STUART YOUNG CONSULTING
Dunmore . Westside . Dunnet . Caithness . KW14 8YD
Telephone: 01847 851813 . Fax: 01847 851813
Email: asksyc@btconnect.com

The Safety Aspects of The Highland Council's Practice of Placing Small Wind Turbines in School Playgrounds

A Review by Stuart Young Consulting on behalf of Caithness Windfarm Information Forum

Protecting Our Environment

Caithness Windfarm Information Forum
www.caithnesswindfarms.co.uk

FOREWORD by Brenda Herrick

I first became involved with the risks of turbines in school playgrounds when Highland Council applied to install them in three local primary schools. The turbines were subsequently constructed in 2011 with, as far as I could see, little regard for safety. Friends had earlier objected to a similar application at Thurso High School, which was withdrawn due to local opposition. I was therefore already aware there was an issue and, as a member of Caithness Windfarm Information Forum, I had seen reports of the failure of a turbine at Raasay School on Skye in 2009. This led to me writing to the then Minister for Children, Health & Safety Executive Scotland, the Health & Safety Department in Highland Council who passed me to their Housing Department, the local newspaper, local councillors, the Director of H&S at Renewable UK and finally the Chief Executive of Highland Council. In February 2012 I saw two school turbine applications on the agenda for a meeting of South Planning Applications Committee so wrote to some Members drawing their attention to the risks and the fact that Highland Council were ignoring their own guidelines. The decisions were deferred with resultant wide press publicity. This later led to all school turbines being braked for several months and a review of Risk assessments by the Building Research Establishment being commissioned to review the risk assessment process and carry out surveys of existing turbine installations. Early this year most turbines were switched on again with no apparent change in the Council's attitude to safety. Other Councils in Scotland with school turbines ignored the whole issue. During this process some CWIF members had become involved and Stuart Young then offered to write a professional report on the issue.

NOTE A Summary of the relevant correspondence etc is appended. The full documentation can be accessed at **Schools Safety Correspondence** .

About Stuart Young

I am Chair of CWIF. CWIF Committee has agreed to support Brenda Herrick's efforts and has asked me to review the safety aspects of wind turbines in school playgrounds. I have undertaken to do this in my business capacity as Stuart Young Consulting. I have no formal qualifications. I have worked in the construction industry in the Highlands since 1974. First with Hugh MacRae and Sons, twenty four years with Morrison Construction Ltd, and since 2003 in my own right as Stuart Young Consulting providing services principally to Dounreay, but also providing services to those opposing wind farm development. With Morrison Construction Ltd my role was increasingly over the years devoted to construction site safety as part of the construction management function. Construction Projects I have managed in Highland include Alness Academy, Culloden Academy, Mallaig High School, the Retail Development at Inches Inverness and its extension, AI Welders factory, Safeway Rose Street, and An Aird Development at Fort William. I have provided input to Aonach Mor Ski development and, principally on Safety issues, to the refurbishment of the original Eastgate Development. As Stuart Young Consulting, I have provided Construction Consultancy services to Dounreay, many of which involved risk assessment and risk management issues.

INTRODUCTION

The Highland Council (THC) has installed small-scale wind turbines in a number of school playgrounds. Following representations from members of the public and Highland Councillors concerned about the safety of these devices in close proximity to children, these generators were shut down while THC reviewed its risk assessments.

A THC document entitled **"Review of Risk Management arrangements covering provision of Wind Turbines within Highland Council property establishments"** was produced in November 2011. This document is not widely available and an intensive search of the THC website failed to find it. A Highland Councillor provided a copy to a member of the public who was concerned about the safety aspects of wind turbines in school playgrounds. Amongst other things, this document indicated that a policy in respect of school playground turbines was being prepared retrospectively.

Ultimately, THC engaged the Building Research Establishment (BRE) to assist in preparation of a risk assessment process. The expectation among concerned members of the public was that BRE would carry out actual risk assessments at the schools in question. BRE has taken part in the putting together of a system to manage and record safety related material and carried out useful site inspections of installed turbines. The actual (retrospective) risk assessments were carried out by Highland Council personnel based on a pro-forma WIND TURBINE RISK ASSESSMENT which emerged from this process.

THC has now re-commissioned these turbines. The principal mitigation measure has been to halve the maintenance intervals. Head teachers have been provided with hand-held anemometers and are to carry out certain tasks when wind speeds reach 80mph. Turbines are not allowed to operate in wind speeds in excess of 107mph.

Some of the concerns and proposed measures highlighted in the **"Review of Risk Management"** document have not been implemented, and an email from a Highland Council officer in response to questions on this matter brushed aside the legitimate concerns of a person who had been pursuing the matter.

Stuart Young Consulting has been asked to review THC's risk assessment and mitigation measures for Castletown Primary School, being a representative sample of the installations.

This paper examines:

- **Review of Risk Management arrangements** covering provision of Wind Turbines within Highland Council property establishments
- **WIND TURBINE RISK ASSESSMENT** for Castletown Primary School
- Email dated 7th November 2012 from Mr Martin Bell of Highland Council (appended)

This paper is informed by, but does not comment in detail on, the correspondence etc. record provided by Brenda Herrick

EXECUTIVE SUMMARY

The turbine installation is judged to have zero residual risk based on the belief that halving the maintenance interval to six months will eliminate all risk of a catastrophic mechanical failure. Logic and experience do not support this belief.

The lower intervention wind speed of 80mph is set too high, and the expectation of what can be physically achieved at such a wind speed is unrealistic. The upper intervention wind speed of 100mph demonstrates a complete lack of understanding of the nature and power of wind. Without such an understanding, the risks arising cannot be properly assessed and if they cannot be assessed, they cannot be managed. The measures in place to mitigate against the risk of catastrophic turbine failure require untrained personnel to venture out in extremely dangerous weather conditions. The only saving grace is that those people will have the sense not to do so.

