windnet/info.html>,
> <mailto:awea-windnet-help@egroups.com>
>List-Unsubscribe: <mailto:awea-windnet-unsubscribe@egroups.com>
>List-Archive: <http://www.egroups.com/group/awea-windnet/>
>X-eGroups-Approved-By: tomgray@igc.org via email
>Reply-To: awea-windnet@egroups.com
>Subject: [a-w] Re: Ice shedding from turbines and public safety
>X-Mozilla-Status: 8001
>X-Mozilla-Status2: 00000000
>
>Jim and Peter,
>
>I've watched over the wind turbines GMP has had installed in Vermont over
>the last 10 years and have several thoughts that be useful to this
>discussion.
>
>Here in Vermont, and elsewhere in the northeastern US, the winds blow

EXHIBIT 2.9.6
AWEA / John Zimmerman (Vera) Icing Recommendations

>strongest at the mountain tops, where it is also the most icy. A common
>first question to wind developers in this region is 'why don't you put the
>wind turbines at the ski areas (where there already is human development)'?
>The answer is because of the danger to public safety due to ice throws. Ski
>areas are not a good place for wind turbines.
>
>Back in the mid 1980s one of the windy areas that was being considered for
>wind development was near to ski trails. Boeing and/or Hamilton Standard
>did some work to determine how far we must stay away from the ski trails to
>be safe from ice being thrown from their turbines (the MOD 5b was the boeing
>machine at the time). Without going back to dig up those papers, and if I
>remember correctly, the distance was between .25 and .5 miles away,
>downwind. It's a function of blade tip speed, so applicable to present day
>turbines too.
>
>While the Boeing study was academic, the danger from ice being release from
>rotor blades overhead is real -- and a hard hat is not going to provide you
>with much comfort. I have stood near the turbines GMP had on Mt. Equinox in
>the early 1990s and more recently the Zond 500 KW turbines in Searsburg Vt
>during and after icing events. When there is heavy rime ice build up on the
>blades and the machines are running you instinctually want to stay away.
>They roar loudly and sound scarey. Probably you would feel safe within the
>.5 mile danger zone however.
>
>One time we found a piece near the base of the turbines that was pretty
>impressive. Three adults jumping on it couldn't break. It looked to be 5
>or 6 inches thick, 3 feet wide and about 5 feet long. Probably weighed
>several hundred pounds. We couldn't lift it. There were a couple of other
>pieces nearby but we wondered where the rest of the pieces went.
>
>In the winter, icing is a real danger and GMP therefore restricts public
>access to the site(s). Maintenance workers have developed a protocol for
>working on turbines during icing conditions, though I am not familiar with
>the details. I'll 'dig into it' if you want.
>
>Regards,
>
>John Zimmerman
>VERA

EXHIBIT 2.9.6
AWEA / John Zimmerman (Vera)
Icing
Recommendations

2.9.7 OSHA REPORT – EDDY KETTLINGER

Often asked is, "If windmills are so dangerous, then why hasn't anyone been killed by one?" Well, in fact, people have been.

There are records in kept of accidents in Germany resulting from collapsed WTGs, as well as WTG blade throws, fires, ice throws, etc. They are surprisingly numerous.

In the United States, there have been people killed in wind site related accidents. Mainly the accidents have been operations and construction-related.

What follows is an USDL OSHA Investigation Summary report #813261 from Pipestone, Minnesota. It refers to three men working at a wind power site. One, named Mark (Eddie) Kettlinger, was killed -- a direct result of ice falling from a WTG tower.

Kettlinger is not named in the report, but referred to as "employee #1."

See OSHA report #813261 in **Exhibit 2.9.7**.

2.9.8 CBC RADIO INTERVIEW – CARL BROTHERS

In a Canadian Broadcasting (CBC) radio interview aired on April 2, 2003, the Project Manager of the *Wind Turbine Complex at North Cape*, Prince Edward Island, Canada. Carl Brothers talked about an ice storm at his wind site, "…all of the towers are glistening in the sun now…but everything has kinda ground to a halt with this accumulation of ice." And, "…but I think they will be shedding ice tomorrow."

It was asked of Mr. Brothers what do the workers do during this period? "Do any of the workers have to go out and start chipping (the ice) off?"

Mr. Brothers replied, "No. No. Whenever there is any ice on a turbine you just stay away from it. You just stay away from the towers when they are iced up. They are too dangerous. There are fairly big pieces of ice attached to the blades and we actually have closed the road into the site proper because one of the turbines is sort of close to the road and there is a lot of ice on the blades. But it is very dangerous whenever you are around the towers with blade ice accumulation. The ice will come off eventually, and when it comes off, it can come off in big sheets and it can do serious damage."

Investigation Summary

CNF CONSTRUCTORS, INC. H0363 #01794

U.S. Department of Labor
Occupational Safety and Health Administration

MOD Date

1. Reporting ID: 552700

2. Summary Number (Identifies This Summary): 813261

3. Related Inspection Numbers: 3.1 Type I, Number 120370895; 3.2 Type, Number; 3.3 Type, Number; 3.4 Type, Number

4. Total Entries

Name Line Number	5. Injured/Deceased (Name)	6. Inspection Number (3.1, 3.2 etc.)	7. Sex	8. Age	9. Injury a. Fatality	b. Hospitalized	c. Nonhospitalized	10. Nature of Injury	11. Part of Body	12. Source of Injury	13. Event Type	14. Environmental Factor	15. Human Factor	16. Task a. Reg. Assigned	b. Not Reg. Assigned	17. Substance Code	18. Occupation Code
1	[redacted]	3.1	[redacted]	[redacted]	X			07	13	25	05	06	01	X			597
2	[redacted]	3.1	[redacted]	[redacted]		X		03	19	43	01	06	01	X			597
3	[redacted]	3.1	[redacted]	[redacted]		X		03	19	43	01	06	01	X			597
4.																	
5.																	
6.																	
7.																	
8.																	
9.																	
10.																	

