Referral of Industrial Wind Turbines Under Market Surveillance of The Machinery Directive

Non Conformance of Wind turbines to Design and CE Certification Criteria.

By John Dooley

To

The Workplace Contact Unit

The Health and Safety Authority

From

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Co. Dublin

Ireland

14th April, 2014

Dear Sir/ Madam.

The 4 section of the EU Machinery Directive authorizes Market Surveillance of all CE Certified equipment released in to the market to ensure that people, domestic animals and property are not harmed by CE Certified equipment failing to operate in the field as Certified.

In my opinion there is a generic technology problem with the design of all Industrial Wind Turbines be they Direct Drive or Gearbox driven machines. Indeed post the recent fatalities in Holland 2013 where two technicians died as a result of a fire in a Vestas V66 turbine there also would seem to be implications as to the application of The Health and Safety at Work Act and the Fire Regulations as outlined in the attachment below where I outlined a number of incidents in Ireland and abroad which in my opinion seriously question the ability of wind turbines to operate within the provisions of The Fire Regulations, The Health and Safety at Work Act 2007? and the Machinery Directive in ENG Amended 2009.

Research carried out by the US Department of Energy Laboratory would suggest that these failures are intractable and insolvable.

The issues of most importance is the likelyhood of fatalities among maintenance technicians as a result of lubrication fluid fire and fatalities among the general public, neighbors, domestic animals and damage to property as a result of blade and fastener and other metal components, detachment from turbines at speed, and as a result of mechanical failure or fire due to electrical shorts causing the lubrication and hydraulic fluid fires.

Moving to the issue of Wind Turbine Blade design there is no Global Design Standard and according the, The British HSE Study and development of a methodology for the estimation of the risk and harm to persons from wind turbines mentions that cheap composites are used in their manufacture. There is also no international standard developed for blade design and manufacture. Indeed the above document indicates that design, manufacturing and test procedures may be inadequate. ”One point to note is that only a single blade is required to be tested under the blade test specification, which may not be sufficient to detect failures due to variations in the manufacturing process. Part of the on-going work at NREL is to assess current test practices with field observations to improve the process. “

Then there is the issue of infrasound/ low frequency noise first identifed and researched by Dr. N. D. Kelly et al, in Acoustic Noise Associated with the MOD-1 2 MW Wind Turbine: Its Source, Impact, and Control at a wind turbine site in Boone North Carolina in the mid to late 1980s. Infrasound/ low frequency noise has a serious impact on the health of people and domestic animals. The Bruce McPherson Infrasound and Low Frequency Noise Study, attached, in 2011, reinforce this. Also an interpretation of the McPherson Study by Wayne Gulden The McPherson Study The Infrasound Smoking Gun raises serious questions with the failure of the wind industry to address the issue of the impacts of infrasound and low frequency sound on peoples and domestic animals health.

Also it is quite obvious that in Europe serious issues in relation to wind turbine noise were identified, in Holland, in 2003 by G.P. van den Berg in effects of the wind profile at night on wind turbine sound, published by The Science Shop for Physics, University of Groningen, Holland in 2003.

Also referenced in”Infrasound From Wind Turbines Could Affect Humans” by Alec.N.Salt and James A.Kaltenbach the different designs of Industrial Wind Turbines gear driven and direct drives have serious issues with infrasound/ Low Frequency Noise.

Studies on domestic animals, such as “The Preliminary studies on the reaction of growing geese (Anser anser f domestica) to the proximity of wind turbines by J. Mikolajczak et al., and a paper given by Professor Mariana Alves-Pereira to The 14th International Meeting on Low Frequency Noise and Vibration and its control in Aalborg, Denmark, 9-11 June 2010, ”also show a significant impact on their health and development of domestic animals of infrasound emitted by industrial wind turbines.”

John Dooley

Introduction.

Referral of Vestas, Siemens, Gamesa and Enercon Wind and all other market certified turbines under the Market Surveillance provisions of the EU Machinery Directive

(DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
Of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast) Amended by: Official Journal No page date.)

►M1 Regulation (EC) No 596/2009 of the European Parliament and of the Council of 18 June 2009 L 188 14 18.7.2009

►M2 Directive 2009/127/EC of the European Parliament and of the Council Of 21 October 2009 L 310 29 25.11.2009

Recent incidents, in Loughderryduff and Corkermore Wind Farms of wind turbine disintegration, in Donegal, Ireland, while operating within design parameters, raise serious issues about the CE Certification and the process used to certify them. As a results of these incident's, which happened in relatively sparsely populated areas but close to habitation and public roads, has encouraged me to look at the conformance to design and CE certification of the turbines involved in these incidents.

Executive Summary
From the introduction to" Wear Analysis of Wind Turbine Gearbox Bearings" prepared for Prepared for Wind and Hydropower Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy:

"Wind power offers a promising renewable energy option for the United States, but its implementation depends upon a combination of **technological,** political, and economic factors. Any one of these factors has the potential to delay meeting the goals of a national wind energy plan**. The focus of this report is on just one part of wind technology: the reliability of the wind turbine gearbox bearings.** Specifically, it was the objective of this study to systematically characterize several used wind turbine gearbox bearings with respect to the nature of their wear and surface damage. Both surface and subsurface examinations were conducted using a variety of measurements and metallurgical tools."

The analysis of the Oak Ridge Laboratory frankly and honestly admits to serious technological problems with bearing design in all types of gearbox driven wind turbines. The evidence below proves that these technological challenges have not been surmounted and many would now express the opinion that theses technological challenges are insurmountable. These wind turbines cannot be installed, operated, maintained and decommissioned safely as the conditions within which they operate are not predictable,

quantifiable and controllable. The recent failure of a blade on the Enercon E126 shows despite all the apparent technological advances turbine blade technology is no more reliable now than it was 15 years ago.

It is also suggests from the frequency of blade failures that the manufacturing technology available is incapable of producing blades that conform to their design requirements on a continuous and repetitive basis to meet a Zero Defect manufacturing standard, which is confirmed by "**Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines". Commissioned by The British HSE and published in 2013.**

So we can safely say that Wind Turbines do not meet the requirements of the Machinery Directive and should be decertified and removed from the market.