The outcome of a supposedly informed Risk Assessment is that the likelihood of harm to the person carrying out the mitigation measures is greater than the likelihood of harm from the risk being managed.

The evidence of known small turbine failures, lack of available study into the frequency and consequence of such failures, and the potential outcome should a catastrophic failure occur all point to a precautionary approach which is lacking.

It is difficult to avoid the conclusion that if Highland Council had formulated a policy for turbines in school playgrounds and subjected it to rigorous risk assessment, informed by observation and experience, these turbines would almost certainly have not been installed. The fact that almost half a million pounds had been spent before a policy was developed or risk assessment undertaken may suggest a reason for the continuing pursuit of placing wind turbines in school playgrounds.

These findings above indicate that an independent expert review of the safety element of putting wind turbines on school premises is essential.

The Risks from Small Wind Turbines

Generally

The enduring risks from the operation of small wind turbines are electrical safety and ejection of parts by the spinning motion in the event of a mechanical breakdown.

Electrical safety is assured by having proper working procedures in place and regular inspections. THC's Risk Assessment Tool deals adequately with electrical risk.

Comment on Relevant Extracts from the Wind Turbine Risk Assessment for Castletown Primary School

Hazard Zones

Five zones have been identified around the wind turbines, the first three of which are relevant to this review:

1. A Fall Zone. It is difficult to imagine when a falling object might create a hazard other than when maintenance is being carried out, and that risk will be managed by the contractor carrying out the maintenance.

2. A Topple Zone. This zone has a radius equal to the height of the turbine. The risk to persons is very slight indeed because the wind conditions which might cause a turbine to topple unexpectedly will be such that no person is likely to be around. There could be a situation where toppling occurred at the end of a period of instability, but that condition would be obvious and one could expect exclusion zones to be established before there was an immediate safety risk.

3. An Ejection Zone. The extent of this zone is variable. The worst case scenario of a small part or component being ejected under differing wind speed conditions can be calculated.

Site Risk Assessment

The site risk assessment on page 4 for Castletown Primary School acknowledges the ejection risk:

(The grey highlighted areas throughout are extracts from the document being examined.)

Ejected objects: Ejection zone defined and protected (Zone 3)
This is the area where parts of the turbine could land if they detach when the turbine is spinning

Potential control measures are:

a) Procedure to preclude access to zone 3 in adverse weather.
b) Regular maintenance and servicing regime on equipment along with visual and audible checks

On a scale of 1-3, it assesses the initial and residual risk severity as 3 (major) and the likelihood as 1 (very unlikely), making a rating of 3 for wind speeds up to 107mph. A rating of 3 is described as:

LOW. May be acceptable; however, due care should be employed and task reviewed to see if risk can be reduced further.

Measures in place for the mitigation of the risk are identified as:

Maintenance and Servicing to take place twice annually; double the manufacturers recommended maintenance schedule. Apply Wind Speed Control measures if necessary. Icing is not a problem associated with small turbines, therefore not a concern in this instance.

The person responsible for completing required actions is stated as RPO (Responsible Premises Officer) who is understood to be the Head Teacher.

Operation Checklist

The checklist on page 8 identifies that there is a "High wind procedure" in place, which is presumably described by this note:

Wind Speed Control Measures: The RPO is to be aware of wind conditions up to 80mph and implement any control measures they deem appropriate. Wind speeds above 80mph, RPO to implement the control measures listed on page 11.

Wind Speed Specific Controls

0 mph — 80 mph — 107 mph

Normal Operation		Limit Operation	
These measures must be applied when the wind speed is within the range of 0mph - 80mph		These measures must be applied when the wind speed consistently exceeds 80mph	
1	Audible & visual checks	1	Contact MO for assessment
2		2	Safety check by local specialist
3		3	Vacate the surrounding area
4		4	Where forecast exceeds 100mph -

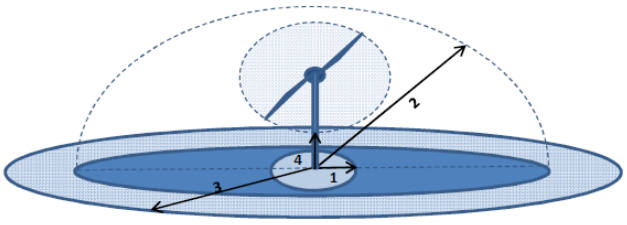
0 mph — 80 mph — 107 mph

NOTE
The turbines installated by the council have been designed and tested to operate safely in wind speeds up to 134mph. The Highland Council has applied a further 20% safety margin to this wind speed so as to reassure building occupants and members of the public. This means that no Highland Council turbine will be allowed to operate in wind speeds exceeding 107mph. Measures have also been put in place to ensure that when high winds (>100mph) are forcast the wind turbine is isolated and made safe before being subjected to the extreme conditions.

MO is understood to be the Maintenance Officer.

Turbine site safety zones

Turbine siting safety zones



Zone	Extent	Typical hazard
1	Circle around base	Fall zone: Hazard if anything were to fall from turbine
2	Hemisphere around base	Topple zone: Hazard if the mast were to topple (incl. margin)
3	Circle around base	Ejection zone: Hazard if something were to be ejected from the spinning rotor.
4	Reachable area	Vandalism: Lowest point of rotating parts above the ground or easily accessible point.
5	Varies	Impact: Hazard from vehicle impacts

Derived from MIS3003 Iss. 3.1a

This report is on the **process** of risk assessment and the tools used to carry out the assessments. Paragraph 2 (page 11) of the Conclusions and Recommendations includes this specific point:

"Some risks (for example ejection zones) will need to be quantified on a case by case basis,…."

