RAASAY WIND TURBINE

REPORT ON FAILURE OF TURBINE

Report by;
Eddie Boyd
Principal Sustainability Officer
Housing & Property Service

27th November 2009
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1. Background

The Highland Council Energy Management Performance Plan has a target of 4000kW installed renewable energy systems and as part of that programme wind turbine installations have been included as a main technology. The Raasay turbine was managed along with the extension to the school to form a new nursery and the project architect, Dorothy Buchanan, organised;

- Specialist site assessment by Proven Energy
- Site selection
- Planning consent

The installation was carried out outwith the school contract period as it was funded through the Energy Capital/Energy Efficiency Improvement budgets, and was undertaken from a separately tendered contract for the specific installation of wind turbine generators.

The wind turbine was erected in the autumn school break between the 19th and 22nd of October 2009 by Sangster Electrical Limited, Tain. Due to weather conditions, the unit could not be commissioned on the day of completion and this led to uncontrolled operation prior to setting and the adjoining neighbours highlighted an initial noise issue.

The contractor returned to site and commissioned the turbine on 6th November 2009 and set it to operation ready for handover.

The wind turbine unit installed at Raasay Primary School suffered a catastrophic failure on 13th November 2009.

2. Incident Details

The wind turbine was reported to have pieces dislodged on the morning of Friday 13th November 2009 and following receipt of the information an instruction was issued to the contractor to immediately attend the site and take action to lower the unit and make the situation safe. The local Building Services Inspector, Finlay MacNab, was contacted and asked to visit the school to ensure that the equipment was isolated.

Contact was made with the school head teacher, Alicia Chapple, to assess the situation and she advised that the school had been closed on grounds of health & safety. Gary Westwater, Head of Construction and Brian Hemming were alerted to the situation.

Eddie Boyd (Principal Sustainability Officer) and Alf Leslie (Senior Energy Inspector) attended the site on the morning to inspect the equipment and oversee the remedial action.

On arrival, it was noted that some of the spring mechanisms that tensioned the turbine blades were unravelled and displaced, it was further noted that 2 springs had come off the turbine and fallen to the ground. One spring had been collected by a parent in the morning and placed outside the school grounds. The other was located in the grassed area adjacent to the extension and had sunk into the ground. The plastic formers within the spring mechanisms had disintegrated and splayed around the area.

The turbine was lowered for inspection and it was confirmed that several springs had almost completely failed with some wrapped around the hub pivot.

The unit was fenced off and isolated from the school.

3. Failure

The turbine was inspected by Hugh Piggott of Scoraig Wind energy on 19th November 2009 to establish the cause and his report is included in section 4 of this document.
The reason for the turbine failure was overspeeding of the hub which put too much tension on the springs resulting in them unwinding and ultimately snapping. The Proven turbine operates as a self-managing unit where in high winds the blades close thereby reducing the wind catch. Springs (zebedees) draw the blades back out as the wind drops. The springs in this case were pulled with excess strength and could not hold.

The cause of the situation was due to the incorrect positioning of the blade assembly by the contractor.

The blade assembly comprises of blades, mounting wedges and springs. These must be put on the inner side of the front hub and are arranged so that the blades are set at the correct pitch. In this case the wedges and blades were attached to the rear of the hub plate and this meant that the turbine would not be able to draw in correctly and left the machine liable to run higher than desired maximum speed.

The misassembled state would have undoubtedly have caused the high noise issue of the turbine and although there was suggestion of early issues with springs it was not clearly identified as a problem.

The turbine assembly has been removed from the site and the pole re-erected so that there are no operational issues for the school.

As a precaution another turbine erected at Craighill Primary School, Tain was inspected as part of the process, it was found to be without fault and has been left operational.

4. Other operational issues

A review of the situation regarding the installation indicated that the location close to the school has posed a risk in terms of the operational failure and it would be fair to identify this as a possible future consideration. This has been considered in the lessons learned and action plan in section 10 of the report.

The Head Teacher needed to stop the turbine on the morning of the failure and this is done manually at the column base, she managed to obtain assistance from a parent, however it highlighted the need to have able and trained support locally.