The impact of Infrasound and Low Frequency Sound.
The EU Machinery Directive in Annex I, section 1.5.8 says that noise is to be reduced to the lowest possible level.
As we quote below Van den Berg has measured an Enercon E66, in 2006, at 90 dB at 1 Hertz massively above the safety thresh hold at a distance of750 meters from the nearest turbine. To detect sound pressure waves at 1 Hertz you have to use the dB G filter.

The health impact of infrasound and low frequency sound on humans and domestic animals living within 2 kilometers within these machines are not addressed, as the IEC614000 part 11 specifies that all noise be measured using dB A filter. That is very ineffective in measuring sound below 20 hertz, despite the fact that studies going back as far as 1985 **by Kelley et al," Acoustic Noise Associated with MOD-1 Wind Turbine: Its** So**urce, Impact, and Control"** highlighted the impact of low frequency and infrasound on people's health., Others, such as **The Bruce McPherson Infrasound and Low Frequency Noise Study** and many others have confirmed Kelley et al's observations .
Yet no attempts have been made to address this major defect in turbine design. This is a deliberate decision made by authorities regulating the positioning of wind turbines to enable the maximum to be erected, thus deliberately ignoring the impact they have on the health and lives of the neighbouring humans and domestic animals.

Therefore the two basic designs, gear box driven and direct drive, of Industrial Wind Turbines are inherently unsafe and should not be certified as machine safe to operate without increasing the risk to humans, domestic animals and property and to maintenance technicians and operators who work on wind turbines and farms.

Grounds for referral

Non-Adherence to Fire Regulations

Between 9 and 20 %, according to Windpro and Umweltkontor, of all insurance claims for wind turbine accidents or damage, relate to fires. This figure shows no significant variation between gearbox and direct drive machines.

The fact that technicians carry out maintenance work on wind turbines makes them a place of work. The locations for the work to be carried may differ according to the type of work carried out. This makes all locations within a wind farm where work is carried out a place of work.

This then obliges employer of maintenance technicians and any other person carrying out work at a wind farm to adhere to all laws regulating conditions and procedures required to be implemented according to law.
Employers of persons employed to carry out maintenance or other activities on wind farms must operate within accordance with the fire regulations.
The deaths of two maintenance technicians at the Piet De Witt wind farm in Holland in October 2013 raises serious questions as to effectiveness of fire exits in the event of fire at heights which is inaccessible in time to safely removes workers at risk. If an adequate escape route from potential fire is not available then consideration must be given to removing the likely cause of fire before maintenance work is carried out. It is clear that procedures in use at wind farms are inadequate and as far as I can determine in Ireland no fire drills have been carried out involving local fire brigades. Fire drills, the immediate raising of the fire alarm and effective fire escape routes are a fundamental part of the fire regulations. Particularly with turbines whose nacelles exceed the height of fire engine ladders.

Not only are these Industrial Wind Turbines a fire risk workers who work on/in them. They are also a fire risk to people and neighboring persons, domestic animals and property because of the risk of local forest’s, bogs and tinder dry grass and other flora being set on fire by a Nacelle fire.

Fig 1 The Piet De Witt Turbine Fire in which two technicians lost their lives 2013

http://renews.biz/52979/two-dead-after-dutch-turbine-fire/

2. Health and Safety at Work risks to maintenance technicians.

1.6.1 of The EU Machinery Directive on Machinery Maintenance
"Adjustment and maintenance points must be located outside danger zones. It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill."

Fire risks working in Nacelles.
Gearbox driven turbines contain up to 1400 litres of lubrication fluid and direct drives contain significant amounts of inflammable resin. With the exception of lightning strikes all the causes of fire in turbines relate to wind turbine malfunction. The causes of fire are mainly mechanical, electrical and system failures. Like braking systems when overheating causing brake fragments to break off and rupturing highly combustible hydraulic fluid which can cause a fire in the nacelle, which is itself mostly made from highly flammable resin and glass fibre.

Electrical Equipment and component failure are another high fire risk area. Capacitors, transformer's, generator's, electrical controls, and transmission equipment all have the capability of igniting fires. As does the Supervisory Control and Data

Acquisition system and the risks are increased by scuffed, loose or broken electrical connections. Fire can also be started by overheated bearings igniting lubrication fluid. I would recommend that lubrication fluids be stored in fire proof tanks or removed during maintenance. For example the cause of the Ardrossan (Scotland) Wind turbine Fire, Fig 2 below, the fire was caused by loss of yaw control due to gearbox failure so that feathered blades could not be pointed into the wind. The turbine head then moved back and forth in the wind, generating extreme heat sparking a fire in the generator enclosure (the Nacelle).

"Second, the report reveals that the turbine was configured to apply a brake to the turbine blades when no power is available to run its electronic systems. So when the wind brought down power lines, the brakes were automatically applied to fix the blades in a stationary position. But the Atlantic storm's winds; proved too strong and the wind forced the blades to turn regardless, dragging the brake pads around a metal disc, generating heat and causing a second flashpoint, possibly through ignition of hydraulic oil".

I am sure that there are many other examples of wind turbines fires being ignited in a similar manner.

This report confirms the observations made above. It would appear it is also confirmed by observations made in The British HSE publication. Web link http://www.hse.gov.uk/research/rrpdf/rr968.pdf , in "Wind Turbine Failure Modes-Fire" "**Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines". Commissioned by The British HSE and published in 2013.**

"The nacelle is fully enclosed on utility class wind turbines so a component failure inside the nacelle could not project into the environment where it could harm persons nearby. However, electric failures or some mechanical failures involving friction or high heat can lead to a fire in the nacelle. Nacelle fires are usually short lived but cannot be extinguished via ground based firefighting equipment due to the height of the tower. Most turbines have fire suppression equipment inside the nacelle that is activated in the event of fire. In such cases fires pose a hazard to personnel inside the nacelle and tower, and to people directly below the nacelle. In this case, burning embers can fall from the nacelle and cause local grass fires within the project area that need to be contained" This could cause cutaway bog and forest fires during dry spells which could spread killing people and domestic animals as well as damaging property.