Mark "X" in only one box

19. Type of Event STRUCK BY FALLING ICE / LADDER FALL FROM HEIGHTS

20. Abstract

Abstract Line Number

Three construction riggers were bolting the top half section of a tube type, wind driven, power generation tower at the interior base section platform which is 60' from ground level. They had 4 of 36 bolts installed when an ice and snow formation was noted around a circumference portion of the upper section 30' above where the employees were working.

One of the employees (#3) went up a fixed ladder to remove the ice and snow. While chipping, a 1'x1'x3' chunk fell to the bottom, striking one (#2) of the two remaining employees that were on the platform on the head, knocking his hard hat down and injuring the employee.

The two platform (#1 + #2) employees began decending the ladder with the injured employee (#2) going first. At the time the third employee (#3) was decending the top section and nearing the mid-section landing platform, all of the remaining snow and ice sections broke loose from the upper section. As this cascaded past the platform area, it knocked the top employee (#3) on the ladder onto the platform and then struck the other two employees (#1 + #2) who were continuing descent down the lower base section of the tower. The injured employee (#2) had been about 20' from ground level when struck again and thrown to the ground. The employee (#3) further up the ladder who had been assisting him fell about 40' and fatally struck his head on a ladder brace on the way down.

Case File Page / of /

OSHA-170 (1/84)

CASE FILE COPY

EXHIBIT 2.9.7
Osha report # 813261 pipestone, minnesota
Accidental death - eddy kettlinger - wtg tower icing

2.9.9 QUANTITIVE RISK – WTG ICE THROW

This table from two of the wind industry's cold weather research groups helps quantify the risk of ice danger given a site's level of icing and distance from the WTGs.

From: ***Kittitas Valley Icing Conditions***; BOREAS IV conference; page 120 , 31 March - 2 April, 1998; Hetta Finland

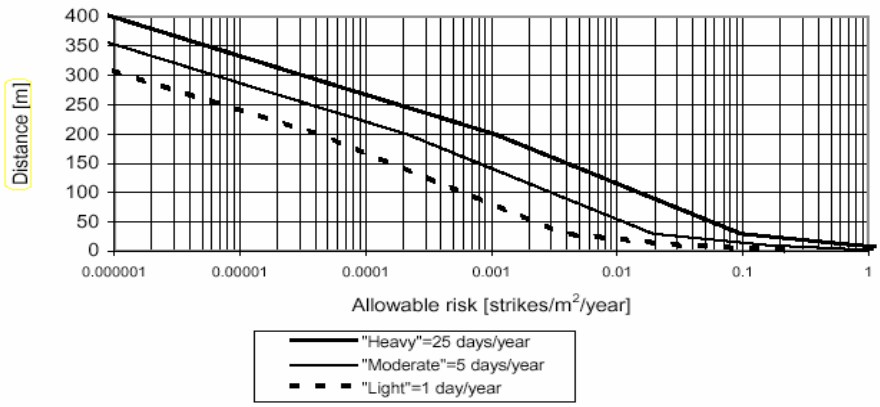


Figure 3Safety distance for different icing levels (50m rotor)

"Figure 3 is based on a rate of ice accretion averaginge 75 kg/day during icing conditions. A figure which has been estimated for a 3-blade turbine of 50m diameter [proposed WWS blades are 80meters]. The allowable risk should be scaled pro rata under different assumptions."

Note: 150 meters is ~500 feet. WWS is a moderate to heavy icing site

"…relatively few turbines have been installed in climates where icing is a serious problem. The situation is rapidly changing as extensive development of the wind resource in many Northern European countries has now [1998] commenced. Indeed, the potential [ice] risk has recently attracted significant publicity in Germany, where a number of significant incidents have been reported in the past year, indicating an urgent need for suitable safety guidelines."

(graphic & text from *Assessment of Safety Risks Arising From Wind Turbine Icing*; by Morgan, Bossanyi, Grand Hassan and Partners Ltd. Bristol BS18 9JB and Seifert, Westerhellweg, Kroning; DEWI, Deutches Windenergie-InstitutGmbH Ebertstr. 96, D-26382 Wilhelmshaven, Germany, presentation to BOREAS IV, April 1998)

2.9.10 WILLIAMS COLLEGE – WIND SITE PROJECT

Proponents of a seven-turbine wind site development on a 400-acre parcel straddling state border west of Williamstown, MA, east of Berlin, NY and south of Petersburg, NY completed an industry study and recommendations-based *Report on the Feasibility of a Wind Power Project on the Berlin Pass*. With elevations on the property ranging from 1,550 to 2,300-feet, this site closely resembles the WWS. Though it has less icing days (3-5) than Wachusett, ice throw was still a significant concern.

On page 6: "Our concern therefore includes ice throw affecting Taconic Crest Trail users, as the college [Williams College, proponent] could face considerable liability should someone get hurt." (*Report on the Feasibility of a Wind Power Project on the Berlin Pass;* Canada, von Mutins, Wu, Schoung, Williams College)

The Berlin Pass report footnoted several studies used in making their decision. Choosing a .00001 risk factor as acceptable [a one-in-a-million (.000001) risk factor is used in Europe], the reports recommended a setback distance, to maintain ice throw safety, of 300 meters (985 feet).

2.9.11 WECO – WTG Setback (Ice Throw)

The Wind Energy in Cold Climate, an International Energy Agency annex recommends a site-specific "detailed calculation" in determining ice throw. They do, however, offer a "rough guess" formula for "planning the position of a wind turbine close to streets or other objects, involving a certain risk."

Applying their equation to the proposed WWS WTGs yields:

Ice Throw Distance = 1.5 (Hub Height + Rotor Diameter)

Ice Throw Distance = 1.5 (231-feet + 268-feet)

Ice Throw Distance = 750-feet (setback)

2.10 WACHUSETT ICE MAP

I provide the following map with a setback -- balanced among the theoretical ice throw limits, the industry's rough guess calculation, the site elevation and proximity to its surroundings, the acceptable risk, and the industry-based manufacturer and developer practices of similar sites.

