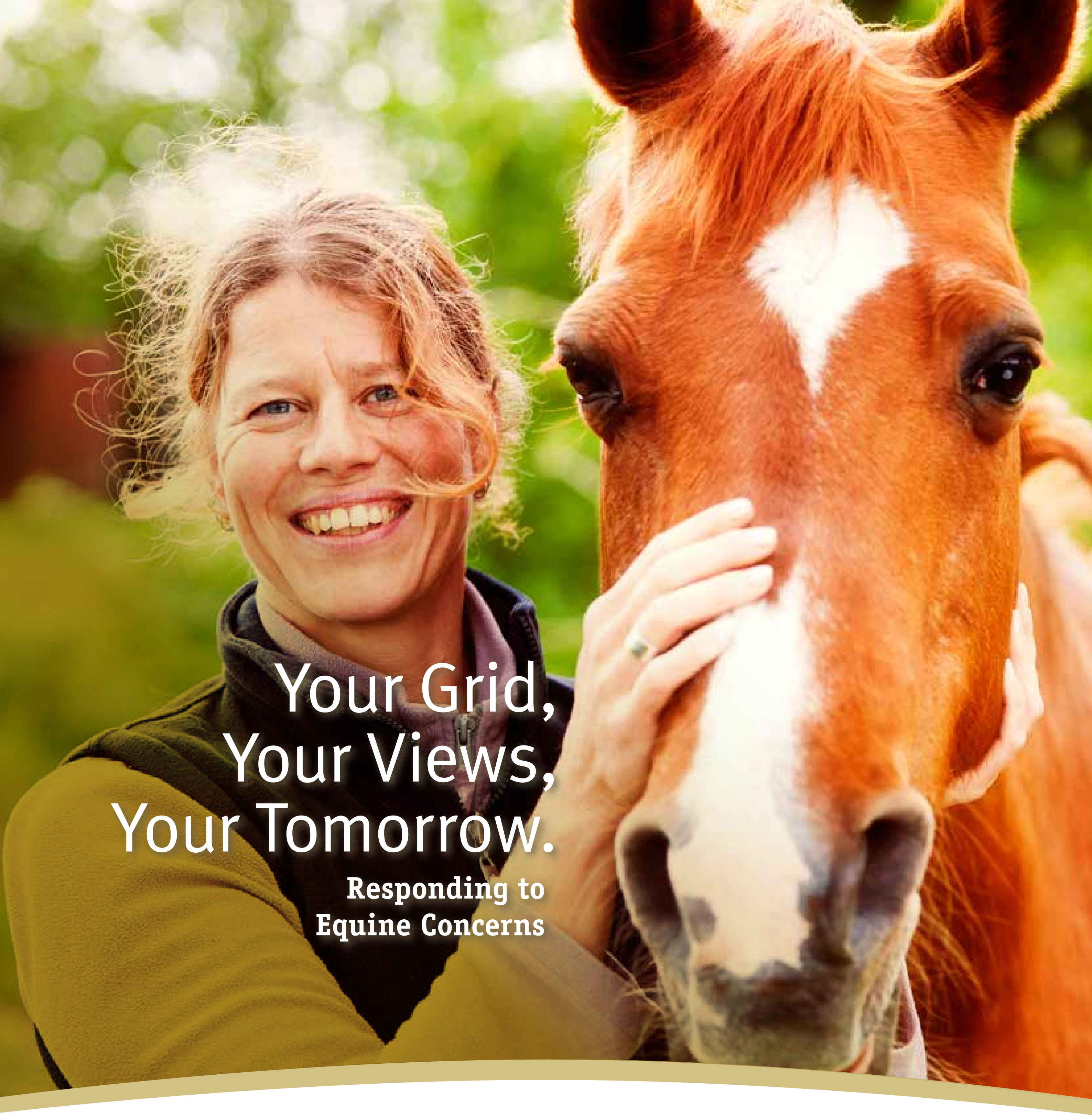

Your Grid, Your Views, Your Tomorrow.

Responding to Equine Concerns

EIRGRID

The current. The future.

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Executive Summary

In January 2014, EirGrid gave a commitment to comprehensively address issues of concern to the equine sector. This work was carried out as part of the Grid25 Initiatives that were announced in response to issues that were raised during consultations on major projects. We are aware of the importance of the equine sector to the Irish economy, and understand the concerns that this sector has raised in relation to the routing of power lines.

EirGrid, in its role as the state-owned operator and developer of the national grid, recognises the role played by landowners, including those operating equine enterprises. We look forward to their continuing support as we seek to deliver the network necessary to help secure Ireland's energy needs now, and for future generations.