There are serious issues with bearing design in modern wind turbines as are addressed by **The USA Department of Energy Research Laboratories Materials Science and Technology Division in Oak Ridge, Tennessee in the" Wear Analysis of Wind Turbine Gearbox Bearings." Final Report published on March 31st 2010 states the following "**Wind power offers a promising renewable energy option for the United States, but its implementation depends upon a combination of **technological**, political,

and economic factors. Any one of these factors has the potential to delay meeting the goals of a national wind energy plan. The focus of this report is on just one part of wind technology: the reliability of the wind turbine gearbox bearings. Specifically, it was the objective of this study to systematically characterize several used wind turbine gearbox bearings with respect to the nature of their wear and surface damage."

All these risks to maintenance technicians, neighbors and other humans engaged in leisure or other economic activity nearby, domestic animals and property question the rationality of CE certifying these turbines into the environment**.**

Fig 2 Ardrossan Vestas V80 burst into fire during storm 55 mph (24.6 m/s) winds. Caused by loss of yaw control due to gearbox failure so that feathered blades could not be pointed into the wind. The turbine head then moved back and forth in the wind. Generating extreme heat sparking a fire in the generator enclosure (The Nacelle). This wind speed is close to the cut out speed for this turbine.

Fig 3 Gamesa G80 Bii Nee Stipa Wind Farm, Mexico. The same model turbine in Corkermore Wind Farm. The wind farm was recently renamed Stipa Nayaa . http://www.windpowermonthly.com/article/1223507/gamesa-investigates-g80-fire-oaxaca

The EU Machinery Directive on Ergonomics.

1.1.6 Ergonomics

Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by
the operator must be reduced to the minimum possible, taking into account ergonomic principles such as:
— allowing for the variability of the operator's physical dimensions, strength and stamina,
— providing enough space for movements of the parts of the operator's body,
— avoiding a machine-determined work rate,
— avoiding monitoring that requires lengthy concentration,
— adapting the man/machinery interface to the foreseeable characteristics of the operators.

The above section of the Machinery Directive states that discomfort, fatigue and physical and psychological stress must be “reduced to a minimum”
Given the fact that maintenance technicians area asked to work in a cramped inflammable nacelle with hundreds of liters of inflammable liquid with and uncontrollable ignition source without an emergency escape route it is hard to see how significant amounts of discomfort, fatigue and physical and psychological stress can be avoided

Design and manufacturing issues for E48 and E126 and other Enercon Models.

The relevant portions of the Machinery Directive

4.1.2.1. **Risks due to lack of stability**
(a) Machinery must be designed and constructed so that it is fitted for its function, and can be operated, adjusted and maintained without putting persons at risk when these operations are carried out under the conditions foreseen but also taking into account any reasonably foreseeable misuse thereof.
The aim of measures taken must be to eliminate any risk throughout the foreseeable lifetime of the machinery including the phases of transport, assembly, dismantling, disabling and scrapping.

1.3.2. Risk of break-up during operation
The various parts of machinery and their linkages must be able to withstand the stresses to which they are subject when used.

Section 1.1.2
Integration
The relevant wordage
"Machinery must be designed and constructed so that its fitted for its function, and can be operated adjusted and maintained without putting persons at risk when these operations are carried out under foreseen but also taking account any reasonably misuse thereof"

Fig 4 Enercon E48 At Fenn Farm Conisholme UK 10th February 2009 aged 6 years. Detachment caused by metal Fatigue. Observers blamed a UFO strike.
http://projectavalon.net/forum/archive/index.php/t-9638.html
This, below, is an amazing admission bearing in mind wind turbines have been Certified CE compliant, not only do we not know whether the design is compliant. We have also no way of knowing whether the manufacturing process used to manufacturing is capable to the design standard required.

The British HSE publication.
Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines:

"A notable gap in the existing certification process for wind turbines is that there is not a design standard for wind blades. Efforts are currently underway to develop an IEC technical specification for the design of wind turbine blades under the remit of IEC TC-88 as IEC 61400-5. The development of the blade design specification should encourage the development of more robust design, inspection, and repair specifications and practices. "
As the IEC61400 Standardization were initiated in 1995 with the first edition release in 2001 for nearly 20 years wind turbine blades have been manufactured with no set of universally accepted blade manufacturing standards.

Fig 5 Enercon E126 in Donnersbergkreis, Rhein- Hunsrück (Germany) 31st December 2013. The blade travelled 40 meters and weighed 60 tonnes. The blades are of a segmented steel –composite hybrid build.

https://www.wind-watch.org/news/2014/01/06/rotor-blade-breaks-off-from-giant-wind-turbine-rotorblatt-bricht-von-windrad-ab/

Between 21st February, 1997 and 31st December 2013, from an analysis of the Caithness Wind Information accident statistics, Enercon had 12 reported incidents of blade detachment across a wide range of its product range. These are not two examples of a mid span blade failure" which indicate a flaw in the laminate or a design limitation**". The British HSE Publication. Study and the development of a methodology for the Estimation of the risk and harm to persons from wind turbines.** This indicates an inability by Enercon wind turbine blade design and/or manufacture to design and make wind turbines that can cope with the wide variation of operation conditions within which it is expected to operate or that the design and/or manufacturing technology is not currently capable of delivering reliable turbines with zero defects in the field.. Which would be contrary to **1.3.2., Risk of Breakup During Operation**, section of the EU Machinery Directive, which deals with linkages of components or sub assemblies to the main assembly. The Fenn Farm E48 blade failure was blamed on metal fatigue. This would be classed as a critical failure by the British Health Executive as quoted below

"That fatigue resistance of wind turbine subassemblies is an important aspect of preventing structural failure of one or more subassemblies that might lead to blade throw". **The British HSE publication. Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines.**
These failures could indicate serious design failures in blade design and or serious defects in the manufacturing technology used to fabricate wind turbine blades, bearing in mind that there is no international standards for blade design or manufacture, though efforts are being made to develop such a standard.