The community have made representation regarding the level of consultation and although a formal planning process was followed, it is felt that further engagement would help to gain ownership of the initiative. Although this is often successful with the school and children, it should be considered as an option for adopting on a wider scale.
5. Specialist Report

A report was commissioned from an industry specialist, Scoraig Wind Energy. Hugh Piggott has extensive experience with Proven Energy wind turbines and hands-on expertise that offered objective assessment of the failure and his report follows.
REPORT ON CAUSES OF FAILURE OF PROVEN 6 kW TURBINE
AT RAASAY SCHOOL IN OCTOBER AND NOVEMBER 2009

SUMMARY

Proven Energy 6kW wind turbines were installed at Schools in Tain and Raasay during 2009. The turbine at Craighill School in Tain has behaved quietly and produced 1500 kWh of electricity in its 8 months of operation. The turbine at Raasay has failed twice in one month due to the springs that govern its speed. These springs broke and parts were scattered around the site where the public and small children need to pass.

The reason for the failure of the springs at Raasay was a simple installation error. However this is not the only instance of springs failing on Proven turbines and it is not unusual that springs fly some distance when they do fail. Previous accidents have happened due to incorrect installation of the blades, and also when the blades and springs have been correctly fitted but have later failed. Proven have modified the design of the spring assemblies to improve safety.

It is easy to see from ground level that the wedges were incorrectly fitted to the turbine at Raasay. Normally the outer face of the blade rotor plate is a clean triangle. In this case the blades have been installed on the outer face. The blades should be fitted to the inner face of the blade rotor plate.

Proven Energy have encouraged customers to install these turbines at schools and shops and on top of buildings. Thus far nobody has been hit by flying springs, but recent events on Raasay could be considered a close miss.
SPEED CONTROL The Proven Energy literature in general and the installation manual in particular gives the following over-simplified description of how the turbine’s speed is controlled:

“One end of the shaft has a propeller blade assembly comprising glass thermoplastic composite blades that are hinged on a rotor plate. The blades are held in their correct position by Zebedee springs that allow the blades to form a cone shape in high winds. In this shape, the turbine is able to limit its rotational speed.”

The photo on the right indicates the movement direction to ‘cone’ the blades. This movement does take place, and is helpful in relieving the bending loads on the blade roots, but it is inaccurate to state that this limits the rotational speed.

I believe that Proven make this statement to protect their intellectual property from competitors. In reality the speed control is achieved by a small change in the blade pitch due to the ‘unwinding’ of the Zebedee hinge/spring assembly.

At a certain rotational speed, the blades pull the springs and unwind the Zebedee and pitch themselves into a stall angle which is flatter than the normal running pitch of the blades.

It is very important to set the blades at the correct initial pitch angle so that they will run with good efficiency, and they will stall at the desired speed.

At Raasay school the blade pitch was set wrongly and the blades were unable to stall. The result was

- excessive speed in high winds resulting in high noise levels and high voltage that resulted in disconnection of the inverter to safeguard it from overload, resulting in

- higher speed and thence damage to the springs. Ultimately the machine was running unloaded and ungoverned in high winds, which is a very noisy and dangerous state for a wind turbine. The position of the turbine directly outside a school maximised the danger to the public and to small children.
CORRECT MOUNTING OF THE BLADES ON THE HUB PLATE

Proven installation manual ABOVE showing correct way to fit wedges and springs.

http://www.provenenergy.co.uk/documents/Proven_6_Grid_Connect_v3.1.pdf

Raasay School turbine: wedge fitted underneath steel hub plate instead of on top of plate. This increases blade pitch by several degrees and prevents the blades from stalling.

Proven installer training does include telling installers to be careful to fit the wedge with the side end at the trialing edge of the blade but does not emphasise which side of the rotor plate to fit the blades, nor explain the significance of the blade pitch angle in the performance and safety of the turbine.
SAFETY CONCERNS  In December 2008, an installer complained to Proven that over 10% of the 6 kW turbines were suffering failures of the spring assemblies within the first three years. He pointed out that the spring brackets are only held by one bolt and are free to swivel.

In my own experience, failures of springs and spring assemblies are widespread, and in most cases these failures result in springs being thrown some distance.