The equine sector contributes in excess of €1billion annually to the Irish economy and sustains up to 16,000 jobs.[1] In developing the national grid we are committed to doing our utmost to minimise any impact on any equine enterprises. In that regard we welcome all of the submissions received relating to equine matters. This report provided an opportunity to review our practices and address the concerns raised.

In order to comprehensively consider the concerns of the equine sector, we carried out a full review of the submissions we received which related to equine issues. We also investigated international practice and research relating to power lines and the equine sector.

Following this review, we have identified three key themes where significant improvements can be made to the way we develop the electricity transmission network and how we can work better with key equine stakeholders to ensure their interests are considered in a more substantive and meaningful way from the outset.

The 3 key themes are as follows:

- Provide Greater Recognition
- Initiate Increased Engagement
- Develop a Package of Measures

From the feedback we received, it is clear that stakeholders from the equine sector believed that there was a lack of recognition for their sector in EirGrid's consultative process. It was felt that EirGrid's engagement was inadequate, and lacked information on what was being proposed. They felt EirGrid failed to listen to or understand their concerns, and failed to develop a package of measures to address these concerns.

We have looked into these criticisms, and have developed commitments to address these concerns which are set out below.

1 Horse Racing Ireland

Theme 1 – Provide Greater Recognition

Landowner Charter

EirGrid, with the assistance of key stakeholders, will develop a Landowner Charter. This Charter will clearly outline the level of professionalism and the response time by which landowners can expect to have their queries answered.

It is important to note that there are existing codes of practice that apply to the relationships between landowners and the development of the electricity network. EirGrid's Landowner Charter will build on the success of these codes.

Theme 2 – Initiate Increased Engagement

Process for Consultation in Project Development

In line with the commitments made within our report 'Reviewing and Improving Our Public Consultation Process',[2] we will improve the effectiveness of our consultation process to clearly define consultation opportunities, to explain how feedback can be provided and to efficiently assess feedback received.

EirGrid is committed to specific improvements in our approach to consultation that reflect the importance of landowners and the wider community to the development of the transmission network.

Agricultural Liaison Officers

EirGrid will appoint Agricultural Liaison Officers. The liaison officers will be located regionally and will liaise with landowners on all agricultural and equine matters.

Landowner's Handbook

EirGrid will develop a Landowner's Handbook, which will contain a full suite of information and provide clarity as is necessary to landowners, farmers and owners of equine enterprises to address the issues raised during consultation.

Theme 3 – Develop a Package of Measures

EirGrid will work to develop a package of measures to address the practical concerns for landowners and farmers resulting from the construction of electricity transmission infrastructure on their land. These include measures to minimise impact on the land and the enterprise and will include clarity around compensation.

2 Report available at www.eirgrid.com

Taking the above as a set of proposed recommendations, we welcome input from equine sector stakeholders to help shape this new approach. We want to agree an approach to the equine sector that enables EirGrid to develop the electricity transmission infrastructure necessary for this country's economic progress.

EirGrid is committed to working constructively with all landowners, including owners of equine enterprises. This section of our community has always played a key role in the development and successful operation of the electricity transmission system, and they will continue to do so.

1. Introduction

This report is EirGrid's response to the commitment made in January 2014 to comprehensively address the major issues arising with regard to equine matters from the submissions received through consultations on major projects.

Some of the submissions received raised concerns about the impact our projects could have on the equine sector. In producing this report EirGrid has reviewed all of these submissions received and issues raised. To enable the issues to be addressed in a comprehensive manner, a number of expert reports have been commissioned - including a survey of practice among other European transmission system operators (TSOs). All reports are included in the appendices and referenced in the document where appropriate.

Both EirGrid and ESB Networks play important roles in the transmission system and it is worth setting out the respective roles of EirGrid and ESB Networks in order to understand the different responsibilities and how we work together.

EirGrid plc is a state-owned commercial company with full responsibility for the Transmission System Operator (TSO) and Market Operator (MO) functions. EirGrid's role is to operate and ensure the maintenance of and, if necessary, develop a safe, secure, reliable, economical, and efficient electricity transmission system and to explore and develop opportunities for interconnection of its system with other systems, in all cases with a view to ensuring that all reasonable demands for electricity are met and having due regard for the environment. EirGrid is also tasked with implementing aspects of Government energy policy.