These incidents show a lack stability with a risk of breaking up and lack the integration required by the machinery directive.

The relevant sections from The Machinery Directive.

Across model and Manufacturer component failure.

1.3.1. Risk of loss of stability
Machinery and its components and fittings must be stable enough to avoid overturning, falling or uncontrolled movements during transportation, assembly, dismantling and any other action involving the machinery.
If the shape of the machinery itself or its intended installation does not offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions.

4.1.2. Protection against mechanical hazards
4.1.2.1 Risks Due to lack of Stability
Machinery must be designed and constructed in such a way that the stability required by section 1.3.1 is maintained both in service and out of service, including all stages of transportation, assembly and dismantling, during foreseeable component failures and also during the tests carried out in accordance with the instruction handbook. To that end, the manufacturer or his authorized representative must use the appropriate verification methods.

1.3.3. Risks due to falling or ejected objects
Precautions must be taken to prevent risks from falling or ejected objects.

Examples of Instability
Common causes of failure across model, type and manufacturer. These wind turbine crashes indicate that design failure is an issue with all manufacturers.
The cause of the collapse of the Vestas V52 in Loughderryduff (Ireland) Wind Farm is not uncommon or unique to Vestas. A similar collapse happened of a Vestas /Nordtank in Aarhus, Denmark also a Siemens collapsed in the same manner as in Oregon in the USA except two maintenance technicians were in the nacelle and one was killed. The other was seriously injured.

To quote **The British HSE publication. Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines.** http://www.hse.gov.uk/research/rrpdf/rr968.pdf ”The probability of wind turbine failure significantly increases during high winds and in fault conditions, so it is very important to distinguish between the different methods of power regulation and fault protection an over speed fault is the condition where rotor speed of the wind turbine increases above the intended operating speed, which can occur as a result of component failure or fault, and loss of generating load and can be exacerbated by high winds” It goes on to say that at least two redundant systems for conducting emergency shutdowns and preventing over speed.” But it appears that two independent redundant stop appears to be inadequate given the frequency blade failures and turbine collapse.

Fig 6 Loughderryduff. The reason given by Vestas for the collapse is the blade hit tower collapsing the turbine. Probably caused by brake failure.

Fig 7. A 10-Year-old Nordtank/ Vestas Wind Turbine collapses after blade hit the tower. Near Aarhus on the 22nd of February 2008

http://www.youtube.com/watch?v=CqEccgR0q-o

Fig 8. A Siemens wind turbine collapses after the tower being struck by a blade killing one technician and seriously injuring a second in Oregon, U.S.A. 25th May 2007. http://blog.oregonlive.com/breakingnews/2007/08/wasco_wind_turbine_collapse_ki.html

These incidents of structural lack of stability indicate that a general design failure of this type of gearbox driven wind turbine. The issue that needs to be resolved is the capability of current blade design envelope to deal with the conditions under which it operates, construction and that the **linkages** to tower are able to withstand the forces under which it operates.

"Failure Modes - Tower Strikes

A tower strike occurs when a wind turbine blade hits the support tower; these are relatively infrequent occurrences for operation of modern wind turbine blades. Strikes are typically due to a failure of a component, with wind turbine blade failure being one such source. Design and certification standards necessitate that the blade clearance between tip and tower be at a minimum of 1.5x the calculated deflection of the blade under extreme static operating conditions. Tower strikes can be due to a loss of stiffness in the structure of the blade but this strike condition would be a secondary effect of a blade failure in progress. **Operating load conditions above design conditions can also cause tower strikes. "**

The British HSE publication. Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines.

This admission alone justifies decertification.

http://www.hse.gov.uk/research/rrpdf/rr968.pdf

Article 4
Market surveillance
▼M2
1. Member States shall take all appropriate measures to ensure that machinery may be placed on the market and/or put into service only if it satisfies the relevant provisions of this [EU Machinery] Directive and does not endanger the health and safety of persons and, where appropriate, domestic animals and property and, where applicable, the environment, when properly installed and maintained and used for its intended purpose or under reasonably foreseeable conditions.
▼B
2. Member States shall take all appropriate measures to ensure that partly completed machinery can be placed on the market only if it satisfies the relevant provisions of this Directive.
3. Member States shall institute or appoint the competent authorities to monitor the conformity of machinery and partly completed machinery with the provisions set out in paragraphs 1 and 2.
4. Member States shall define the tasks, organization and powers of the competent authorities referred to in paragraph 3 and shall notify the Commission and other Member States thereof and also any subsequent amendment.

The Risk to the Health and Safety of persons, domestic animals, property and the environment.

The fact is that **Loughderryduff Wind Farm**, **Fig 9 is** located close to a public road and a public access route increases the risk to health of all persons, domestic animals and the risk of damage to property on or using these roads and areas of public access . Prior to the erection of the wind farm there was no such risk. Not only that the areas of risk intersect creating hot spots of increased risk of being hit by parts being sent flying by different disintegrating pieces of wind turbines. The British HSE publication "Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines."

http://www.hse.gov.uk/research/rrpdf/rr968.pdf

Clearly the HSE Document outlines in its Executive Summary the inadequacy global data on such issues a blade throws when it says that there is no readily available database meeting HSE's requirements for recording wind turbine failures. The estimate of 600 meters for blade travel, used to outline the risk of injury from blade disintegration was obtained from the Caithness Wind Farm information Forum. So the risks of death and injury quoted could be significantly underestimated.

These Caitness Wind Farm Accident Statistics, could be an under estimate as no accurate comprehensive list of industrial turbines that is publically available.

The Caithness Accident statistics are probably the most reliable available to the public. As "owners and operators do not provide information on failures." and RenewableUK have to guarantee confidentiality before wind farm owners or operators, in the UK, will report incidents that happen to their wind turbines

Link to Caithness wind information site

,http://www.caithnesswindfarms.co.uk/fullaccidents.pdf .,These are not a comprehensive list of all wind turbine collapses, fires or blade disintegration as they are extracted from newspaper and other media reports of wind turbine accidents. But given the comments, below, the British HSE Publication "**Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines"** it must now be regarded as one of the most comprehensive database on wind turbines in the world. This quote "Blade failures are currently not subject to a detailed classification system. Observational methods currently used to report failures identify blade failure in very general terms. Much information is derived from photographs taken in the proximity of the wind farms by reporters or industry groups. Most of the time, information on failures is not provided by owners and operators." suggests that owners and operators actively destroy evidence. If that is the case no confidence can be given to any counter argument made by wind turbine operators, owners or manufacturers.