E-mail from Mr Martin Bell (THC) to Brenda Herrick dated 7th November 2012
A copy is included in the Appendix. Relevant extracts are below:

1. What is the actual diameter of an ejection zone as referred to in the reports, say for a 15m tower turbine?

   There are no fixed dimensions for the "ejection zone" identified in the diagrams contained within the various Risk Assessments. ……..The Council's approach has been on prevention of risk, thereby negating the need for exclusion.

2. How has this been calculated ?

   As above.

3. Since failure can occur at any time, not just in adverse weather, how do you propose to permanently exclude children from this area? With a fence? How high? Exclusion from only the fall or topple zones will not protect children from flying parts.

   The conclusion of the risk assessment is that there is no need to exclude anyone from a hypothetical 'ejection zone'. The turbines were installed by fully qualified contractors and are approved by the MCS scheme. They are maintained to a higher level than would be a normal requirement and are operating significantly within their design limits.

Review

Evance R9000 Wind Turbine

Literature for the **Evance R9000** machine confirms that it has a 5.5m diameter rotor and a "nominal" speed of 200rpm. At that rotational speed, the blade tip travels at 207km per hour

(129mph). A piece of debris leaving the blade tip at that speed would travel a considerable distance and be potentially lethal. It can be calculated.

Exclusion Zone

No exclusion zone has been provided or even calculated on the assumption that an enhanced maintenance regime will eliminate **all** risk of ejection of machine parts.

Maintenance Regime

All machines are operational until they break down. Bi-annual inspections may identify parts which need to be replaced earlier than annual inspections will, but the fact will remain, that parts wear and need to be replaced. There is no guarantee that a component which is sound in October will be sound in April. Once the initial deterioration in a moving component takes place, the pace of deterioration will accelerate, and at 200rpm, the final failure will be rapid.

Risk Matrix

The risk matrix used is too simplistic for the circumstances. A scale of 1 to 3 for likelihood with 1 being "Very unlikely" is a very blunt instrument when the possible consequence of an event is the death of a child.

		SEVERITY / CONSEQUENCE		
Risk Rating		1. Negligible	2. Moderate	3. Major
LIKELIHOOD	1. Very unlikely	1	2	3
	2. Possible	2	4	6
	3. Probable	3	6	9

1-3 Low	May be acceptable; however, due care should be employed and task reviewed to see if risk can be reduced further.
4-6 Med	Task should only proceed with appropriate authorisation. Where possible the task should be redefined and/or measures employed to reduce the residual risk.
7-9 High	Task must not proceed. It should be redefined or further control measures put in place to reduce risk. Controls should be re-assessed prior to the task commencing.

The evidence that catastrophic turbine failures occur with consequent debris ejection is out there. It cannot be ignored. Linked to this Review is a compilation of **Reported records of small turbine failures** from the Accident Statistics on the **Caithness Windfarm Information Forum** (CWIF) website.

Photograph of a severely damaged turbine taken at Finstown, Orkney on 14th September 2012

Photograph of a severely damaged turbine taken at Oust in Caithness in January 2013

With the knowledge that catastrophic failures do occur, it is not logical to arrive at the conclusion that the residual risk is zero (other than when the turbine is shut down).

Residual risk dependent on increasing wind condition. Shut down in red zone

RISK SUMMARY	Initial Risk	Residual Risk	Residual Risk	Residual Risk
	3	0	0	0

The risk assessment should have been applied to the **POLICY** to erect wind turbines in school playgrounds, not just to the individual turbines.

There are sixteen turbines erected in school premises in Highland. Over a ten year period, these turbines will clock up 1.3 million operational hours. Is it conceivable that not one single catastrophic failure will occur over 1.3 million operational hours? The proper application of the THC matrix to this scenario gives the following results:

Is it likely that:	**Likelihood**	**Severity**	**Residual Risk**
there will be at least one catastrophic failure during the operational period?	3	3	9
there will be more than one catastrophic failure during the operational period?	3	3	9
there will be ten or more catastrophic failures during the operational period?	2	3	6
a catastrophic failure will result in human injury?	2	3	6
a catastrophic failure will result in death?	2	3	6

The limitations of the matrix are exposed by this exercise. The application of the criterion "possible" indicates a degree of interpretation is required. Is "possible" a 50/50 chance? 10:1?

The first three questions are relative to the likelihood of an event happening. The possibility of a human death cannot be acceptable if it is preventable. Indeed the action indicated by a Medium Risk score is **"Task should only proceed with appropriate authorisation. Where possible the task should be redefined and /or measures employed to reduce the residual risk."**

Authorisation for a process which might possibly kill a child and which is readily preventable must come from the highest authority in the organisation. It is not a decision to be delegated to individual Officers.

In fact, it is not a decision which needs to be made nor indeed should be made. The solution is simple. Calculate and apply exclusion zones. The risk to be assessed becomes:

If ejection zones are properly calculated and physical means are applied to prevent unauthorised access to these zones, what is the likelihood of injury or death to a child in the event of a catastrophic turbine failure?

The answer is of course **"Very unlikely"**.

Assessment of 80mph Wind Speed Action Trigger Level

The measure to be carried out by head teachers is to monitor the turbine through audible and visual checks up to a wind speed of 80mph. Over 80mph wind speed, the surrounding area is vacated, the head teacher calls for assistance, the turbine is closed down if wind is forecast to be in excess of 100mph, and is not allowed to operate in wind speeds in excess of 107mph.