On the map, I chose a 1000-foot perimeter to show the effect of ice throw on the will have on the surrounding Wachusett Reservation environment and Princeton's Westminster Road. See **Exhibit 2.10**.

ICE ZONE MAP – Wachusett Mtn. Wind Site Expansion

ICE ZONE

+

Proposed windmill locations w/ 1000-foot ice throw radius

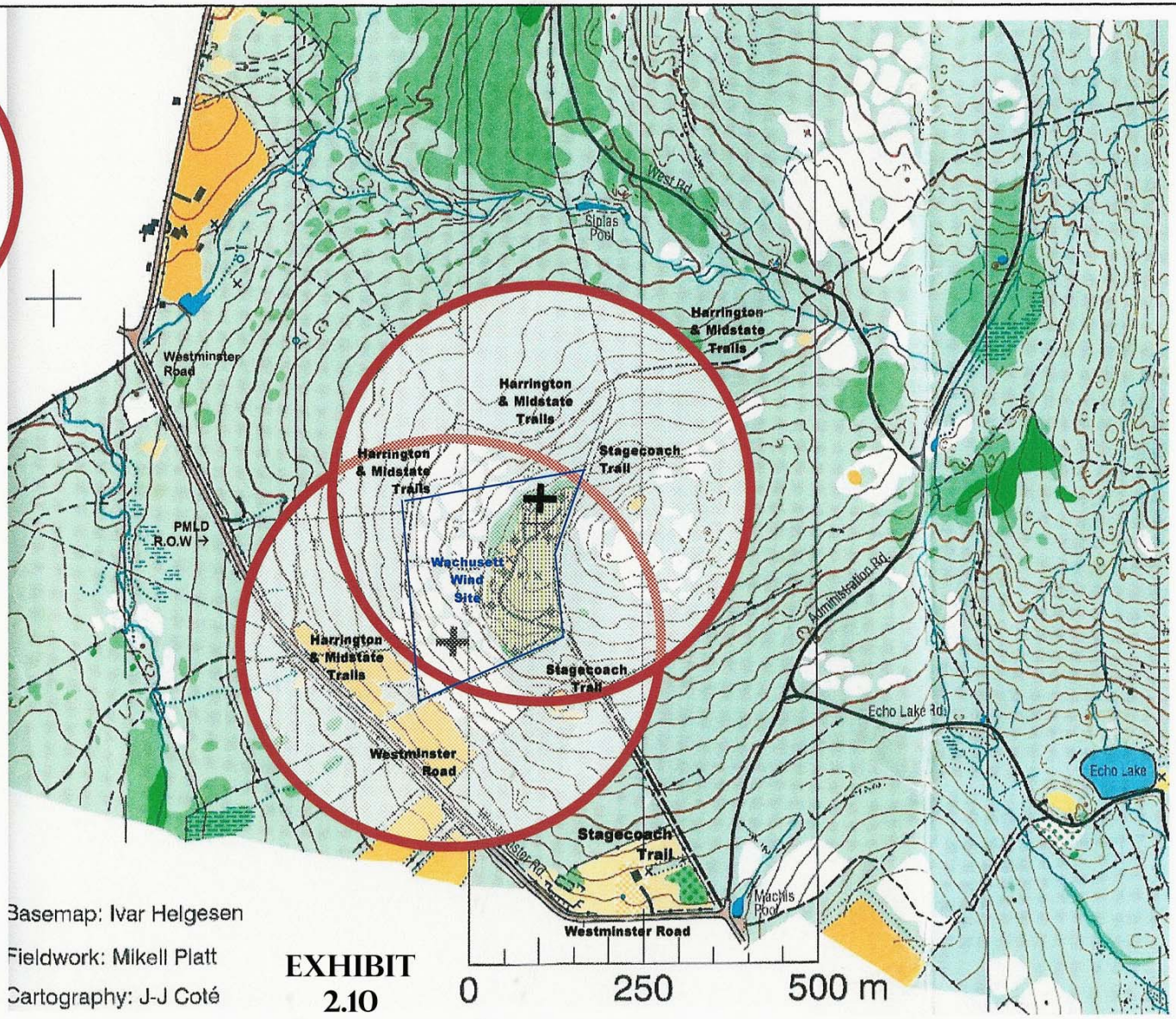
Restrictions Article 97 Easements

Wachusett Reservation (Article 97 land)
~ 100 acres

Harrington & Mid-state Trail
~ 3,300-feet
(.62 mile)

Stage Coach Trail
~ 1,750-feet
(.33 mile)

plus
Westminster Road
~ 1,650-feet



Basemap: Ivar Helgesen
Fieldwork: Mikell Platt
Cartography: J-J Coté

EXHIBIT 2.10

2.11 WACHUSETT WIND SITE ICE – THE BOTTOM LINE

The messages from this Section 2, on icing, are:

- Ice occurs on Wachusett
- Industry says ice is dangerous when thrown or released from WTGs
- Industry quantifies the risk of the ice throw danger
- Industry recommends perimeter – setback as a proven mitigation of the risk
- Due to proximity of the WWS (proposed turbine locations) and the Wachusett State Reservation *reasonable setback*, based on industry findings, will insure the citizen's Article 97 rights
- Due to proximity of the WWS (proposed turbine locations) and the Wachusett State Reservation *lack of setback* will threaten the safety of the Commonwealth's citizens

The bottom line is that -- *if* the EENF proponent (PMLD) and the wind site facility owner and operator (Community Energy, Inc.) have done their due diligence with respect to the assessment and mitigation of ice at their proposed WWS expansion –they have not come even close to revealing it. With what they have filed, they trivialize the rights of citizens, the safety of state park visitors, and that of the sensitive Wachusett environment.