Danish Certification Requirements, dss-904_2014-01 Type Certification of Wind Turbines

The DNV Certification,Stiftelsen Det Norske Veritas, is issued with the objective of ”Safeguarding life, property, and the environment.”

The DNV Certification is based on review according to a certification scheme defined by the International Electrical Commission (IEC) in the document IEC WT 01. The following modules are mandatory of the IEC WT 01:2001 scheme are mandatory.

.Design Evaluation; is based on the safety requirements of IEC 61400-1

.Manufacturing Evaluation;

.Final Evaluation.

It also states to conform to IEC61400 requirements, wind turbines must cope with an extreme 2-second gust of wind in a one in 50 year period.

The Loughderryduff Wind Turbine collapsed at its cutout speed. The occurrence of winds operating at the cutout speed is significantly more frequent than once in 50 years.

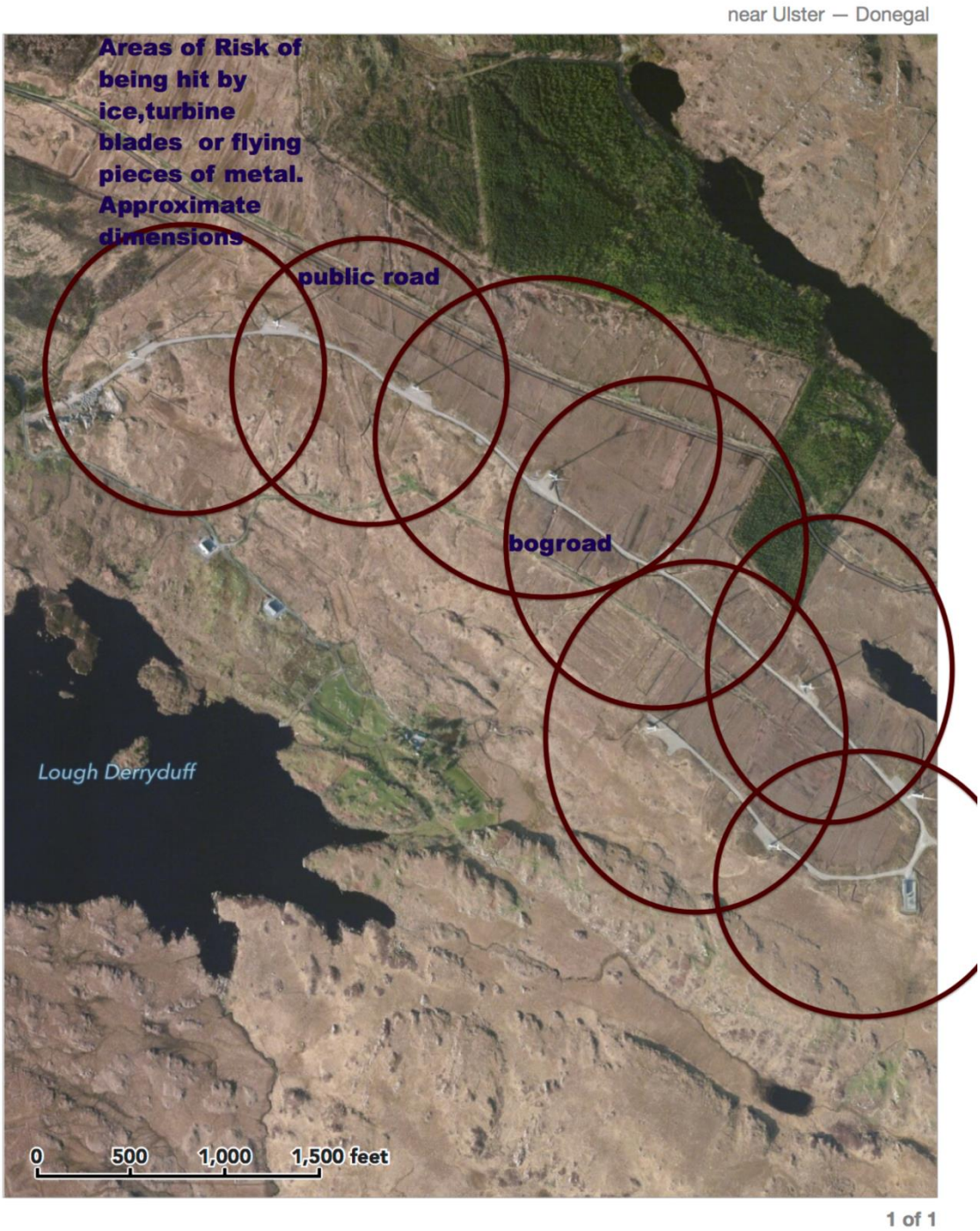

Fig 9. Risks to humans, domestic animals and property. Areas of risk around Loughderryduff Wind Farm including areas of public access.

The flight distance of large blade pieces being up to 600 meters and smaller pieces like rivets, bolts and other pieces of materials being up to ONE MILE (1600 meters).Most likely caused by bolts close to the base of the yaw being improperly torqued and flying due to flexing of the tower. The circles on the aerial photograph represent a distance of 600 meters or so. The of being hit by smaller component and
other pieces is not shown
Taking Loughderryduff as an example the and the likely distance, 600 meters, of a thrown blade or portion of blade the picture shows the area of risk to humans, domestic animals, dog's sheep, goats,, cattle or property like cars, motorbikes or bicycles. Therefore an area approximate to that marked our in the aerial picture should be made an exclusion zone. Where the circles intersect once the risk of injury doubles. Where the circles intersect twice the risk of injury trebles.