At Raasay, the teacher decided to stop the turbine so as to reduce the danger to her pupils and the public. She had been shown how to do this but did not have any protective clothing.

DESIGN MODIFICATIONS

- Proven have changed the design of the wedges. The wedges and rotor plate are now pinned so as they can only be fitted one way.
- Since March 2009 the spring attachment brackets have been changed to make them stronger and safer. They are now secured with two bolts at each end. The blade assemblies and rotor plates now also have two holes to match.

REPAIR OF RAASAY TURBINE With new spring assemblies, the turbine would be serviceable. However there may be other minor damage. The blade tips appear to be swollen as if something inside had been forced outward by the centrifugal forces. The blades are also slightly eroded by the high speed of rotation.

The damaged spring assemblies should be kept for spares. The plastic washers and bushes are parts that wear out over time and need replacement (for example on the Scoraig turbine). Spares like these are difficult and expensive to obtain from Proven.

The electronics in the school will have been subjected to excessive voltage during the overspeed of the turbine. Overvoltage can destroy the inverter, but the controller is designed to prevent this. Overvoltage can also damage the controller itself. Visual inspection revealed no damaged components in either unit. The capacitors in the inverter usually explode with overvoltage and there are some small diodes in the controller that burn out. The electronics appear to be in good condition.

It is also possible that the alternator has suffered damage (for example dislodged magnets) but again this was not apparent in a quick inspection. The windings all showed equal resistance.

Hugh Piggott 23rd November 2009
6. **Contractor Report**

The Contractor, Sangster Electrical, was asked to provide a report on the incident and this is included in the following section.
23rd November 2009

Mr. Eddie Boyd  
The Highland Council  
Kinmylies Building  
Leachkin Road  
Inverness  
IV

Dear Sir

CONTRACTOR REPORT ON RAASAY TURBINE FAILURE

Following the recent turbine failure on Raasay we have carried out an in-house investigation to what caused the problem, what corrective action was, or is yet to be, taken, and what procedures we can put in place to prevent a re-occurrence of the problem.

Pre-Start
With any new contract we carry out a pre-construction meeting with all our operatives and staff who will be carrying out the works. Alan Sangster was to be our senior technician on this contract and, as he had completed the Proven training course earlier this year and been involved in two previous Proven turbine installations, he was aware of the type of problems usually encountered.

The tower pole to be used to for this turbine is not the type that Proven provide during their training course however we have installed an identical tower and turbine on a previous contract. Instructions for the tower assembly were provided by Hydro Contracting.

Planning
We visited site in July 2009 to assess the position, ground conditions and what machinery we would require to install the turbine. We found the site to be in good order with a newly tarred access path and no foreseeable access issues. Positioning of the turbine and planning applications had been carried out by The Highland Council.

Construction
The installation of the base was to be carried out by a local contractor. This works was overseen and recorded by The Highland Council’s Clerk of Works. On completion of the base installation we arranged with the school and The Highland Council that the turbine would be installed during the schools October holidays.

Alan and another of our engineers began work on the turbine installation on Monday 19th October 2009 and had completed both the internal and external works by Thursday 22nd October. Due to lack of wind he was unable to fully commission the turbine and inverter. As the inverters are delivered with the correct G83 compliant settings already configured he did
not think it would be a problem to have the turbine in operation prior to the commissioning check being carried out.

**Commissioning**

Alan returned to the school on Friday 6th November with myself to carry out the commissioning check on the turbine and inverter. This followed reports from the school the previous day of excessive noise from the turbine. They described the noise to be compared to a helicopter passing overhead. We assumed that the noise was due to the turbine not being correctly controlled by the inverter. Once set the inverter can partially control the turbine speed by increasing the demand during higher wind speeds. During high wind speeds the turbine blades are also designed to “furl” out of the wind, which will also reduce the rotation speed.

The inverter comes pre-set to lock onto the grid after a sustained set voltage is reached for 180 seconds. Following this period the inverter will lock onto the grid unless the voltage drops below the limit for more than 2 seconds. During the Proven Installers course we were advised to change the latter of these settings to 3000 seconds so the grid will be held for longer periods during lulls in wind.