ESB Networks is the licensed Transmission Asset Owner (TAO), with responsibility for the management of capital work programmes related to transmission. This includes the construction of new high voltage substations, and their associated overhead lines and underground cables. Their responsibility also involves responding to network faults and carrying out planned maintenance and refurbishment on these assets.

Where stakeholders raised issues pertaining to construction and maintenance activities, we sought the input of ESB Networks for this report.

A number of submissions related to quite specific equine matters for individual stakeholders, and these are being responded to directly with the individuals concerned.

To address concerns in relation to noise from overhead lines, we have commissioned a survey to measure noise. This will require measurements over a prolonged time period in different weather conditions under one of our 400kV lines. This research has commenced, but at time of going to print, the study has not been completed. The findings from this survey will be published in due course.

The report contains a number of key recommendations: We hope that when these are implemented, they will address the concerns expressed in the submissions we received. In addition to this report on the concerns of the equine sector, we have also produced a report that specifically deals with our consultation process when developing new transmission lines. Our consultation report titled *"Reviewing and Improving our Public Consultation Process"* addresses concerns expressed by many, including landowners and farmers, on how EirGrid engages with stakeholders during project development. The report is published on the EirGrid website.[3]

EirGrid recognises the value and important role of the equine sector to the Irish economy. We see this report as the start of a dialogue with this industry to help shape an approach to the equine sector that can enable the continuing development of our electricity transmission infrastructure. This is essential to this country's economic progress, and we are committed to working with owners of equine enterprises to achieve this goal.

It should be noted that in the context of this report, equine enterprises refer to stud farms, racehorse training facilities, livery yards and all other locations where all regular significant equine related activities occur.

3 Report available at www.eirgrid.com

2. Landowner engagement: EirGrid's approach to date

For new transmission developments, EirGrid is responsible for all engagement with landowners[4] and farmers during the pre-planning stage. During the construction stage, EirGrid is also responsible for the landowner relationship and together with ESB Networks, who are responsible for construction, we work to deliver infrastructure with the least impact to the landowner. At the time of writing we are working on a new project development framework and therefore the description below reflects the approach to date.

Our consultation process commences when we define a study area where new transmission lines are needed, and identify any potential constraints that are specific to this area.

What are constraints?

In the development of EirGrid's transmission projects a 'constraint' is something that limits or restricts where infrastructure can be built.

There are many different kinds of constraint. They can be physical, such as the presence of a large town or an airfield, or geographic, such as a wide river or a steep slope. There are also locations that are protected in law, like Special Areas of Conservation or UNESCO heritage sites.

During the early stages of a project we work to identify potential constraints. This is based on site visits, desktop studies and feedback from the relevant local authorities and statutory bodies, various stakeholders and, through consultation, members of the public.

Not all constraints are treated the same. Cities and towns, for example, are classified as primary constraints. National parks and locations that are protected for environmental reasons are also primary constraints. We do our utmost to avoid locating infrastructure where it could impact on a primary constraint.

Following this, we can identify potential route corridors and then select the least constrained corridor. At this point, we have an indicative route for the transmission line, and so we now consult directly with landowners.

Landowners are identified in the first instance from a search of the Property Registration Authority of Ireland (PRAI) database of registered lands. This returns the name and address of the current registered owner of the lands. Based on this, the PRAI map outlining the lands is retrieved. This becomes the basis for the generation of landowner mapping for the project, as it shows the extent and boundaries of the land registered to a landowner.

4 The term "landowner" in this context refers to the owner(s) of land, over which the proposed line route crosses, regardless of the activity that takes place on that land.

On completion of this task for the entire line route, we prepare a pack for each individual landowner whose lands are crossed by the indicative line route. The pack contains a map that shows the route of the indicative line across the individuals land. This line, drawn on the basis of the information gathered up to this point, represents the line that has the least impact across all of the constraints previously identified.

This pack is either posted or hand delivered to each landowner and a meeting organised to discuss the proposals. This meeting begins the process of landowner engagement. This lasts through the pre-planning stage and right through the construction phase. At this first meeting, we confirm land ownership details, and we then outline the details of what is proposed for the individual's lands. This is generally done by walking the lands with the landowner to show the proposed route. This provides the landowner the opportunity to raise any initial concerns and make practical suggestions. Landowner responses vary greatly at this point: Some question the alignment, or outline how it would impact on their land. Others propose alternative alignments, and indicate where the siting of pylons would be most or least favourable with respect to the activities they undertake on their land.

We recognise that equine enterprises are businesses - and that it is important to minimise any impact to the business. These initial meetings also offer landowners and business owners the chance to tell us about any local constraints or restrictions that we may not be aware of, but that could impact on the route of the line.