Instead of business as usual, and in lieu of in-kind offerings worth a few thousand dollars, the proponents need to show that they understand and undertake suitable responsibility in seeking the rewards of a business dovetailed with a priceless state preserve. *They need to report* on their research into the wind industry's, and subsequently their, knowledge of wind site icing with respect to WWS environment, and make project commitments based on such.

Section
3

Structural Integrity & safety

3.0 STRUCTURAL INTEGRITY & SAFETY

3.1 SUMMARY – STRUCTURAL INTEGRITY & SAFETY

- The Wachusett Wind Site (WWS) has a history of structural failures.
- Three of those WWS failures occurred within a recent one-year period – November 2002 thru November 2003.
- Expanded Environmental Notification Form (EENF) #13229 fails to mention any of these dangerous failures.
- EENF #13229 fails to mention that icing increases the risk of structural failure due to fatigue loading and often resulting from unspecified design considerations due to such weather.
- In the case of structural failure, both of the the proposed Wind Turbine Generators (WTGs) and the data monitoring towers include reservation properties within their fall zone.
- In the case of the structural failure of two (130-foot and 165-foot) data monitoring towers, manufacturer's specifications were violated and the WARNINGS (in capital letters) on setback within the Installation Guide were disregarded. To this day, they still are, and will be -- with the proposed expansion.
- Structural failures and resulting accidents occur worldwide – even with new WTGs.
- Setback is the wind industry's mitigation strategy for structural failure.
- The proponent should be required to report on their research into industry and manufacturer's recommendations, assessments and mitigation strategies relative to these issues for their proposed installations as well as the history of such site failures. They should be required to make commitments to mitigations and provide for independent audit of performance -- before any sanction of this their proposal is conditionally or permanently granted by any agency of the Commonwealth – for liability sake, for the unthreatened exercise of citizen's rights and vitally for their safety.

3.2 STRUCTURAL COLLAPSES -- WACHUSETT WIND SITE

The WWS has a history of mechanical and structural failures. In several cases these have presented danger to state park visitors. Some of these were publicly known. Others were not made so, and were "found out."

I believe, due to the evidence I've accumulated, that some of these events were avoidable and were a result of neglect. These issues stand as a factor in PMLD seeking approvals from any agency to accommodate their expanded operations.

To all of this, I don't believe words are the answer. Instead proactive, industry sanctioned and proven mitigations would be a prudent beginning. This because PMLD also has a history of not doing their homework – not thoroughly researching an issue, even not using just common sense. Evidence of this is that even after being advised, they still believed that Stagecoach Trail was their legal right of way to the wind site.

Early in the WWS's life the bearings on the new turbines failed. The turbines stood inactive for approximately a year's period because the manufacturer went out of business and custom-made bearings needed to be machined.

Here are the examples of the WWS structural failures:

1. **Early Wind Site Collapse – 1980's**
   In speaking with employees, who worked for PMLD in the mid-1980's, one told of a tower structural failure right after the WTGs were installed. Evidently the top 60-feet of one of the lattice towers, with the turbine on it, collapsed down into itself.

2. **Lightning & Imbalance Collapse – 1990's**
   On a summer day in the early 1990's, lightning struck a windmill on the northern boundary of the wind site. It disintegrated a blade sending parts of it over 300-feet from the tower.

   Later that day as the wind picked up, the turbine began to operate. With only two blades, its operation was uncontrolled and unbalanced. This state of unstable function caused the WTG to resonate until it collapsed completely to the ground.

3. **Tower Collapses -- November 19, 2002**
   A 130-foot monopole used to measure wind speeds collapsed following an ice storm in November 2002. This tower was put up in July 2000.

   To the right is the data tower just a day before its demise. Note, the lax guy-wires connected to the ice-covered tower. **Exhibit 3.2.3** show it about a week after the collapse.

   This 130-foot tower was sited 110-feet from Stage Coach Trail (80-feet from the reservation boundary). Manufacturer *NRG Systems* warns installer to insure that this tower be setback 195-feet. It landed 30-feet from state property.

   This event was never made public until I brought it up 2 1/2-months later at a PMLD Board meeting

Iced With Slack Guy Wires
130-foot Data Monitoring Tower
– day before collapse (Nov. 2002)

EXHIBIT 3.2.3

Wachusett wind power site

Collapsed 130-foot wind data tower (November 2002)

4. **Tower Collapses – March 2003**

A 165-foot monopole used to measure wind speeds collapsed in March 2003. This tower was put up two months before.

An anchor bolt holding tower guy wires pulled out of the ground causing the top of the tower to lean. The photo to the right shows the tower moments before it snapped in half.

Leaning 165-Foot Data Tower
Just prior to its collapse (March 2003)

The engineering report claimed a fault to be in the bedrock the anchor was sunk into. Yet photos of the tower leading up to its collapse showed overly loose guy wires and icing. See **Exhibit 3.2.4.**

Due to the drooping stabilization, it appears that the tower rocked back and forth jarring and bending the anchor bolts, as well as stretching the guy wires creating more and more slack in them. The more slack that was created, the wider the diameter of movement of the tower back and forth in the wind, and with greater torque, until serious failure(s) of its anchoring system occurred.

This 165-foot tower sited 140-feet from Stage Coach Trail (120-feet from the reservation boundary). Manufacturer *NRG Systems* warns installer to insure that this tower be setback 250-feet.

Despite the loss of two wind data towers within 4 1/2 months, it seems beyond belief and perhaps negligent that the likely causes of the failures have to this day not been corrected – not even on the WWS wind data towers installed as replacements. Within a few weeks of this March event, I wrote an eleven-page letter to the PMLD Light Board that detailed with pictures the data tower collapses and their causes. It was never replied to or even acknowledged.