Following commissioning we waited with the turbine and were listening and checking for any other problems. It was at this point we noticed some of the springs had turned from their original position and appeared to be slightly bent when at rest. We decided at this point it would be best to leave the turbine with the brake on until the springs could be replaced.

**Replacing Springs**

We immediately arranged for a set of replacement springs to be provided and these were installed on Wednesday 11th October. As I have also completed the Proven Installers course we decided it would be best if I also attended during the lowering and replacing of the springs. Once on the ground we replaced the springs and checked the tension of all bolts attaching the blades to the rotor head. We checked the orientation of the wedges by comparing what we were looking at to a photo included in the Proven manual. At the time we found no obvious difference but this was later to become clear. We re-erected the turbine and set it into operation once again. We found the turbine to be smooth running and, in a good wind, quiet in operation.

I called the school the following day to check the turbine was still smooth running and they advised this was the case. They also advised that wind conditions were similar to the previous day.

**Turbine Failure**

On Friday 13th November the head teacher called our office to advise that a part had fallen from the turbine. She was concerned for the children’s safety and would be moving them to the local community hall. I called Alan and we immediately made preparations to visit the school the same day to check and, if possible, rectify the situation. My second call was to notify yourself of the problem and advise you of the action we were taking.

We attended the school along with yourself and your colleagues to assess the situation. As you know the turbine was lowered and it remains such to date.

**Investigation Into Failure**

Having worked on a previous project with Hugh Piggott of Scoraig Wind, we called him asking if he had encountered any problems of this nature on previous projects. He advised that Proven had experienced spring failure on earlier models but due to improvements in design and the addition of a locating knob to the wedges this had reduced failures. He did admit to it being some years since he had worked on a Proven unit but would be happy to assist if he
could. We advised him that the turbine you had supplied us did not have a locating knob on the wedges and was possibly an earlier model, however he was not educated enough to know if changes were made to this unit.

Since this point we understand Hugh’s services have been directly employed by you to investigate the failure. On providing Proven with photo’s they easily pointed blame to an installation error caused during the fitting of the wedges and blades.

**Remedial Actions**
Although corrective actions are yet to be taken on the Rassay turbine we have began developing a checklist that also highlights areas of possible error. Although the Proven instruction manual does warn of over-speed problems if the wedges are not fitted in the correct orientation we feel the orientation of the wedges we fitted was correct and only we had installed them on the wrong side of the rotor plate. While design modifications may now stop this problem from occurring we feel more emphasis should have been put on this during the installer course.

**Summary**
While the pole assembly was not that of the one used during the Proven Training course we had been provided with instructions by Hydro Contracting. The pole assembly and main turbine rotor had all been installed out correctly. An error was made when fixing the blades to the rotor plate that, we assume, has caused the spring failure but we await Hugh Piggott’s report. We are disappointed in ourselves for making this error and the on-going impact this may have in The Highland Council’s program to reduce their carbon footprint. We are also disappointed in Proven for both not highlighting, during their training course, the dangers and error like this can cause and with their spring unit as it failed in such a dangerous and catastrophic manner.

We continue with our efforts to improve in all aspects of our work and an incident such as this highlights to us the importance of training, checking and re-checking. An area we feel should be addressed by clients purchasing any Proven turbine through an agent is the availability of a communication route between the installer and Proven technical help. We have found Proven very difficult to contact for information and were almost obstructive in providing information on the tower that was supplied and only following a chance meeting with a Hydro Contracting supervisor were we able to gain this information.

We feel our response to the situation could not have been improved. We made a conscious effort to ensure you and the staff of the school was kept informed of what action we had been taking throughout the installation. We clearly regret the error made and will ensure every effort is made, on future installations, that there will be no repeat of this incident.