At the end of this first meeting with the landowner, we consider all suggestions made about the alignment of the line, in the context of the overall route. Where possible, we facilitate suggestions of alternative alignments. However, we will only do so when this change does not cause an unduly adverse affect to another landowner, resident or to a previously identified environmental constraint. As soon as a decision has been reached with regard to the proposed changes, we contact the landowner to inform them of the decision, and to explain whether the change was possible or not.

On completion of the route's path, the next task is to progress the design of the line. In this task, we identify locations for supporting structures such as steel towers or pylons. The location of towers is driven by technical requirements. Specifically, we must achieve a minimum ground clearance for the conductor, based on the tower design chosen for the individual project. However, during this process we also facilitate requests from landowners to change tower locations, if they have concerns about obstruction or disruption. These requests will, however, always be bound by technical limitations. A common request from landowners is to place towers on or close to hedgerows to minimise the impact on fields. EirGrid can do this where technically possible, but we require the co-operation of the landowner and access to the land to carry out walkover environmental surveys.

The next step is to issue a map of the revised line route showing structure locations to each landowner, and to seek their comments. Again, all landowner requests are considered and implemented where possible.

Impact on equine enterprises is considered in the Environmental Impact Statement or Environmental Report that is prepared and lodged with the planning application. Throughout the process, landowner representatives locally are briefed on the project. On lodgement of the planning application, landowners are issued with a map showing the line route and structure locations on their land as submitted for planning.

After planning permission is granted for a new transmission line and prior to construction, EirGrid and ESB Networks will meet to discuss and agree details of the construction phase. Prior to construction, wayleave notices are served on all landowners and EirGrid will meet with these landowners to discuss the construction programme, access and agree compensation. EirGrid and ESB Networks will meet to discuss and agree details of the construction phase. New transmission lines are constructed subject to the landowner's entitlement to be paid compensation.[5]

Closer to the start of construction the access officer on behalf of ESB Networks will visit the landowner to assess access routes and to give a definitive date for the commencement of works having regard to the landowner's enterprise.

All planned maintenance works on existing lines is carried out by ESB Networks, landowners are consulted in advance to discuss the works.

5 Landowners are entitled to compensation for the placing of an electric line on their lands according to section 53 of the Electricity (Supply) Act, 1927 as amended by section 1 of the Electricity (Supply) (Amendment) Act, 1985. EirGrid seeks to agree a package of measure with landowners and their representatives to compensate for losses arising as a result of works on their lands. This is a very important element, which gives landowners assurance that they will not be at a loss resulting from the works. If compensation cannot be agreed landowners can refer the issue of compensation to arbitration under the provisions of the Acquisition of Land (Assessment of Compensation) Act, 1919.

3. The Irish Equine Industry

EirGrid recognises the importance of the equine sector to the Irish Economy and that as a nation, Ireland is hugely successful internationally at breeding, horse racing and in many other equestrian disciplines. The Irish equine sector has two significant segments – the thoroughbred Industry and the sporthorse Industry.

Thoroughbred Industry

The thoroughbred industry in Ireland is very successful and globally competitive. It employs up to 16,000 individuals and it made a direct economic contribution of nearly €1.1 billion to the Irish economy in 2012. This economic value is generated primarily through our internationally renowned breeding industry, but with significant contributions from the management and care of horses in training.

Breeding Industry

The Irish breeding industry is the main power base of the Irish Thoroughbred industry. It is mainly composed of a large number of small-scale operations spread throughout the country, as well as some large-scale operations which can employ, in some instances, hundreds of people.

Irish stallion farms held a huge advantage up to 2008 in that stallion fees were tax-free. This encouraged stallion owners to base stallions in Ireland. As a consequence, this encouraged mare owners to send high quality mares to Ireland where they often remained and thus increased the strength and depth of the Irish genetic pool. Their successful progeny gave further credence to Ireland's reputation as a leading International Thoroughbred nursery.

However, the removal of the tax-free advantage has coincided with an increase in the number of successful stallions based in the UK. In 2007, nine of the ten top stallions (by total prize money earned by their progeny that year) were based in Ireland. By 2010, seven of the top ten stallions were based in Ireland, and this has reduced further to five in 2013.[6]

As distinct from high value breeding operations focused on flat racing, the typical National Hunt breeder was traditionally a farmer with either dairying or mixed stock farming. Their enterprises were usually small, 1-4 mares and their progeny which were either raced or sold. However, with the frenzied economic activity of the late nineties and the early naughties here in Ireland, National Hunt racehorse ownership increased significantly. This increased the demand for National Hunt horses which encouraged full time National Hunt farms to develop. The economic crash in 2007 had a profound effect on this industry due to its local market place, and prices for stock plummeted. However, there has been some recovery in prices over the past 12 months.