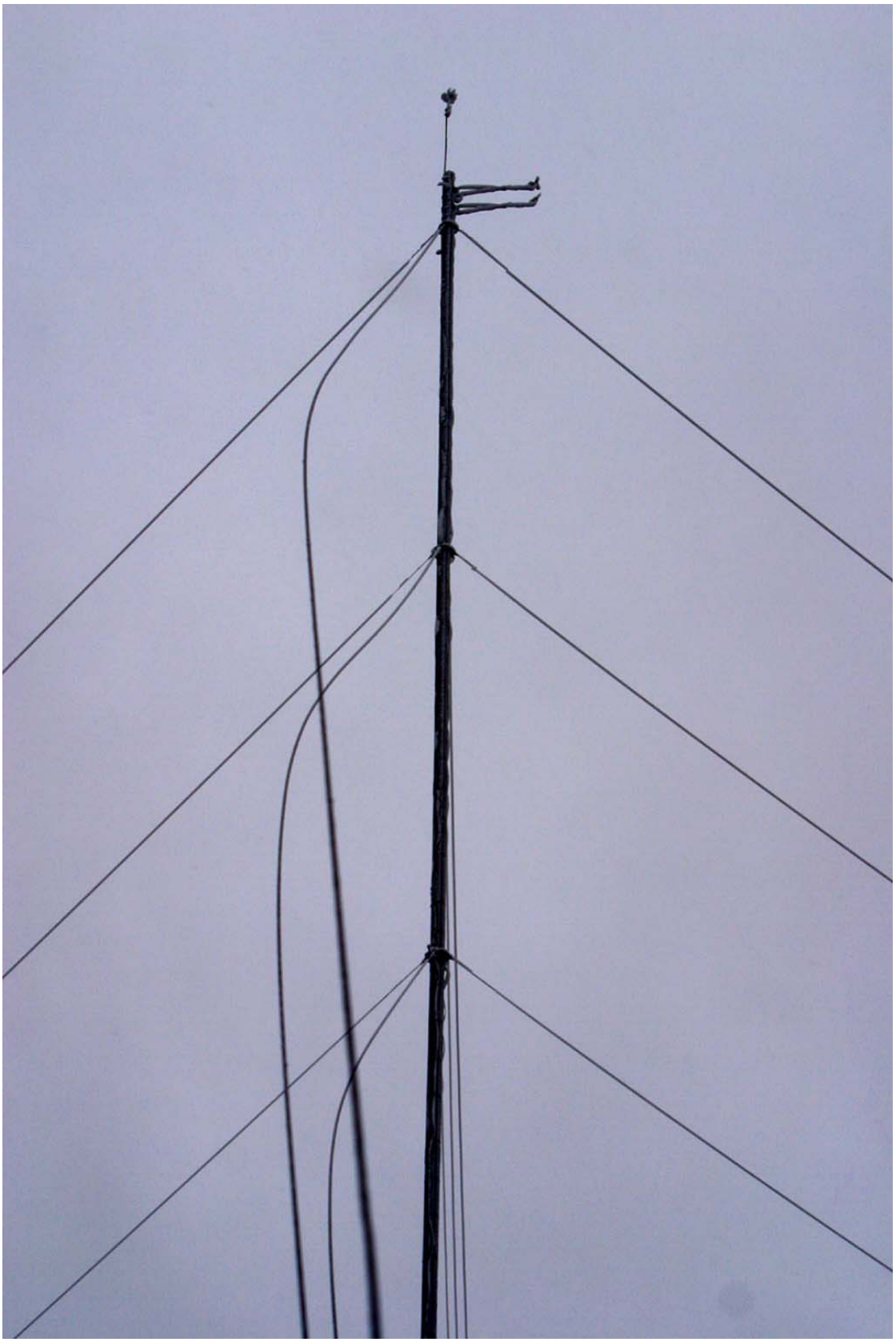


EXHIBIT 3.2.4
Wachusett wind power site (February 2003)
165-foot wind data tower – lax guy wires blowing in wind
one month before collapse

5. WTG Blade Disintegration – November 2003

In November 2003, all three blades from on an existing WWS WTG were completely obliterated. An anchoring pin, on the turbine the blades were attached to, broke allowing the turbine to tilt forward. The rotating blades struck the tower. They disintegrated spewing hundreds of pieces of fiberglass and wooden shards across the properties. The pieces were from toothpick size to approximately five-feet in length.

As the wind was blowing to the northeast, most debris was spread across the WWS. Some did land on the Commonwealth reservation, which was 25-feet away, in the direction from which the wind was blowing. One blade tip landed ricocheted off the tower and landed in an obtuse direction, 185-feet away. The furthest pieces that I found were 195-feet away, uphill.

Some of the remaining blade debris was cleaned off the road running through the WWS, on the morning of the MEPA site visit, April 7th. Pieces are still in abundance on the WWS roadside.

Exhibits 3.2.5 include a photograph of the failed WTG and another photograph taken of it, from the reservation, showing the proximity of both.

Wind Turbine Tilting Forward - blades hit tower – wood & fiberglass shards litter the WWS & Wachusett Reservation (Nov. 2003)

3.3 INDUSTRY EVENTS - STRUCTURAL INTEGRITY & SAFETY

3.4 HAVOYGAVLEN, NORWAY – WIND TURBINE DAMAGE

The following shows that the reality that is possible with WTGs, and that structural failure occurs in newly installed machinery as well.

"On Tuesday afternoon (October 29, 2002), one of the Nordex [manufacturer] wind turbines installed in Norway was damaged. At around 5:00 pm in the afternoon, the nacelle including the rotor was severed from the tower [turbine and blades fell to the ground]. Prior to this, the rotor had been turning at an excessively high speed as a result

EXHIBIT 3.2.5 - Wachusett wind power site -- November 2003
failed WTG tower with Broken blade in Foreground

EXHIBIT 3.2.5 - Wachusett wind power site -- November morning 2003
with failed WTG tower & blade in wachusett reservation tree

of an incorrect manual adjustment to the turbine control system. The turbine had only recently been put into operation.