Fig 10 the closeness of the fallen Turbine Vestas V52 to the road.
In considering the risk to buried services due to the risk of damage caused to buried services and exclusion zone of 1.5 times mast height was proposed.

One can presume that if there is a risk to buried services been damaged by detached wind turbine blades the same risk would be there for transport on roads or people walking within the same distance.
From the "Study and development of a methodology for the estimation of the risk and harm to persons from wind turbines". Published by the British HSE:

“A literature survey has been carried out to investigate the current status of available data for wind turbine failure rates. This has confirmed that there is little publicly available failure data for wind turbine failures. “

Fig 11, Loughderryduff Danger Zone. Risk to all human activity on the access road. Risk introduced by the erection of these Industrial Wind Turbines. Zero risk prior to erection of Wind Farm. This area would have an elevated level of risk because of the closeness of the turbines to one another. Access to this road way should banned.

“

Fig 12 Corkermore Wind Farm Co.Donegal (Ireland)
Courtesy Apple Maps

Fig 13 Corkermore Wind Farm Broken Blade of a Gamesa G80 on the 9/12/2013 http://renews.biz/55803/gamesa-probes-irish-blade-snap/

According to The British HSE Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines:

"Tower can collapse under a buckling failure at some point mid-way up the tower if the over turning design loads on the tower base is exceeded due to an extreme event. Wind turbines are **generally** designed to withstand the 50-year return wind speed at a particular site. **Based on anecdotal evidence,** blade failure is more likely to occur than tower buckling, but exact statistics are not available".

Also according the above document when addressing the issue of blade failures "**Classification of Blade Failures**":
"Blade failures are not subject to detailed classification system. Observational methods currently used to report failures identify blade failures in very general term. Much information is derived from photographs taken in proximity of the wind farms by reporters or industry groups. Most of the time, information on failures is not provided by owners and operators"

"Normal Operation Mode Failures" The target low cost of wind turbine composites versus those of aircraft. Target for wind $5 USD/lb versus a range aircraft that have $100-$1000/lb.

"The combination of thick laminates **(with common manufacturing defects)** and rapid transition in geometry make the mid spans susceptible to catastrophic failures. Additionally, the large laminate panels employed near the maximum chord promote buckling sensitivity, making the ~20% to 40% span of the blade (measured from the root) a common area for failure. "

This admission to the use of cheap laminates and common manufacturing defects surely must prove that industrial wind turbines do not meet the requirements of the Machinery Directive on two fronts. One they use manufacturing systems that cannot meet the design specifications, as required by type certification section 3.4.1.1 of dss-904_2014-0 of DNV-DSS-904 Type Certification of Wind Turbines, and the use of cheap laminates ensure they that cannot withstand the stresses of operation. Number Two being unstable contrary to section 4.1.2.1. Risks due to lack of stability section of the Machinery of the Machinery Directive. Section 2.2.1.4 of Type Certification states "The certification module "manufacturing evaluation" is mandatory."
It is also contrary to Annex VIII of The Machinery Directive part 3 in particular.

"ANNEX VII

3. The manufacturer must take all measures necessary in order that the manufacturing process ensures compliance of the manufactured machinery with the technical file referred to in Annex VII, part A, and with the requirements of this Directive."

Manufacturing Systems Failures.

Modern manufacturing systems are developed around the concept zero defects and lean manufacturing concepts. It is clear a manufacturer has serious problems when they are forced to admit fitting a known and indentified faulty component to a product that subsequently failed in the field. Such admitted manufacturing systems failures confirms that a particular manufacturer is incapable of repetitively manufacturing certified assemblies or products to the standard required. Therefore products are released to the market are in a non-conformance to their certification. This is however, as the comments below suggest, would indicate that the testing procedures are inadequate to detect likely failures or that stability of the process is inadequate to produce a consistent product. In such cases you carry out 100% inspection until the process is upgraded to deliver product within the specification range and can be monitored and controlled using sampling techniques.
I would also suggest that some dynamic testing to be carried out which replicates conditions in the field. Even dynamic testing is not required by the IEC 614000 regulations.
The HSE publication refers to the fact that could get no data to perform an event tree analysis. Data is collected on a confidential basis by RenewablesUK. Data is confidential to encourage reporting. If wind turbine failure data is confidential and not made public even for research purposes how can you have any confidence in any information quoted by Wind Energy Interests?. How can also be any certification that corrective actions are put in place to rectify in the field non conformance with the type certification and the Machinery Directive.

According to "**The British HSE publication "Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines":**

"Laboratory testing includes static strength evaluations which test the blade in multiple directions to simulate quasi-static maximum load events. Fatigue test loads of millions of test cycles are applied to the blade to simulate the 20-year equivalent life of a blade. Even with the standard test requirements in place, there are still many blade failures being observed in the field. One point to note is that only a single blade is required to be tested under the blade test specification, which may not be sufficient to detect failures due to variations in the manufacturing process. "

This observation essentially states that the current manufacturing processes used to manufacture wind turbine blades cannot produce a uniform blade that can operate to the design specification .I doubt that is possible to develop a unit test procedure that can simulate the likely sequences and ranges of component stresses that are likely to be experienced in a volatile and stochastic environment.

This is confirmed by the fact that Vestas has had to admit to problems in manufacturing of the product on at least two recent events, one as listed below in Denmark. Also when a recently installed turbine blade was thrown from the machine in Oregon as linked to below.
"Documents filed Friday with the Ohio Power Siting Board (OPSB) by Vestas and by EDP Renewables show the cause of the failure of one of the blades to be a defect in the manufacturing of that single blade."
http://timesbulletin.com/Content/News/News/Article/Broken-turbine-blade-problem-found/2/4/173854

On the 18th of February 2014 a blade was thrown off a brand new Vestas 3 megawatt Wind Turbine in at Saeby in Denmark. Vestas admitted to a manufacturing defect. As a matter of fact they even admitted that the defect was discovered in the manufacturing process but through human error the wing was approved. Either Vestas complete manufacturing system is a complete mess or the distinction between approved and rejected components is difficult to determine.
Other incidents dealing with component failure and the reliability of their manufacturing process is outlined below.