6 www.RacingPost.com

Racing Yards

There are hundreds of training operations spread throughout Ireland and according to the Horse Racing Ireland Factbook 2014 there are 3,706 racehorse owners in Ireland. Ownership comes in a variety of forms, for example, from the single owner through to syndicates, racing clubs and occasionally limited companies. However, in 2014, approximately 84% of racehorses had a single owner, reflecting the demise in racing clubs and syndicates. The financial return owners make on their investment comes from the prize money, income from breeding and the sale of horses in training. The long-term success of the industry rests on the relative attractiveness of the return - as all other industry participants are directly or indirectly dependent on investment by owners.

There are 640 licensed trainers, training anything from 2 to 400 horses. Trainers are dependant on owners who will either breed or purchase the horses and put them in training. Some trainers have very wealthy owners who can provide the individual trainer with dozens, or in some cases hundreds of horses to train. Other trainers,would own a significant percentage of the horses they train, and depend on selling a successful horse to make ends meet.

Costs to run a yard are high: costs include staff, insurance, rent, transport, feed, bedding, waste-disposal and gallop fees. Daily training rates vary hugely from 25 euros upwards to 60 euros. There are many variables that can affect performance and ultimately the success or failure of that yard.

Sporthorse Industry

The Sporthorse Industry can be divided into its three integral sections - Breeding, Competition and Leisure. Breeding is self-explanatory; competition horses are horses that are competed regularly - show jumping is extremely popular in Ireland and our riders are some of the best in the world. One day eventing, three day eventing and dressage are also very popular with high levels of participation . Leisure horses are horses that are used for hunting, pony club events and other leisure riding activities.

It is estimated that there are 110,000 horses in the national sporthorse herd, making Ireland one of the most equine dense countries within Europe (per head of population). It has also been estimated that there is one person regularly involved per 2.1 horses, gives rise to a figure of approximately 53,005 or 1.33% of the population regularly involved in the industry. There is 65% private to 35% commercial involvement in the industry. In addition, 28% of animals owned by leisure participants are kept for breeding purposes. Although profit may not be an important factor, these owners need to make informed breeding decisions, as their collective breeding is influential to the status of the national herd. Similar percentages of competition horses were owned either by business (17%) or leisure interest (15%) participants. Therefore a high proportion of competition horses are owned and often competed by leisure riders.

Equine Management

Humans interact with horses in many ways, but it's possible to classify these management interactions in two broad categories: intensive or extensive management.

Intensive management is best defined where the human and the horse work in close company. This can range from humans handling mares and foals, to exercising yearlings, to breaking horses, riding horses, driving horses, transporting horses etc.

Extensive management is best defined where horses are turned out into paddocks or fields. Although humans will monitor these horses frequently, they will not be in direct contact with them.

Man's intensive interaction with the breeding stock on stud farms occur in periodic bursts: foaling, getting the mares back in foal, weaning, foal handling, and foal and yearling sales preparations. There are usually specialised yards on the farm where these procedures are performed. Otherwise, the stock are normally turned out into paddocks to graze.

In thoroughbred racing stables, man's interaction with the horses is very intensive with little or no extensive management.

In the sporthorse world, broadly speaking, the same applies. On stud farms, there are areas on the farm where intensive equine management occurs and the rest of the farm is usually used for grazing stock. In riding schools, indoor and outdoor arenas, and in sporthorse training yards, there is significant intensive equine management.

4. Issues raised with respect to equine

All submissions received in response to the project consultations were reviewed and the following is a list of common issues raised in respect of the concerns of the equine sector.

4.1 Impact on the Industry/Business

Some of the submissions express concerns that there would be economic damage to equine enterprises - particularly to the viability of stud farms. In addition some submissions expressed the concern that compulsory purchase option compensation would be inadequate to cover the possible economic damage to stud farms. Furthermore some of the submissions raised the issue of potentially negative impact to the capital value of stud farms.

4.2 Primary Constraint

Many submissions were seeking that equine enterprises should be considered as a primary constraint in relation to the route selection and design process. (A primary constraint is one that should be avoided in the first instance and only considered where no alternatives exist.)

4.3 Noise

Concerns have been raised in relation to potential noise from new transmission lines having an impact on thoroughbred horses.