Wind Speed Specific Controls

0 mph 80 mph 107 mph

Normal Operation		Limit Operation	
These measures must be applied when the wind speed is within the range of 0mph - 80mph		These measures must be applied when the wind speed consistently exceeds 80mph	
1	Audible & visual checks	1	Contact MO for assessment
2		2	Safety check by local specialist
3		3	Vacate the surrounding area
4		4	Where forecast exceeds 100mph -

0 mph 80 mph 107 mph

NOTE
The turbines installated by the council have been designed and tested to operate safely in wind speeds up to 134mph. The Highland Council has applied a further 20% safety margin to this wind speed so as to reassure building occupants and members of the public. This means that no Highland Council turbine will be allowed to operate in wind speeds exceeding 107mph. Measures have also been put in place to ensure that when high winds (>100mph) are forcast the wind turbine is isolated and made safe before being subjected to the extreme conditions.

It is useful to consider what conditions are like in an eighty mile per hour wind.

A wind turbine was reportedly blown over near Peterhead on 17th April 2013 during what is described as "gusts up to 65 miles per hour". Below is a compilation of extracts from the North East edition of the Press and Journal (P&J) of 18th April. A more readable version is appended.

Gales: Wind turbine bowled over – by wind

The skyline at Hatton, near Peterhead, was changed in an instant as 65mph gusts battered the area and toppled a 90ft turbine tower. The tower was one of two installed by Jim Anderson at his Ardiffery Mains home. He was in a field with a tractor yesterday retrieving the three massive blades. Pages 2

TURBINES

Illustrating the power of the wind

Much has been made of wind turbines and their apparent reluctance to turn when required; too little wind renders them redundant on occasion. But what happens when there is too much wind? And we are not talking about verbose monologues from those arguing the pros and cons of this controversial form of renewable energy.

We draw your attention to a wind turbine in the north-east which was knocked over and flattened by high winds. It was a sorry sight, but it really did give us an illustration of wind power in action.

Turbine is toppled by gale-force winds

Weather: Mast brought down by 65mph gusts

It is clear that the wind conditions were regarded as severe at the time. The P&J refer to it as "gale-force". We are all familiar with the term "gale force 8" from the shipping forecast.

"8 Gale force" is a measure on the Beaufort Scale. The Beaufort Scale describes observable physical conditions at various wind speeds. https://en.wikipedia.org/wiki/Beaufort_scale

Appended is a copy of the Modern Beaufort Scale taken from Wikipedia. **8** is indeed **Gale, fresh gale,** 39 to 46mph. It is described as *"Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded."*

The P&J reports 65mph gusts as responsible for toppling the turbine. This wind speed is just above the upper boundary of **10 Storm, whole gale**, 55 to 63 mph, and just within the category of **11 Violent storm,** 64 to 73 mph.

10 Storm, whole gale, is described in the Beaufort scale as **"***Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs."*

11 Violent storm is described in the Beaufort scale as *"Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely."*

The following are thumbnail image extracts from the John o'Groat Journal of 29th and 30th January 2013. Winds in excess of 80mph had been forecast. Full size readable images are appended.

John O'Groat Journal and Caithness Courier

News Sport Features What's On

John O'Groat Journal -> News

Published: 29/01/2013 15:20 - Updated: 30/01/2013 11:16

Like 301 Tweet 8

Caithness braces itself for 80 mph winds

HURRICANE-strength winds are expected to batter Caithness tonight and into tomorrow with disruption to travel likely.

The west of the county will bear the brunt of the storm locally, according to Scrabster weather watcher Paula Fisher who said exposed western areas will "really get it in the teeth".

Mrs Fisher, who runs Caithness Weather, is predicting winds gusting up to 80 mph during the peak of the stormy weather between 8am and noon tomorrow.

She said the high winds will be the worst to hit the north since December 2011 when damage to properties and minor travel disruption were reported across Caithness.

Mrs Fisher said: "The Wick side will probably be sheltered from the worst of it as the winds are coming from the west.

"It will start to build later on this evening, it's going to be really bad tomorrow morning and then by about tomorrow teatime it will be back to sensible levels again which means you can stick your washing out and not have to chase it down the garden.

"It'll be wheelie bin races galore tonight and you could find a few trampolines flying around."

The Met Office has issued an orange weather warning for much of the Highlands, meaning the public should be prepared.

Spokesman Charlie Powell said the far north is set to be one of the worst hit places in the country.

"Potentially, it could cause some disruption across the region, particularly on the high seas and could even be strong enough to knock trees over. An area of low pressure is passing the north of Scotland and there is a squeeze on the isobar charts.

"Rain will continue in daytime tomorrow but should clear by the evening but the winds will remain consistently strong."

John O'Groat Journal and Caithness Courier

News Sport Features What's On

John O'Groat Journal -> News

Published: 30/01/2013 09:59 - Updated: 30/01/2013 11:19

Like 18 Tweet 4

Caithness ferry services called off

Written by See video clips from around Thurso

Scroll down for video

FERRY services between Caithness and Orkney have been disrupted as the Pentland Firth was battered by wind speeds of up to 85 mph.

Pentland Ferries has announced all of its crossings between Gills Bay and St Margaret's Hope have been cancelled for Wednesday.

Thurso was battered by rough seas due to severe gales.

Serco NorthLink Ferries also cancelled its services between Scrabster and Stromness on Wednesday morning and is reviewing its 4.45pm sailing from Stromness and the 7pm sailing from Scrabster.

A decision is expected to be made at noon today.

Have you been affected by the weather? Leave a comment below.

The Modern Beaufort scale extends from 1 to 12. Beaufort Scale **12** is **Hurricane,** equal to or greater than 74mph, and is described as *"Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris and unsecured objects are hurled about."*

Wikipedia also states:
"The Beaufort scale was extended in 1946, when forces 13 to 17 were added. However, forces 13 to 17 were intended to apply only to special cases, such as tropical cyclones. Nowadays, the extended scale is only used in Taiwan and mainland China, which are often affected by typhoons."