We trust you find this report in order, however if you have any queries or require clarification on any item noted above please contact me at our office

Assuring you of our best attention
For Sangster Electrical Ltd

Peter Sangster MIET
7. Proven Energy Response

The turbine manufacturer, Proven Energy was invited to provide some input to the report, but have provided no response.
8. Planning Consent

The planning consent was granted on 6th November 2008, issued by the Area Planning Office, Portree.
PLANNING PERMISSION
SUBJECT TO CONDITIONS

THE HIGHLAND COUNCIL
TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997

Grid Reference
Easting: 155049
Northing: 836043
Reference No: 07/00233/FULSL

To: Education Culture & Sport, Highland Council
Glenurquhart Road
Inverness
IV3 5NX

Per: Property & Architectural Services
Tigh Na Sgire
Park Lane
Portree
Isle Of Skye

With reference to your application received on 27 April 2007 for planning permission under the above-mentioned Act for the following development, viz:-

Erection of 15 metre wind turbine
Raasay Primary School, Isle Of Raasay, Kyle, Highland IV40 8PB

The Highland Council in exercise of its powers under the above-mentioned Act and Order hereby grant planning permission for the said development in accordance with the plan(s) docketed as relative hereto and the particulars given in the application, subject to the following standard condition:-

In terms of Sections 58 & 59 of the Town and Country Planning (Scotland) Act 1997, this approval is granted subject to the condition that the development to which it relates must be begun not later than the expiration of five years beginning with the date of this permission

and also to the following condition(s), viz:-

(1.) Noise arising from the wind turbine shall not exceed L A90, 10 min of 35 dB at the nearest noise sensitive property. The foregoing condition shall apply at wind speeds not exceeding 10m/s, as measured at a height of 10 m above ground level at the wind turbine. In the event of audible tones being generated by the wind turbine a 5d(A) penalty for tonal noise shall be added to the measured noise level. Any measure and assessment of noise from the turbine shall be carried out in accordance with the The Assessment and Rating of Noise from Wind Farms (ETSU- R - 97). (Available from ETSU, Hartwell, Oxon, OX11 0RA).

Reason: In the interests of neighbouring amenity.

FOOTNOTE TO APPLICANT RELATIVE TO APPLICATION 07/00233/FULSL

Please note: Your attention is drawn to the conditions attached to this permission. Any pre-conditions (those requiring certain works, submissions etc. prior to commencement of development) must be fulfilled prior to work starting on site. Failure to meet these conditions may invalidate your permission or result in formal enforcement action.

Dated 6th November 2008

Area Planning & Building Standards Manager
10. Correspondence and consultation with neighbours & Community

There has been received various correspondence from the community and a meeting was held at the island on Friday 20th November 2009, hosted by the Energy & Sustainability team in which representatives from the community were invited to put views forward on the turbine. Representatives of the neighbours, Community Council and School Parent board were present.

The discussions related to their concerns on;

- Planning Process
- Noise
- Safety

It was agreed that the community would be consulted on the way to progress with the turbine installation and the Council would look for their views to be part of any decision making process.

Attached is correspondence received regarding the turbine.
Mr Hugh Fraser  
Director of Education, Leisure & Sport  
Glenurquhart Road  
INVERNESS  
IV3 5NX

Dear Sir

Wind Turbine – Raasay Primary School.

The above turbine has been situated on the boundary of my croft and is 100m from my home - the noise so excessive that the turbine can be heard above the television in my sitting room. During the night it is having an effect on sleep patterns. It sounds like a helicopter has landed and remains outside with the engine running.

At the initial planning stage we lodged an objection to this wind turbine and one of our concerns was the possibility of excessive noise.

Proven Energy Ltd state in their Company Planning Pack -

"Proven Energy Ltd recognizes that noise can be a nuisance............"

Proposed location was also an issue

"our technology requires a location that offers good exposure such as the highest point on the land." This is not the highest point on the land.

Due to the sound level of this nuisance and the effect on our quality of life in the short time since its erection, you can appreciate that this is an intolerable and unacceptable situation which we are prepared to take all necessary steps to have remedied. We would be obliged if you would take immediate action.