"Vestas has concluded that the root cause of the failure of the initial blade was due to a wrinkle in the carbon fiber of the spar (the support structure of the blade)," the report reads. "This wrinkle caused damage to propagate to the point of failure after the blade experienced high loads for a low number of cycles."

It is not only Vestas that have issues with build quality, but all manufacturers do. You find of inexplicable component failure in the field relatively easily.

Like Siemens who could not determine the cause of the below linked fault. It could have either been a design issue or a manufacturing issue. Therefore they ordered wind turbines

in this particular case had to be run at reduced speeds as they were unable to determine the cause of the fault.
http://www.windaction.org/posts/37340-some-siemens-turbines-to-slow-unclear-if-b53-blade-issues-to-affect-hutch-site#.UwdKOXlNzGs

So their manufacturing system, without a transparent effective corrective action, is not compliant with ISO 9001 for a necessary requirement for CE certification.

”**The British HSE publication Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines:**

“ Fibre shifting, fibre misalignment and resin voids are common in the industry”.

The HSE also say, “Damage due to outboard stations of blades is more commonly due to manufacturing defects including improper bond lines or external conditions like including lightning and erosion”
I am sure Vestas are not the only wind turbine manufacturing company with problems like this declaring ‘one of the blades to be a defect in the manufacturing of that single blade.“

http://timesbulletin.com/Content/News/News/Article/Broken-turbine-blade-problem-found/2/4/173854

The British HSE publication Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines:
”Design problems are considered to be a significant source of failure”.

The HSE Publication also refers to manufacturing of blades and the particular methods used to construct these long and use thick composites compared with other industries.” The high aspect ratios present’s problems in keeping fibers aligned and fully wetted.”

Certification requirements Annex VII of the Machinery Directive.
Annex VII of deals with the development of a technical file for machinery. This technical file must cover design, manufacture and operation of the machinery. The DNV Type Certification of Wind Turbines checks compliance with Annex VII of the Machinery Directive

To be certified by the DNV, Det Norske Veritas, in Denmark the DNV Certification includes compliance with “Manufacturing Evaluation.

“The Manufacturing Evaluation Module comprises of the following.

. Quality System
. Manufacturing inspection

The requirements for the Quality System Evaluation are satisfied if the clients Quality Management System are certified by an accredited Certification Body to ISO 9001 -2008 including design. If this is not the case, DNV, will perform an audit for verification of compliance with ISO 9001."

It is quite clear in relations to these observations that there is significant doubt as to compliance with ISO 9001, a requirement for certification, given the very high level of failure in the field and the admissions by The British HSE.

Market Surveillance
Article 4 of the Machinery Directive requires member states ensure that machinery placed on the market and/ or put in service only if it satisfies the relevant provisions of the directive and does not ENDANGER the health and safety of persons and, where appropriate, domestic animals and property and, where applicable, the environment, when properly installed and used for its intended purpose under reasonably foreseeable conditions.

The first published paper on the impact on Low Frequency Sound and Infrasound was published in February 1985 predating the Machinery Directive. The impact of Low Frequency Sound Infrasound on people's health living within 2 kilometers should have been reasonably foreseen.

Infrasound and Low Frequency Noise

Section 1.5.8 obliges all certified equipment have noise emissions that are reduced to the lowest levels taking account of technical progress"

"1.5.8 Noise
Machinery must be designed and constructed in such a way that risks resulting from the emission of airborne noise are reduced to the lowest level, taking account of technical progress and the availability of means of reducing noise, in particular at source.
The level of noise emission may be assessed with reference to comparative emission data for similar machinery".

Noise from Wind Turbines first identified

In 1985 the US Department of Energy published an investigation into the impact of infrasound and low frequency sound on people living within 2 km of wind turbines. This Study is called "Acoustic Noise associated with the MOD-1 Wind Turbine: Its Source, Impact and Control", the authors being N.D. Kelley, H.E. McKenna, R.R. Hemphill , C.L. Etter, R.L. Garrelts and N.C. Linn. They concluded, as quoted below, that low frequency sound seriously impacts the health:

"OUR detailed field investigation of the effect of the MOD-1 noise on two of the affected houses during March 1980 corroborated and confirmed the nature of the annoyance. We have found strong evidence that the major causal agent responsible for the annoyance of

the complaining residents was the excitation of highly resonant structural and interior air volume modes by the acoustic impulses generated by the operation of the MOD-1 turbine. The coherent, low- frequency acoustic radiation indicative of these impulses coincides almost perfectly with the fundamental and higher resonant structural modes of the homes. Comparison with a nonimpulsive, low frequency source,
affecting residential structures has supported the existence of the annoyance situation perceived by the Boone residents and has shown the same strong acoustic- structural dynamic interaction. "

These findings have been confirmed by the McPherson study and other studies in Europe (Holland) published in 2003.

In an article on Infrasound From Wind Turbines Could Affect Humans published in The Bulletin of Science ,Technology & Society, Alec N. Salt and James A. Kaltenbach, quote the following dB determined for an Enercon E-66 at the Rhede Wind Farm.

"But in many situations, the sound can contain a substantial low-frequency infrasound component. One study (Van den Berg, 2006) reported wind turbine sounds measured in front of a home 750 m from the nearest turbine of the Rhede wind farm consisting of Enercon E-66 1.8 MW turbines, 98 m hub height, and 35 m blade length. A second study (Jung & Cheung, 2008) reported sounds measured 148 to 296 m from a 1.5 MW turbine, 62 m hub height, and 36 m blade length. In both these studies, which are among the few publications that report full- spectrum sound measurements of wind turbines, the sound spectrum was **dominated by frequencies below 10 Hz, with levels of over 90 dB SPL near 1 Hz.** "

It would seem that this is an issue regarding all Enercon models as there have been many complaints against and Enercon E77 installed in a wind farm in Skrine Wind Farm in County Roscommon. The Skrine Wind Farm consists of 2 2.3 megawatts turbines with 100 meters tower with blades diameter of 71 meters.
Infrasound low frequency noise also has a negative impact on the health of domestic animals as is outlined by studies on domestic animals, such as "The Preliminary studies on the reaction of growing geese (Anser anser f domestica) to the proximity of wind turbines by J. Mikolajczak et al., and a paper given by Professor Mariana Alves-Pereira to The 14th International Meeting on Low Frequency Noise and Vibration and its control in Aalborg ,Denmark 9-11 June 2010".