Highland Council's adopted lower level intervention wind speed is 6mph higher than the lower bound of Beaufort Scale 12, and turbines have to be manually shut down when the wind speed reaches tropical cyclone levels.

Comment

We all unconsciously assess risks every day. In the conditions described by Beaufort Scale 8, particularly *"Progress on foot is seriously impeded",* we will be aware as we venture out that it will be uncomfortable, but will probably go anyway. However, if the wind increases by 8mph to Beaufort Scale 9, 47 to 54mph, our unconscious risk assessment will apply mitigation measures and we will probably decide to stay in.

It is worth noting that large-scale wind turbines are shut down in wind speeds around 50mph and greater.

Head teachers are expected to go out in wind conditions considerably in excess of 50mph and deal with turbine issues, as part of their jobs.

THC has no Risk Assessment for dealing with turbine issues in wind speeds over 50mph. The probability of an accident to a head teacher in winds over 50mph is far higher than that of a catastrophic turbine failure, but it has not been considered. This comes within the remit of the HSE.

In winds of 80mph let alone 100mph or more, any flying turbine parts will merge with other flying objects but the likelihood of hitting a person will be very slight indeed as none are likely to be out and about.

Observations on the Highland Council Document:

"Review of Risk Management arrangements covering provision of Wind Turbines within Highland Council property establishments"

There follows a number of observations on specific elements of this report.

Observations

Page 2 - Caption to the right of the photograph of Raasay Primary School

"In respect of knowledge of incidents involving wind turbines within Highland Council the failure of the wind turbine at **Raasay Primary School** in November

2009 (where no harm occurred) related to a tension spring which became detached due to inadequate assembly by the installing contractor."

No harm occurred, but the head teacher had to visit the turbine in an unstable condition in high winds to stop it. The incident was a "near miss" and lessons ought to have been learned. The fact that the unexpected cause of this particular incident is now known should serve as a warning to be prepared to expect the unexpected.

It should also be noted that while HSE has no remit over the potential dangers of turbines in schools per se, the head teacher, in the workplace, had to deal with the incident as part of his/her duties. Had he/she been injured, it might well have been a reportable incident under RIDDOR.

Page 3 –

c) Steps taken by the renewables industry to gather incident information

The confidentiality surrounding industry knowledge of small wind industry incidents should lead to a precautionary approach. A good track record is never confidential.

Page 6 –

b) Risk perception

Expectation and understanding

Wind turbine installation in property establishments is a relatively new venture for Highland Council. With 12 turbines installed so far and only one incident (Rasaay Primary during a pilot phase) expectations are high that this form of energy production will make significant contribution to reduce our carbon footprint. With such a positive desire and interest from across the range of stakeholders the appetite for provision of more installations is buoyant.

One incident in twelve installations should trigger alarm bells, not complacency.

c) HSE project to study and develop a methodology for the estimation of the risk of harm to persons in the vicinity of wind turbines

A final draft of the HSE commissioned report (which is very detailed and technical in nature) has been reviewed and the conclusion confirmed;

- that there is little publicly available failure data for wind turbine failures
- where databases have been compiled, the data are typically held in confidence by manufactures or industrial bodies, or are compiled by pressure groups and the source data cannot be verified
- risks of fatality associated with a 2.3 MW utility scale wind turbine are not particularly high relative to other risks commonly experienced
- typically the Location Specific Individual Risk (LSIR) at two-hub-heights from the turbine is roughly equivalent to **the risk of fatality by lightning strike** in England and Wales
- smaller wind-turbines are more likely to be used in populated areas. If the frequency of failure of such devices is significantly higher, then so too will the LSIR.

Note: An extract from the report containing the Conclusion and Estimated annual risk of fatality due to impact from a blade/fragment of a large 2.3 MW wind turbine compared with other societal risks (such as fatality from Road accidents, Construction industry) is provided in the **Appendix** for information.

This report by MMI Engineering has now been published. Its relevance to the school playground size turbine scenario is limited. This is acknowledged in the MMI report and in the Highland Council "Review of Risk Management" report, which is the subject of this section of this paper.

Wind Turbine Failure Modes – Blades ……..Blade throws may be more likely on small machines with fast rotating blades. (MMI Engineering)

The comparison of the risk of fatality from part of a large 2.3MW turbine blade with other societal risks is unsafe. Small turbine failures may be more frequent, (and certainly appear to be from the known incidences cited in this paper). Footfall levels in school playgrounds are higher than in moorland windfarms. *"Even without any prior record of accidents, it goes against any risk assessment methodology to place a high speed rotating machine above an area where people regularly congregate. Public access to normal windfarms is mitigated by time-at-risk considerations and the fact that it is their choice to be there. Over the course of a child's school attendance the time at risk is considerable and, apart from missing outside activities, there is no choice in the matter."* (Anon.)

3.2. DIRECT IMPACT

Fragment Impact

Fragments are considerably smaller than the human body such that they will impact only part of the body. The mass of such fragments will typically range from a few grams to tens of kilograms. The velocity of such fragments may range from a few metres per second (for simple dropped objects) to hundreds of metres per second (for items ejected from turbine tips) and will only experience limited air drag due to their small size. Typical examples relating to wind turbines include nuts and bolts, small pieces of casing/cladding and individual mechanical components. (MMI Engineering)

Small turbines have proportionately more small components per metre length of blade than large turbines.

Page 9 - Locations of installed and planned wind turbines

In twelve cases the known distances of turbines from buildings range from "Approx 10m" to 135m. If all turbines are the same as those in Caithness, it is not stated that the distance of turbines to accessible play areas is only 2 ½ metres.