The detailed control log reveals that at the time of the accident the turbine was operating at 44 rpm (tipspeed 663 km/h [**452 mph**]). Under normal operating conditions, a maximum of only 19 rpm (tipspeed 289 km/h [180 mph]) is permitted. This high turbine speed exerted extreme strain on the turbine, ultimately causing the incident.

According to Nordex, the wind speed at the time of the accident was up to 15 m/s, normally an uncritical speed for this turbine." (*Nordex web site*; April 13, 2003)

3.5 BLYTH, NORTHUMBERLAND, UK – BLADE DAMAGE

Another example of new equipment breaking down – a blade on a 93-meter (306-foot) WTG tower in the UK.

"Wind farm closed after blade Snaps

A turbine propeller blade has folded in half at the UK's first electricity-generating offshore wind farm, at Blyth, in Northumberland.

It will not be known until data are gathered from a companion turbine whether high winds in the region are to blame for the breakdown.

The turbine operators, Amec Wind, hope to carry out an investigation with the unit's Danish makers, although bad weather has so far hampered plans for an inspection.

Small boats have been warned to stay away after a blade on one of the two 93-metre-high turbines snapped.

Dr Chris French, a lecturer in marine electrotechnology Newcastle University, said it could be a long and tricky job to fix the blade. Dr French told BBC News Online: "Before there is any attempt to take anything off, they will want to look at some of the data that come back from the instrumented turbine.

"I would also think a huge crane barge will be needed to come alongside to carry out the repair work. They are going to have to wait for a suitable gap in the weather before work can start. I cannot believe the turbines would have been without stress testing being carried out first, so I suspect a materials abnormality. "

The turbines were opened in December 2000, just under a kilometre off Blyth, in a £4m operation by Hexham company Amec Wind. The turbines were switched off when the fault was discovered, and an inspection by makers Vestas of Denmark is due …"
(Wednesday, 23 January, 2002, 12:23 GMT)

3.6 MICHIGAN STATE UNIVERSITY --BLADE LOSS CALCULATION

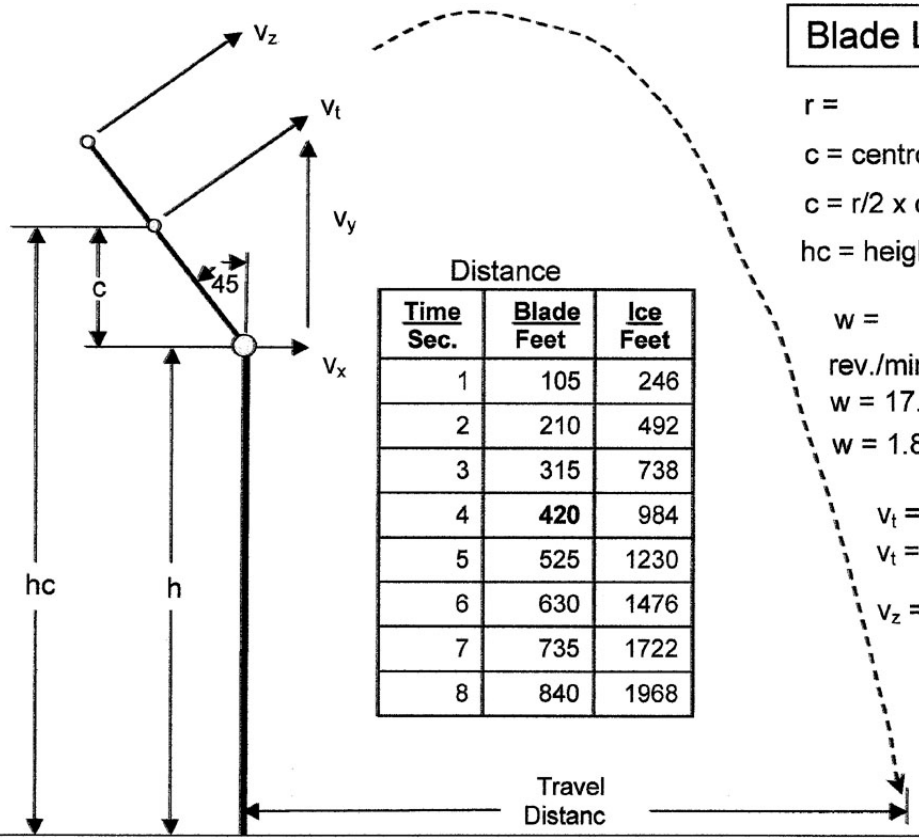
As with ice throw, and in fact including that, is a *Blade Loss & Ice Throw* calculation worked up by an environmental resource program at Michigan State University. Again theoretical using ideal conditions, including no wind, yet shows why setback is important in matters such as blade loss, tower failure, etc.

It is included as **Exhibit 3.6**. Note the speeds at which the ice and blade throw distances are achieved in.

3.7 WWS STRUCTURAL INTEGRITY & SAFETY – BOTTOM LINE

The messages from all of the above is that:

- WWS has had a greater-than-average structural failure record
- Despite their record WWS has not corrected causal factors
- Disregard for Wachusett Reservation environment is real and documented
- Setback or any mitigation for this issue has never been a reality
- PMLD's disrespect continues as an accounting for, or an assessment and mitigation of structural failure possibility is not disclosed or proposed in EENF #13229
- Due to proximity of the WWS (proposed turbine locations and data towers) and the Wachusett State Reservation, *lack of setback* in structural failure events will increased risk and threaten the safety of the Commonwealth's citizens
- Of rights and safety sake, PMLD (the project proponent) should be comprehensively required to report on its research, assessments of risk and mitigations for the impingements and the danger, to the Article 97 protected Wachusett Reservation environment that their chosen WTG setback distances will present. As well, they should account for their history of structural failures -- before any sanction of this proposal is conditionally or permanently granted by any agency of the Commonwealth.