4.4 Equine Health and Welfare

Some respondents raised concerns about electric and magnetic fields, and their potential impact on equine behaviour, health and performance.

4.5 Health & Safety

Matters of health and safety during construction and maintenance operations have been raised in a number of the submissions. Some submissions outlined that the overhead line would be perceived as a hazard to both staff and thoroughbred horses. Concerns were also raised on the risks of accident, electrocution and risk of conductors falling to ground.

4.6 Impact on Property

A number of submissions refer to a possible reduction in property values as a consequence of high voltage lines – and they express concerns that compensation would be inadequate.

4.7 Visual Impact/Environment

Some submissions raised concerns about the possible negative impacts of high voltage lines and their support structures on the visual character of stud farms. In general, stud farms take great pride in the maintenance and appearance of their farm, as it is part of their service offer.

4.8 Undergrounding

As a mitigating measure to address equine concerns, some of the submissions sought undergrounding of the lines.

4.9 Construction & Maintenance Issues

Submissions received from owners and operators of equine enterprises made the case that thoroughbred horses are highly sensitive and easily startled. As a consequence, many submissions raised concerns about the impact on thoroughbred horses of construction and maintenance activities at equine enterprises including stud farms.

4.10 Insurance

Some of the submissions outlined the high value of bloodstock and raised concerns about any potential loss that might occur in the case of fallen lines. In particular, they sought clarification and reassurance about where liability lies in the event of such an incident.

4.11 Consultation

A number of submissions expressed disappointment that landowners are not consulted earlier - even though their land is considered during the corridor selection stage.

5. Response to the issues raised

Where we have responses to the issues raised, we have provided them below. Other issues have led to a number of recommendations that we intend to implement following consultation with key stakeholders. The recommendations are listed in chapter 6.

5.1 Impact on Industry/Business

EirGrid recognises the importance of the equine sector to the Irish Economy and that equine enterprises are businesses. The development of the transmission system is required to meet Ireland's need for a high quality, reliable electricity grid. This is critical for the future growth and prosperity of the country, and to facilitate the EU objective of supplying 40% of electricity from renewable sources by 2020. In developing the transmission system, EirGrid does not intend to negatively impact on equine enterprises. We will work with owners and operators of equine enterprises including stud farms to minimise any impacts that may arise. That is why early and regular engagement is the key to finding feasible solutions.

As part of the commitments outlined in this report, we will engage with landowners at a local level through personnel who understand the concerns of equine enterprises and the broader equine sector.

5.2 Primary Constraint

We understand that many stakeholders want EirGrid to avoid land being used for equine activities when routing power lines or cables.

Equine enterprises, such as the breeding, rearing and training of thoroughbred horses are not identified as constraints at the corridor selection stage of new overhead electric line projects. However, such enterprises are considered at the line routeing stage of projects – to minimise the impact of chosen line routes.

To address this concern, and to discover whether EirGrid was treating the equine sector in line with international practice, we sought to learn more about how this issue is handled elsewhere. In particular, we wanted to understand how other TSOs treat equine enterprises when developing new electricity transmission lines, and to see if these learnings could improve EirGrid's approach.

A survey was carried out amongst European Transmission System Operators via the representative body ENTSO-E.[7] The results show that the respondents do not have a policy of avoiding agriculture and equine enterprises when routeing new transmission lines (please refer to appendix 1).

EirGrid has also consulted with other international organisations such as Cigre (International Council on Large Electric Systems), RGI (Renewables Grid Initiative Organisation) and EUCI (Electric Utility Consultants Inc). These consultations were to find out if there were any recommended or special practices concerning equines and the development of transmission lines. EirGrid is not aware of any other TSO that treats equines as a primary constraint at route selection stage, and neither did we identify any special practices for the equine sector.

However, we do recognise the greater importance of the Irish Equine Industry compared to other European countries. EirGrid notes that Ireland breeds more thoroughbred horses than any other country in Europe and is the fourth largest producer in the world overall. We are committed to working with owners and operators of equine enterprises earlier in our projects. Our goal is to use this earlier consultation process to minimise the impact on farms and thoroughbred horses throughout our route selection and construction stages of project development.

As part of our commitment to improve our process for consultation during project development, we will review the approach to the various considerations that must be taken into account in routing a power line or cable.

5.3 Noise

Due to the sensitivity of thoroughbred horses, many of the submissions raised concerns about an increased potential for injury to horses and staff as a result of horses being spooked by noise from overhead lines.