The conclusion of these academic investigations is that infrasound and low frequency noise impairs sleep and this increases stress which leads to several other adverse effects on humans. This then leads to much more serious medical problems for both humans and domestic animals within 2 kilometers of wind turbines.

The recently announced Consultation on Wind Turbine distance from habitation.

The consultation of turbines closeness to habitation relies on a desk based Acoustic study carried by Marshall and Day. Which references Crichton et al which is reviewed by Jerry Punch PhD as follows "In my opinion, this study is merely a good example of junk science, and it is unfortunate that it was considered publishable in the Journal Psychology."

Rene Descartes, 1596 to 1650, the French philosopher is quoted as saying " I think therefore I am". The Irish Government should remember another reality "It can be measured therefore it is". If low frequency sound or infrasound can be measured it therefore exists. All you got do is use the correct tools when measuring. In the case of Low Frequency Sound or Infrasound you have to use the dB G Noise Filters. Of course you also need truthful and qualified technical professionals who should work in close cooperation with the affected wind turbine neighbors to identify the peculiarities in th wt noise related to season, time of day, meteorological and other relevant conditions.

Conclusion

Annex 1 of the Machinery Directive sets out the health and safety requirements required prior to designing and construction of a machine. Risk assessments must be carried prior the design and construction of a machine. Using an iterative process reducing risk and the limits of risk must be determined, which include the intended use of the machine and any foreseeable misuse thereof. It is difficult to see how such steps were taken given the known risk to health caused by low frequency noise. Which the wind energy denies exists despite the indisputable scientific evidence that wind turbines produce significant amounts of infrasound low frequency noise on a virtually continuously.

It is also difficult to see how the requirements of Annex I were carried out given the frequent failure of wind turbine blades, as referred to below, and the continued use of cheap composites.

The Quote below is an extraordinary admission as to the state of the technology used to build Wind Turbines. There most important component has not got a manufacturing or design package that can reliably design or manufacture blades that can meet the requirements of The Machinery Directive.

"A notable gap in the existing certification process for wind turbines is that there is not a design standard for wind blades. Efforts are currently underway to develop an IEC technical specification for the design of wind turbine blades under the remit of IEC TC-88 as IEC 61400-5. The development of the blade design specification should encourage the development of more robust design, inspection, and repair specifications and practices. "

The British HSE publication Study and development of a methodology for the Estimation of the risk and harm to persons from wind turbines:

The certification of all working wind turbines is seriously undermined because they were manufactured using technology, which cannot repetitively produce this component ,actually the most important component of an industrial wind turbine, to the design

standard of type certification, The question then we have to ask is, How many wind turbines have been released with components that do not even meet the design standard, required by type certification, never mind the requirements of the Machinery Directive.?

If we analyze the above incidents relating to both direct drive or gearbox types of wind turbines it is difficult to see how they could have been certified in compliance with the Machinery Directive or how they can maintain their certification. Annex 1 outlines the "Essential health and safety requirements to the design and construction of machinery". It rightly states that" the manufacturer of machinery or his authorized representative " eliminate the hazards or reduce the risks associated with these hazards by application of protective measures, in the order of priority established in section 1.1.2(b "
Section 2 of Annex1 in the EU Machinery Directive states that the obligations only apply "when the corresponding hazard exists for the machinery in question when it is under the conditions foreseen by manufacturer or his authorized representative or in foreseeable abnormal situations".
All operational environments in which wind turbines are foreseeable if sometimes abnormal and there is unlikely to be any unforeseen abnormal operational environments. Of course it operates in a foreseeable abnormal environment when linkages break. This however makes it non compliant with the Directive. Which is not an infrequent occurrence. Google the Internet and it is not difficult to get information on many occurrences of blades breaking within a relatively short period from wind turbine installation. See below.
Some being linked publicly by the manufacturer to other incidents, in the case quoted below it was Siemens, referring to similar incidents with the same assembly elsewhere. These manufacturing related failures questions are centered around the ability of their manufacturing operations to comply with ISO 9001 which is a fundamental part of the Type and CE certification process.

The inability of the manufacturing process to manufacture product that meets the design specifications or if the design specifications are incapable of being manufactured surely must mean that these machine machines do not conform to the Machinery Directive and should not have been certified.

From the link to www.Earthechling .com a citation below:
"The company went on to say that it was "working to determine if and how this is related to a recent similar incident in Iowa," and that in the meantime was "curtailing all turbines with the B53 blade type globally.""

http://www.wgrz.com/story/news/local/2013/11/19/3641051/
http://www.nawindpower.com/e107_plugins/content/content.php?content.12302
http://www.windaction.org/posts/39138-third-wind-turbine-blade-breaks-in-east-central-illinois#.UvN4Y3lNzGs
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It is also clear that issues in relation to Low Frequency Sound and Infrasound could have been reasonably foreseen the effects of low frequency noise and infrasound before these latest wind turbines were designed and placed in the field. N.D. Kelley et al. identified the phenomenon of low frequency noise as an issue with wind turbines in the 1980s. The refusal of wind turbine manufacturers, operators and authorities to acknowledge this reality defies logic. Given that continuous exposure to Low Frequency Sound and Infrasound has a serious negative impacts on the health of humans and domestic animals contrary to the Machinery Directive. If these machines are to be placed in the environment they should be in locations where the requirements of the machinery directive can be met. The most likely distance is at least 2 kilometers from the nearest domestic animal or human.
In conclusion I think I have shown that Industrial Wind Turbines break almost all the provisions of Annex 1.
These breeches are in relation to almost all sections of Annex 1 Section 1.5.1 Electricity Supply, 1.5.6 Fire, 1.6.1 Maintenance, 1.5.14 risk of being trapped in a machine, 4.1.2.1 Risks due to lack of Stability.

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