Yours faithfully

Ann & Donald Oliphant
Mr Victor Hawthorn  
Area Planning & Building Standards Manager  
Highland Council  
Kings House  
The Green  
PORTREE  
Isle of Skye  
IV51 9BT

Dear Sir

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Yours faithfully

Ann & Donald Oliphant
Mr Alistair Dodds  
Chief Executive  
The Highland Council  
Council Offices  
Glenurquhart Road  
INVERNESS IV3 5NX

Dear Sir

Wind Turbine  Raasay Primary School

As you will no doubt be aware the above wind turbine suffered a catastrophic failure on Friday the 13th November. I would like to take this opportunity to provide background to this matter.

A planning application was lodged by The Highland Council for this turbine in May 2007 resulting in ourselves and the next immediate neighbours Mr & Mrs Smith lodging objections with the local planning department on the grounds of adverse visual impact, potential noise and safety. The Community Council of which I, Donald, am Chairman also lodged an objection on behalf of the community. Nothing was heard, or happened on the ground and the assumption was made that the turbine was not going ahead.

During the summer holiday 2009, work was started on the proposed site. We then discovered that planning permission had been granted by Delegated Powers in November 2008.

The turbine was subsequently erected and immediately emitted a noise like a helicopter landing and remaining in our garden. This continued for twenty four hours a day.

We then researched planning regulations and our understanding is that Highland Council cannot be Judge and Jury in the use of Delegated Powers. To our amazement we also discovered that the three letters of objection to the initial planning are not on record and we have been informed by a local planning official that we will have to take this up with Royal Mail. To our knowledge there has not been a problem with incoming or outgoing mail on this island but the planning manager accepts the same could not be said for his department.

From initial installation until the breaking up of this turbine there was no one on Raasay with any knowledge of its working or the action required should a fault occur. It was actually a parent with no knowledge of wind turbines who managed to lower the turbine to the ground.

I would suggest this was a major failing on the part of Highland Council and the Contractor and questionable under health and safety regulations.
Given the foregoing it is obvious that from the outset this installation was poorly conceived without public consultation, badly managed on installation and erection and took no account of the impact on children’s safety and neighbour’s quality of life. Mr Eddie Boyd at a recent meeting with us and a representative of the school board, advised that this turbine would remain out of action until an independent survey was carried out and full public consultation held. It is our view that this turbine should not be re-erected in its present location but on an alternative site on the island. Similar views are being expressed by Mr & Mrs Smith and the population of Raasay at large. Your assistance to bring this matter to a satisfactory conclusion would be much appreciated.

Yours faithfully,

Cc: John Laing (Councillor)
Donald Oliphant  
Chairman  
Clachan Lodge  
Isle of Raasay  
IV40  

23rd November 2009  

Mr Alistair Dodds  
Chief Executive  
The Highland Council  
Council Offices  
Glenurquhart Road  
INVERNESS IV3 5NX  

Dear Sir  

Wind Turbine Raasay Primary School  

As you will no doubt be aware the above wind turbine suffered a catastrophic failure on Friday the 13th November. I would like to take this opportunity to provide background to this matter.  

A planning application was lodged by The Highland Council for this turbine in May 2007 resulting in Raasay Community Council lodging an objection on behalf of the community with the local planning department on the grounds of adverse visual impact, potential noise and safety. Nothing was heard, or happened on the ground and the assumption was made that the turbine was not going ahead.  

During the summer holiday 2009, work was started on the proposed site. We then discovered that planning permission had been granted by Delegated Powers in November 2008.  

The turbine was subsequently erected and immediately emitted a noise like a helicopter landing and remaining on the ground. This continued for twenty four hours a day.  

We then researched planning regulations and our understanding is that Highland Council cannot use Delegated Powers to deal with planning issues in which they have a vested interest. We also discovered that letters of objection to the initial planning are not on record.  

From initial installation until the breaking up of this turbine there was no one on Raasay with any knowledge of its working or the action required should a fault occur.
It was actually a parent with no knowledge of wind turbines who managed to lower the turbine to the ground.
I would suggest this was a major failing on the part of Highland Council and the Contractor and questionable under health and safety regulations.
Given the foregoing it is obvious that from the outset this installation was poorly conceived without public consultation, badly managed on installation and erection and took no account of the impact on children’s safety and neighbour’s quality of life. In a recent letter to the Stop Highland Wind Farms Campaign the Director of Planning and Development Mr J S Black states:

“that development that is judged to have significant long term detrimental impacts on communities or individual householders for that matter should not be granted.
Indeed, this is a fundamental aspect of the Councils current planning policy.”