Page 9 –

a) Policy and risk information

(i) Highland Council currently has no formal policy on the provision and use of wind turbines.

(ii) Emerging constraints have been drafted following meetings with managers of ECS and the Corporate Health and Safety Team. A copy of a paper titled 'Wind Turbines (informing policy)' prepared by the Health, Safety and Wellbeing Manager is included in the Appendix.

(iii) Provision for auditing and monitoring has been promoted to be carried out by the Health and Safety Team.

It is not within the remit of this review to discuss Highland Council Policy, but it appears that Highland Council embarked on a process of installation of turbines in schools at a reported cost in excess of £400,000 without a Policy, and without a formal process of risk assessment.

Page 17 –

4. Wind Turbines (informing policy)

1.0 Planning stage

It is essential that a health and safety risk assessment is conducted as early in the decision making process as possible. Although the risk of a passer by being injured by an object falling from a turbine (or the turbine falling over) is extremely low, it has to be accepted that the risk is not negligible. Consideration should be given to excluding school children entirely from the area.

The risk assessment should take into account as a minimum:

• Siting of turbines: ensure there is adequate distance from pathways and occupied areas(including play areas) and buildings. The area within the rotor radius around the turbineshould not be used. Fencing should be considered if access is difficult to control.
Separation distance between the turbine and areas of high footfall, such as occupied buildings, playing fields, frequently used roads, play areas etc. should be a ***minimum*** *of tip height plus 10%.*

Page 17 –

b) Decision making, at paragraph (v) notes:
(v) If introduced this policy aspect would require a reappraisal of a number of existing turbine locations which are adjacent to carpark/playing field edges (e.g. Dornoch Academy, Stoer Primary School).

The foregoing quotations (Page 17 etc) are from the undated document "Wind Turbines (informing policy)", which predated the review and is incorporated in it. Although it did not appear to consider the risk of ejection, it did propose a fenced exclusion zone of a minimum of tip height plus 10%, which has not been taken forward into the Risk Assessment. It appears that the proposed safety measures (in italics) have not been adopted. At Castletown Primary for example, and elsewhere, the exclusion zone which was formerly a low picket fence a couple of metres from the turbine base, is now a metal fenced enclosure 5m x 5m and 2m high with the vertical mesh members cut in such a way to deter climbing over.

There has clearly been a further examination of turbine risk which has concluded that falling objects, toppling towers and ejection of parts pose no risk. No record of this can be found on Highland Council's website, and Mr Bell's email of 7th December 2012 shows a marked reluctance to expand on the detail.

Discussion

It is clear from the document "**Review of Risk Management arrangements covering provision of Wind Turbines within Highland Council property establishments"** that The Highland Council embarked upon a programme of installation of turbines in school premises without a formal policy and without a strategic risk assessment.

In February 2012 when Planning applications were scheduled to be heard for turbines at Nairn Academy and Inshes Primary there was no evidence that the proposed measures indicated in the Review of Risk Management document, nor the measures being considered for adoption as policy which it referred to, had been implemented.

Brenda Herrick drew the attention of Members to this and they succeeded in deferring the decisions. This led to the formulation of the WIND TURBINE RISK ASSESSMENT proforma which is the basis for the risk assessment for Castletown Primary. The Building Research Establishment was involved with the formulation of risk assessment tools, but not the risk assessments. The risk assessments were carried out in-house.

The risk of flying debris from a mechanical failure is clearly recognised in the risk assessment but it is assumed to be **wholly** mitigated by the implementation of shorter intervals between servicing. That is irrational. The following image shows extracts from the BRE school turbine inspections. While the serious faults found are no doubt now rectified, it shows that human error in its many and varied forms **must be expected.**

- Inver Primary School
  - The turbine earth was disconnected.
    - Action: Instruct the manufacturer, installer or maintenance contractor to reconnect the earth.
- Stoer Primary School
  - The spare ways in the local 'turbine' distribution board were not all safely sealed using blanks or similar.
- Acharacle Primary School
  - No turbine earth was witnessed during the survey although this does not necessarily mean that one does not exist.
- Portree Waste Transfer Station
  - The turbine earth tape was not properly secured to the turbine structure i.e. the tape had not been drilled but had rather only been clamped down using the bolt head.

The reality that turbines break down has been ignored in spite of the break-up of the turbine at Raasay Primary School followed by another at Stoer. The latter was not a Highland Council turbine, but THC officers were aware of it at the time.

The "Wind speed specific controls" expects that a head teacher will venture out with a hand-held anemometer in winds of 80mph or more to determine whether further action is required or whether to disable the turbine. Few people if any can stand unaided at such wind speeds.

A risk assessment for the activity of actually taking an anemometer reading would identify a wind speed beyond which the task should simply not be undertaken because of the risk of being blown over or being struck by airborne debris. Beaufort Force 9 would appear to be the candidate wind speed.

Even though the risk of ejection of machine parts is acknowledged, no calculations have been done to determine the magnitude of risk, or if they have, they have not been divulged. The theoretical trajectory of a turbine component released at 60% of the blade tip speed can extend as far as70m. This would suggest an exclusion zone of 140m diameter, which would take in a large area of the adjoining field, for which a risk assessment is also required in respect of farming activities. This situation is likely to occur in other schools.

No consideration has been given to gusting. A review has been carried out of the wind speed record at Lossiemouth on 16th April 2013, the day the turbine in Aberdeenshire was severely damaged. This is reproduced below.

http://www.weathercast.co.uk/world-weather/weather-stations/obsid/3068.html

This shows that gusts can be 50% and more above underlying wind speeds, which suggests that an action trigger wind speed of 50mph would be more appropriate at Castletown Primary, particularly as gusts cause most damage, compared to constant wind speeds.