To address concerns in relation to noise from overhead lines, we have commissioned a survey to measure noise. This will require measurements over a prolonged time period in different weather conditions under one of our 400kV lines. This research has commenced, but at time of going to print, the study has not been completed. The findings from this survey will be published when available.

5.4 Equine Health and Welfare

Possible impacts on equine health from electric and magnetic fields were raised in some of the submissions. EirGrid commissioned a separate review of research in this area. The engineering and scientific group, Exponent,[8] undertook this and the full review is contained in appendix 2. In relation to horses, Exponent summarises that *'No scientific studies of potential EMF effects on horses were identified in the literature review.'*

7 The European Network of Transmission System Operators for Electricity). Responses were received from most of the major TSOs operating in Western Europe including RTE (France) who operate the largest grid among ENTSO-E members at 104,684km, and our nearest neighbours in England and Wales (National Grid).

8 www.exponent.com

However, more broadly the report concludes that *"the available scientific evidence summarised in the current report does not provide consistent or convincing evidence that either electric or magnetic fields associated with the Irish electric transmission system may adversely affect the livestock or crops produced on Irish farmlands"*.

We are committed to a process of on-going monitoring of research on EMF, and we will provide the latest information to the general public on the issue. We will also continue to design and operate the transmission system in accordance with current international guidelines on EMF (ICNIRP), as reviewed by the World Health Organisation, and as endorsed by the EU and the Irish Government.

5.5 Health & Safety

Matters of health and safety during construction and operational phases have been raised in many of the submissions. Safety is a core value for EirGrid and safety is never compromised. All construction and maintenance work is carried out in compliance with all legislation and Health and Safety Authority guidelines. The lines themselves are designed and constructed to the highest national and international standards and follow best practice in relation to construction and maintenance.

Electricity is a powerful and safe energy when it is treated with care and with a common-sense attitude to safety. Just like other aspects of farm life – such as handling animals, working with machinery, handling chemicals - an awareness of safe practices is essential in order to minimise the risk of injury or death.

Any person working near overhead lines has a responsibility to prevent dangerous contact with the overhead line. The Health and Safety Authority publication, Guidelines for Safe Working Near Overhead Electricity Lines in Agriculture[9] outlines the control measures applying to the party in a position to implement the precautions specified therein. In addition, two further publications are available from ESB Networks that provide guidance to farmers. These are *Farm Well… Farm Safely* and the second, published last year, is *Farm Safely with Electricity.*[10]

As part of the commitments outlined in this report, EirGrid will develop a Landowner's Handbook, which will contain a full suite of information and provide clarity as is necessary to landowners and equine enterprises to address the issues raised during consultation.

Some submissions were concerned that overhead lines could be a hazard to both staff and thoroughbred horses, due to a perception that overhead lines could increase the risk of accident. Appendix 3 contains a report that was prepared to assist EirGrid in responding to the equine concerns that have been received. This report provides information relating to 'Equine Psychology and Behaviour', which concludes that most horses will acclimatise to new situations. This is one of the main reasons why man has used horses so effectively in many roles for centuries.

9 www.hsa.ie
10 www.esbnetworks.ie

5.6 Impact on Property

There is a statutory entitlement to compensation for directly affected landowners. The statutory entitlement to compensation is considered to offer an appropriate mitigation to landowners in respect of the impact, if any, upon property arising from the development of strategic transmission infrastructure.

As part of the commitments outlined in this report, EirGrid will work to develop a package of measures to address the practical concerns for landowners and equine enterprises resulting from the construction of electricity transmission infrastructure on their land. These include measures to minimise impact on the land and will include clarity around compensation arising from the location of high voltage power lines.

5.7 Visual Impact/Environment

EirGrid will endeavour to route new lines and site structures in consultation with owners so as to minimise any possible negative impacts on equine enterprises. As part of the commitments outlined in this report, we will engage with landowners at a local level through personnel who understand the concerns of equine enterprises and the broader equine sector.

5.8 Undergrounding

In response to calls for the projects to be undergrounded and as a separate initiative, EirGrid has committed to conduct a comprehensive underground analysis for the Grid Link and Grid West projects. EirGrid will work with the Government appointed Independent Expert Panel to review underground and overhead options before the projects proceed to the next stages of project development.

As outlined in our recently published 'Draft Grid Development Strategy',[11] that while underground technology has always been considered during initial project scoping and technical analysis, in future we will always publish underground options for public consultation. We also commit to engaging with the public before we identify a preferred technology. This consultation will explain the transmission technology options, and then seek feedback from stakeholders.