Mr Eddie Boyd at a recent meeting with us and a representative of the school board advised that this turbine would remain out of action until an independent survey was carried out and full public consultation held. It is our view that this turbine should not be re-erected in its present location but on an alternative site on the island. In fact a local renewable energy group carrying out consultation on wind energy on the island were not contacted and Mr Boyd admitted he was not aware of its existence.
It is the view of my council members that the erection of this turbine in its present location is, without public consultation or concerns for the safety of children and members of the public, running rough shod over the community and shows complete disregard for the way of life of an island community.
The Community of Raasay is not against renewable energy of any form and would be more than willing to meet and discuss any future acceptable projects.

Yours faithfully,

Donald Oliphant

Cc: John Laing (Councillor)
11. Action Plan

It is essential to review the events in the context of a school and Council building environment to determine what action is required and this action plan highlights the main issues, the lessons learned and what improvements can be made moving forward.

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<th>Issue</th>
<th>Points of Note</th>
<th>Actions</th>
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<td>Location of wind turbines.</td>
<td>Ensure that there is an adequate buffer zone from the main pathways and occupied area, in schools this should include entrance and regularly used pathways and playground areas.</td>
<td>Arrange for guidance to include an assessment process that will highlight areas on each site that should be kept clear of proposals and are outwith any potential dispersal area.</td>
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<td>Noise from Turbines</td>
<td>Take efforts to ensure that the noise impact is evaluated at an early stage so that any potential problems can be highlighted and addressed</td>
<td>Standard assessment procedures to be raised that include a calculation at scoping stages for wind site selection.</td>
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<td>Community Engagement</td>
<td>A failure of this particular installation was the lack of opportunity for the neighbours and community to get engaged over the plans for the turbine and although a formal planning process was undertaken, further discussion would have added value to the overall outcome.</td>
<td>Arrangements are to be put in place for proactive engagement with the neighbouring properties and communities affected by wind turbine installations. And this is to be an action at each stage of the project delivery process.</td>
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<td>Turbine Selection</td>
<td>It is essential that the equipment selected is appropriate and suitable for the location and required operation.</td>
<td>Robust assessment procedure to be established for selection of this type of equipment.</td>
</tr>
<tr>
<td>Contractor and Installation Checking</td>
<td>Technical sign off needs to be improved</td>
<td>Process to be mandatory, timely and effective.</td>
</tr>
<tr>
<td>Local Technical Support</td>
<td>Support on hand for any issues raised</td>
<td>This is to be established at initial stages.</td>
</tr>
</tbody>
</table>
12. Wind Turbine Guidance Documents

Following the installation of the turbine at Craighill Primary School, Tain, an officers group help a workshop to review the installation and prepare guidance on future installations and the process that would be proposed to be adopted for future installations.
14. Options moving forward

There are a number of options to consider moving forward with the Raasay school, neighbours and community and these are outlined below;

1. Reinstate the turbine

The failure is an installation issue and the unit can be replaced and reinstated in a short timescale with the benefits of the renewable energy immediately available to the school.

This would need careful handling with the school so that any concerns are addressed relating to:-

- Safety
- Noise
- Operational support

The issue of safety is paramount and in the context of a school environment cannot be compromised; this is the main obstacle that will need to be addressed prior to reinstatement.

It is clear from the representations of the school, parents and community that they will need to be fully assured of the situation in respect to the concerns above and although a repair can be engineered, the perception of risk needs to be proved and there may be opposition to moving forward on this basis.

The issue of noise has requirements to meet within the planning consent and this will need to be measured and monitored.

2. Relocate the turbine

The turbine could be relocated to another site within the school grounds or at a location agreed with the Community.

There are restrictions in terms of the distance that the turbine could be located to minimise the loss from transmission of the low voltage energy it produces, but it is possible that it could be quite remote if a suitable location could be found.

3. Remove the turbine

The turbine could be removed from the site and used at another location, the column and equipment could be mainly used, with some adaptation at a more suitable or agreeable location.