Blade Loss & Ice Throws

r = h =

c = centroid = ft. above

c = r/2 x cos45 = 40.6

hc = height to centroid = 304

w =

rev./min. = 17.5

w = 17.5 x 2π x (1 / 60

w = 1.83 radians /

v_t = rw = tangential

v_t = (115/2) x 1.83 = **105** ft. /

v_z = tip velocity = 168 mph

= **246** ft. /

Distance

Time Sec.	Blade Feet	Ice Feet
1	105	246
2	210	492
3	315	738
4	**420**	984
5	525	1230
6	630	1476
7	735	1722
8	840	1968

_ mile = 1320 feet
_ mile = 2640 feet

Notes: Blade loss occurs at 45 degree angle. Air resistance and wind speed are neglected. **Distance** is dependent upon the nature of the fracture and how the blade is liberated – whether it goes end over end or flies like an arrow. Blade loss assumes fracture near root and blade velocity at the centroid. Ice throws would occur from any point along the blade and, depending on the blade pitch, could travel the length of the blade to the tip before being liberated.

Reference: Handbook of Mathematical Tables and Formulas, Burington, 1956

EXHIBIT 3.6 - MICHIGAN STATE UNIVERSITY
CALCULATIONS (THEORETICAL) FOR BLADE & ICE THROW
EXHIBIT 3.6 - MICHIGAN STATE UNIVERSITY

Section
4

NOISE

4.0 NOISE

4.1 SUMMARY – NOISE

- Setback is the wind industry's mitigation strategy for Wind Turbine Generator (WTG) noise.
- Setback is also the proponent's mitigation strategy for WTG noise – however their setback solely utilizes Article 97 properties, protected from excessive noise.
- The Commonwealth's Department of Environmental Protection (DEP) provides for no more than a 10 dB gain above ambient noise at an abutting property line. Of this the proponent should be required to have independently analyzed for feasibility, and to meet.
- PMLD (the project proponent) has failed to research, test, assess, map and mitigate the noise levels, to the Article 97 protected Wachusett Reservation environment that their proposed WTGs will present.
- Of such, the proponent should be comprehensively required, using an independent agency – before any sanction of this filing is conditionally or permanently granted, by any agency of the Commonwealth – for the unencumbered exercise of its citizen's rights

4.2 PROPONENT _ ASSESSEMNT & COMMENT – BRIEF

Comment-Section	EENF ASSESSMENT	COMMENT
4.4.1	Sounds from new turbines are similar to "trees rustling in the wind.	What is the basis for this statement?
4.4.2	Noise generated by proposed WTGs will be 50-55 dB at 122-feet.	PMLD consultant -PB Power's- *Noise Impact Assessment* shows a higher noise level at that distance.
4.4.3	The noise level at 2,200-feet will be 36 dB (background noise level).	By what basis is 36 dB the background noise level? This means that 350-acres of state park will be subject to noise greater than background noise.
4.4.4	Statements: "Noise level at 1,640-feet will be completely masked by background noise" AND "noise at 2,200 feet will be…similar to background noise"	These are contradictory statements.
4.4.5	Noise level of proposed turbines is significantly less than noise level of existing units.	Of what origin and basis is this assessment formed?

4.3 PROPONENT – MITIGATION & COMMENT – BRIEF

Comment-Section	EENF MITIGATION	COMMENT
4.5.1	2.200 feet -- until the turbine noise equals the background noise	Proponent's setback for noise *is* the Commonwealth's property.

4.4 PROPONENT ASSESSMENT of IMPACTS OF NOISE
(EENF SECTION *3.2.3 NOISE*)

1. ***EENF Assessment:* "**The sound from a new turbines that is perceptible is a low regular background sound similar to trees rustling in the wind."
   Comment: This is quaint but unsubstantiated and placating.

   Is there anyone who wouldn't be able to discern among the sound of rustling leaves and a wind turbine if they were presented with an audio recording of both? Let me play you my tapes of both of these.

   Analytically, trees yield random sounds; a windmill's sound is a repetitive.

2. ***EENF Assessment:* "**…the noise generated by proposed units will be approximately 50-55 dB at approximately the same location [122-feet]."
   Comment: There's too many "approximately's" here …
   This is statement contradicts with the preliminary acoustical assessment done by PMLD consultant PB Power, which has noise level at ~57dB at this distance.

   A clothes dryer emanates noise at ~55dB – is this appropriate for the Wachusett Reservation?

   A real study is in order -- not a "preliminary assessment" (which is a noise-curve taken from a turbine brochure).

3. ***EENF Assessment:*** "…relative to the nearest private property 2,200 feet away. The assessment indicates…the level of the noise at 2,200-feet will be 36 dB…"
   Comment: This means that all the property between the turbines and the private property 2,200 feet away, will be noisier than the natural background sounds. Too bad for 350-acres of the state park…

   The proponent is clueless about the noise rights in Article 97?

4. ***EENF Assessment:*** 'Noise level at 1,640-feet will be completely masked by background noise' simultaneous with 'noise at 2,200 feet will be…similar to background noise.'
   Comment: These statements are contradictory and show that the proponent is shooting from the hip, and needs to employ an agency for an independent acoustical study and report – with relative assessments and mitigations.

5. ***EENF Assessment:*** "Noise level from the turbines proposed at the existing windfarm site is significantly less than noise level of existing units."
   Comment: What are the quantitative noise levels of the new units at specific distances from the turbines until the sound dissipates?

   From the present contradictory noise figures, it appears as if the proponent is replacing a noisy boom-box, with a boom-box. "Quieter" or "less noise" is relative and may not be appropriate for a state reservation. Let the proponent show otherwise.

4.5 PROPONENT MITIGATION of IMPACTS OF NOISE
(EENF SECTION *3.2.3 NOISE*)

There really isn't a mitigation of noise offered. The following is subtle.