Brenda Herrick's record of communications

A great deal of effort has been expended by many in avoiding the obvious. If there is a possibility of a small turbine part ejection causing an injury, why take that risk?

The answer may well lie in William Brown's FOI email of 17 May 2012: "There are fourteen schools in the Highland area with these turbines at a capital cost given by you at £27,000 each. That is more than a third of a million pounds on capital costs alone."

(Now sixteen schools at a capital cost of £432,000)

STUART YOUNG
May 2013

Appendix

Summary of correspondence with comments

Email dated 7th November 2012 from Mr Martin Bell of Highland Council

Extracts from the North East edition of the Press and Journal (P&J) of 18th April 2013.

Extract from the Beaufort Scale (Courtesy Wikipedia)

Extracts from the John O'Groat Journal of 29th and 30th January 2013

SCHOOL TURBINE SAFETY CORRESPONDENCE

(Brief summary by Stuart Young inserted in red italics)

From: Martin Bell
To: Brenda
Cc: Rob Coghill - Member ; Jim Crawford - Member ; Donnie Kerr - Member ; Gary Westwater ; Eddie Boyd
Sent: Wednesday, November 07, 2012 4:58 PM
Subject: Wind Turbines on School Sites - CRM 452475

Dear Ms Herrick,

I have been asked to respond to your query *(my questions below with his replies inserted)* in the absence of Eddie Boyd, who is currently on leave, and would respond to your question as below;

As suggested, I should be grateful if you could supply answers to the following basic questions:

1. What is the actual diameter of an ejection zone as referred to in the reports, say for a 15m tower turbine?
   There are no fixed dimensions for the "ejection zone" identified in the diagrams contained within the various Risk Assessments. We have interpreted the ejection zone as a hypothetical area around a turbine in which an object, if thrown from the turbine, could land. The MCS is unable to provide any guidance on exclusion zones due to the number of variables at any given time, however it was considered appropriate to include the diagram to ensure this issue was considered. The Council's approach has been on prevention of risk, thereby negating the need for exclusion.

2. How has this been calculated ?
   As above.

3. Since failure can occur at any time, not just in adverse weather, how do you propose to permanently exclude children from this area? With a fence? How high? Exclusion from only the fall or topple zones will not protect children from flying parts.
   The conclusion of the risk assessment is that there is no need to exclude anyone from a hypothetical 'ejection zone'. The turbines were installed by fully qualified contractors and are approved by the MCS scheme. They are maintained to a higher level than would be a normal requirement and are operating significantly within their design limits.

4. Where such exclusion leaves too little play area remaining, will the turbine be removed?
   Not applicable.

5. What action will be taken to remove play equipment, such as football goals at Bower, from the ejection zone?
   There are no plans to move equipment at Bower.

I trust this answers your questions.

Regards,
Martin Bell
Renewable Energy Engineer
01463 255 280 | martin.bell@highland.gov.uk

Gales: Wind turbine bowled over – by wind

The skyline at Hatton, near Peterhead, was changed in an instant as 65mph gusts battered the area and toppled a 90ft turbine tower. The tower was one of two installed by Jim Anderson at his Ardiffery Mains home. He was in a field with a tractor yesterday retrieving the three massive blades. Page 2

TURBINES

Illustrating the power of the wind

Much has been made of wind turbines and their apparent reluctance to turn when required; too little wind renders them redundant on occasion. But what happens when there is too much wind? And we are not talking about verbose monologues from those arguing the pros and cons of this controversial form of renewable energy.

We draw your attention to a wind turbine in the north-east which was knocked over and flattened by high winds. It was a sorry sight, but it really did give us an illustration of wind power in action.

BROKEN: The collapsed wind turbine at Ardiffery Mains yesterday

Turbine is toppled by gale-force winds

Weather: Mast brought down by 65mph gusts

BY JAMIE BUCHAN

A controversial 90ft wind turbine has toppled following a night of gales.

The mast near Hatton, south of Peterhead, broke apart as 65mph gusts battered the north-east.

Its three blades were found scattered in a field yesterday morning.

The tower is one of two installed by Jim Anderson at his Ardiffery Mains home last year.

The project was approved by councillors despite concerns that the masts could interfere with radar equipment at Aberdeen Airport.

Mr Anderson had led a successful campaign just months earlier against proposals for three other turbines near the airfield he owns at Auchenten. He used a tractor with a digger attachment to gather the fallen blades yesterday but declined to comment on the incident.

Neighbour Willie Mitchell, whose home overlooks Mr Anderson's land, said he noticed the collapsed mast yesterday morning. "It just goes to show how dangerous these things can be," he said.

"It's worrying because there are so many turbines in this area now. If someone had been walking by when this came down, it could have been very serious.

"You don't often hear about turbines coming down like this, but I reckon it's more common than you think."

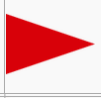
But Renewable UK, which represents the wind energy industry, said such incidents were rare.

A spokesman said: "It is important to learn from them and implement any lessons fully and promptly."

The north-east was hit by gale-force winds throughout Tuesday. Gusts caused thick sandstorms near Fraserburgh, Banff and across parts of Moray, creating visibility problems for motorists.

Yesterday, snowploughs were used to clear sand from roads around Lossiemouth and Forres.