1. ***EENF Mitigation:*** Noise at 2,200 feet equals the background noise. 36 dB.
   Comment: There is no empirical basis for the Wachusett background noise level that was cited. This is focused on private property distances, only. Evidently the 350-acres of the state park is not getting the equal respect as are private landowners. The proponent is oblivious to the Wachusett Reservation – as if it didn't exist?

4.6 WACHUSETT – HISTORY OF NOISE

The Wachusett Mountain State reservation's southwest side is quiet – not quieter. The present windmills in that environment make alot of noise. Maybe the new ones are quieter. But will they be quiet? Will they accommodate the noise rights afforded under Article 97.

I, on many occasions and under many conditions, have made video/audio tapes of the present WTGs and their noises. They are both mechanical – from the turbines, and aerodynamic – from the blades cutting the wind.

The present WTGs are unnatural in their noise – so that levels equal to the environmental background would be annoying and stand out. In music, setting two vocalists voices to equal volumes in no way eliminates either one; they have the same amplitude. Neither is masked. In fact the unnatural one (the turbine) in the case of the Wachusett reservation would stick out – as it is unusual in that environment. It would be as obvious as a sour note amongst a group of vocalists.

Simply the idea is to provide an opportunity for the unwanted sound to dissipate with distance. This is particularly indeterminate in environments such as Wachusett where the sound source is above the receivers who sit in the rises and valleys below.

As such the present turbines offer strange acoustical patterns. They go unheard at 1/2 mile; but in the same direction at 1 mile away they are heard. Today they are heard 1-mile away from the WWS on Rhodes Road to the west, and in the opposite direction, 1 mile away on Mountain Road to the southeast (at the Fernside, on the National Historic Register).

The above is confirmed for the WWS, although tentatively, in the following quote by the AWEA -- wind industry advocates.
"…background noise of the wind tends to mask any sounds that might be produced by operating wind turbines… The only occasional exception to this general rule occurs when a wind plant is cited in hilly terrain where nearby residences are in dips and hollows downwind that are sheltered from the wind – in such a case the noise may travel further than on a flat terrain."
(*Facts About Wind Energy and Noise;* American Wind Energy Association)

4.7 NOISE – WINDMILL AT HULL

In Hull, Massachusetts, there is a windmill about 1/2 the size of the proposed WWS WTGs. This single windmill is noisy. I've seen it and videotaped it. This is subjective as is the view of people who consider it quiet.

One thing that is for sure is that Wachusett isn't Hull – when it comes to background noise. The windmill there is amidst and masked by surf sounds, the sounds of the high school ball field, the densely populated beach-town noises, the sounds of the diesel motors of the boats in the harbor and the jets overhead in this landing flyway for Logan

International Airport. Compared this to Wachusett? Don't take my word or anyone's word for it – find out with proper noise measuring equipment, operated by an independent audio professional.

4.8 NOISE – INDUSTRY ASSESSMENTS AND MITIGATIONS

"Strategies for addressing or mitigating noise from turbines should consider the different tonal frequency of the sounds emanating from wind turbine, not just the overall decibel level. Background noise should also be considered. Most local requirements use some form of exceedance over measured background levels as a threshold. The exceedance level can vary from 5 to 8 decibels.
Distance is the most effective mitigating measure in addressing noise from wind turbines. Utilizing setbacks that specify a certain sound level at a certain distance from the turbine is also effective."
(*Wind Energy Development: A Guide for Local Authorities in New York*; page 30; New York State Energy Research & Development Authority, Albany, NY October 2002)

"If noise is an aspect which is required to be remedied or mitigated through a plan or in a consent condition, it is most appropriate to do this by setting a level not to be exceeded at a receiving point, rather than by determining turbine location, distance or type. This leaves a developer free to make choices in respect of the means of achieving the performance requirement."
(*Guidelines for Renewable Energy Developments*; New Zealand Government; 1995)

" a change in sound level of 5 dB will typically result in a noticeable community response; and

" a 10 dB increase is subjectively heard as an approximate doubling in loudness, and almost always causes an adverse community response."
(*Wind Energy Development: A Guide for Local Authorities in New York*; page 30; New York State Energy Research & Development Authority, Albany, NY October 2002)

"The Department has established a Noise Level Policy for implementing this regulation. The policy specifies that the ambient sound level, measured at the property line of the facility or at the nearest inhabited buildings, shall not be increased by more than 10 decibels weighted for the "A" scale [dB(A)] due to the sound from the facility during its operating hours.
(*DEP Bureau of Waste Prevention Noise Policy;* Massachusetts Department of Environmental Protection; 310 CMR 7.10 – U Noise; 1990)

4.9 WACHUSETT WIND SITE NOISE – THE BOTTOM LINE

The messages from this Section 2, on icing, are:

- Noise will be generated by the proposed Wachusett Wind Site (WWS) turbines
- Noise will emanate non-linearly based on industry findings and WWS experience of 20-years.
- Estimates are that noise level at the Wachusett Reservation boundary will be equal to that of a clothes dryer (57 dB at 150-feet per PB Power)
- No noise study has been done by the proponent
- Industry recommends setback – as a proven mitigation of noise
- Mass DEP limits noise to 10dB gain at property line
- Article 97 grants rights to "freedom from excessive and unnecessary noise"
- Due to proximity of the WWS (proposed turbine locations) and the Wachusett State Reservation *reasonable setback*, based on industry findings, will ensure on the citizen's Article 97 rights
- PMLD (the project proponent) has failed to research, test, assess, map and mitigate the noise levels, to the Article 97 protected Wachusett Reservation environment that their proposed WTGs will present.
- Of such, the proponent should be comprehensively required, using an independent agency – before any sanction of this filing is conditionally or permanently granted, by any agency of the Commonwealth – for the unencumbered exercise of its citizen's rights