Comment

Beaufort number	Description	Wind speed	Wave height	Sea conditions	Land conditions	Sea state photo	Associated Warning Flag
0	Calm	< 1 km/h < 1 mph < 1 knot < 0.3 m/s	0 m 0 ft	Flat.	Calm. Smoke rises vertically.		
1	Light air	1.1–5.5 km/h 1–3 mph 1–3 knot 0.3–1.5 m/s	0–0.2 m 0–1 ft	Ripples without crests.	Smoke drift indicates wind direction. Leaves and wind vanes are stationary.		
2	Light breeze	5.6–11 km/h 4–7 mph 4–6 knot 1.6–3.4 m/s	0.2–0.5 m 1–2 ft	Small wavelets. Crests of glassy appearance, not breaking	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.		
3	Gentle breeze	12–19 km/h 8–12 mph 7–10 knot 3.5–5.4 m/s	0.5–1 m 2–3.5 ft	Large wavelets. Crests begin to break; scattered whitecaps	Leaves and small twigs constantly moving, light flags extended.		
4	Moderate breeze	20–28 km/h 13–17 mph 11–16 knot 5.5–7.9 m/s	1–2 m 3.5–6 ft	Small waves with breaking crests. Fairly frequent whitecaps.	Dust and loose paper raised. Small branches begin to move.		
5	Fresh breeze	29–38 km/h 18–24 mph 17–21 knot 8.0–10.7 m/s	2–3 m 6–9 ft	Moderate waves of some length. Many whitecaps. Small amounts of spray.	Branches of a moderate size move. Small trees in leaf begin to sway.		
6	Strong breeze	38–49 km/h 25–30 mph 22–27 knot 10.8–13.8 m/s	3–4 m 9–13 ft	Long waves begin to form. White foam crests are very frequent. Some airborne spray is present.	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.		
7	High wind, moderate gale, near gale	50–61 km/h 31–38 mph 28–33 knot 13.9–17.1 m/s	4–5.5 m 13–19 ft	Sea heaps up. Some foam from breaking waves is blown into streaks along wind direction. Moderate amounts of airborne spray.	Whole trees in motion. Effort needed to walk against the wind.		
8	Gale, fresh gale	62–74 km/h 39–46 mph 34–40 knot 17.2–20.7 m/s	5.5–7.5 m 18–25 ft	Moderately high waves with breaking crests forming spindrift. Well-marked streaks of foam are blown along wind direction. Considerable airborne spray.	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.		
9	Strong gale	75–88 km/h 47–54 mph 41–47 knot 20.8–24.4 m/s	7–10 m 23–32 ft	High waves whose crests sometimes roll over. Dense foam is blown along wind direction. Large amounts of airborne spray may begin to reduce visibility.	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.		
10	Storm,[6] whole gale	89–102 km/h 55–63 mph 48–55 knot 24.5–28.4 m/s	9–12.5 m 29–41 ft	Very high waves with overhanging crests. Large patches of foam from wave crests give the sea a white appearance. Considerable tumbling of waves with heavy impact. Large amounts of airborne spray reduce visibility.	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.		
11	Violent storm	103–117 km/h 64–73 mph 56–63 knot 28.5–32.6 m/s	11.5–16 m 37–52 ft	Exceptionally high waves. Very large patches of foam, driven before the wind, cover much of the sea surface. Very large amounts of airborne spray severely reduce visibility.	Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.		
12	Hurricane [6]	≥ 118 km/h ≥ 74 mph ≥ 64 knot ≥ 32.7 m/s	≥ 14 m ≥ 46 ft	Huge waves. Sea is completely white with foam and spray. Air is filled with driving spray, greatly reducing visibility.	Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris and unsecured objects are hurled about.		

John O'Groat Journal
and
Caithness Courier

Published: 29/01/2013 15:20 - Updated: 30/01/2013 11:16

Caithness braces itself for 80 mph winds

HURRICANE-strength winds are expected to batter Caithness tonight and into tomorrow with disruption to travel likely.

The west of the county will bear the brunt of the storm locally, according to Scrabster weather watcher Paula Fisher who said exposed western areas will "really get it in the teeth".

Mrs Fisher, who runs Caithness Weather, is predicting winds gusting up to 80 mph during the peak of the stormy weather between 8am and noon tomorrow.

She said the high winds will be the worst to hit the north since December 2011 when damage to properties and minor travel disruption were reported across Caithness.

Mrs Fisher said: "The Wick side will probably be sheltered from the worst of it as the winds are coming from the west.

"It will start to build later on this evening, it's going to be really bad tomorrow morning and then by about tomorrow teatime it will be back to sensible levels again which means you can stick your washing out and not have to chase it down the garden.

"It'll be wheelie bin races galore tonight and you could find a few trampolines flying around."

The Met Office has issued an orange weather warning for much of the Highlands, meaning the public should be prepared.

Spokesman Charlie Powell said the far north is set to be one of the worst hit places in the country.

"Potentially, it could cause some disruption across the region, particularly on the high seas and could even be strong enough to knock trees over. An area of low pressure is passing the north of Scotland and there is a squeeze on the isobar charts.

"Rain will continue in daytime tomorrow but should clear by the evening but the winds will remain consistently strong."

John O'Groat Journal
and
Caithness Courier

Published: 30/01/2013 09:59 - Updated: 30/01/2013 11:19

Caithness ferry services called off

Written by See video clips from around Thurso

Scroll down for video

Thurso was battered by rough seas due to severe gales.

FERRY services between Caithness and Orkney have been disrupted as the Pentland Firth was battered by wind speeds of up to 85 mph.

Pentland Ferries has announced all of its crossings between Gills Bay and St Margaret's Hope have been cancelled for Wednesday.

Serco NorthLink Ferries also cancelled its services between Scrabster and Stromness on Wednesday morning and is reviewing its 4.45pm sailing from Stromness and the 7pm sailing from Scrabster.

A decision is expected to be made at noon today.

Have you been affected by the weather? Leave a comment below.