This will assist us in determining the best transmission technology for future projects. We are committed to looking for alternative options that may avoid, or reduce, the necessity for new overhead lines.

5.9 Construction & Maintenance Issues

Concerns with respect to the impact of construction and maintenance activities on equine enterprises have been raised in many of the equine related submissions. As ESB Networks are responsible for construction and maintenance, we have discussed these issues with them. EirGrid recognises that thoroughbred horses are highly sensitive and can be easily spooked. EirGrid also recognises that impacts will result from these activities on the land and the normal activities occurring thereon.

11 www.eirgrid.com

EirGrid endeavours to minimise these impacts by:

1. Having the right people at the interface between construction teams and landowners or owners of equine enterprises including stud farms. These are people who understand the equine sector, who can understand the issues from the landowner's perspective and work to resolve any issues that arise.
2. Good communications between the parties involved.
3. Ensuring that landowners are fully compensated for any losses legitimately arising due to activities associated with the line.

Concerns regarding helicopter patrols were raised in a considerable number of the equine submissions. In accordance with EirGrid instructions, it is the ESB that undertakes all maintenance work on the transmission network. The ESB have notification procedures in place for farms with equines, and these procedures have worked well in the past. The ESB will ensure that all equine farms affected by new lines are facilitated with the opportunity to be included in their database. This will ensure that there is appropriate consultation and notice in relation to any maintenance work on lines - and in particular, to the annual helicopter inspections.

Concerns were expressed in some submissions in relation to the spread of disease among horses during the construction and maintenance phases. In response to this concern, EirGrid can provide the following reassurances: Construction crews will observe best practice in relation to disease prevention and precautions on all equine holdings. The ESB code of practice in relation to the prevention of the spread of animal diseases is contained in section 4.0 of the ESB Code of Practice in Relation to Access to Land and/or Premises.[12]

At the planning and route selection stage personnel will also have to access the land - and we will ensure that best practice is followed at all times. (Please refer to appendix 4 for EirGrid's Code of Practice in Relation to Access to Land and/or Premises). A review will also be undertaken so as to improve on the current practice and procedures, where possible.

Recognising the significance of construction and maintenance issues for landowners, EirGrid, as part of this review has committed to producing a "landowner handbook" to address in detail the specific issues that have been raised. This is outlined in section 6. Additionally a 'Package of Measures' is required to be put in place of which compensation is an important element. This would also be consistent with findings from the ENTSO-E Survey of TSOs (Appendix 1) in that most TSOs have codes of practice or packages of measures setting out how works on lands will be undertaken. As stated in section 2 of this report, landowners are entitled to compensation for any losses arising as a result of works on their lands.

5.10 Insurance

Some of the submissions raised concerns in relation to where liability lies in the case of fallen lines. The position with respect to indemnification is clearly outlined as follows (the Board refers to the Electricity Supply Board);

12 www.esbnetworks.ie

The Board shall indemnify and keep indemnified the landowner, his servants, agents, licensees and invitees against all sums in respect of loss or damage, claims, demands, costs and expenses which the landowner shall become legally liable to pay as compensation for any illness or accidental bodily injury or accidental loss of or damage to property where such injury or damage is caused by, arises from, is traceable or connected with the works or equipment other than in consequence of any malicious act or omission on part of the landowner.

The Board shall pay compensation to the landowner, his servants, agents, licensees and invitees in respect of any illness or bodily injury or loss or damage to material property suffered by him or them (together with all consequential loss arising there from) where that same is caused by, arises from, is traceable to or connected with the works, or equipment other than in consequence of any malicious or criminally reckless act or omission of the landowner and except insofar as the same has been made good by the Board without loss to the landowner.

The above is without prejudice to the Board's and Landowners' Statutory and Common Law rights. Illness in this context is understood to mean damage to the personal health and well-being of the landowner or his animals or his agents, servants, licensees and invitees. It is noted and agreed that the ESB will issue, to any individual landowner requiring same, a letter of acknowledgement that the Board's wayleave over his land is subject to the provisions of the code of practice, including specifically the indemnity clause.

5.11 Consultation

As one of the commitments outlined in this report, EirGrid will engage with key stakeholders to agree principles of engagement for future contacts with landowners to improve the effectiveness of our consultation process. As stated earlier, EirGrid is committed to the development of a Landowner Charter.

This Charter will clearly outline the level of professionalism and the response time by which landowners can expect to have their queries answered.

In response to concerns regarding consultation, we have produced a separate report titled *'Reviewing and improving our public consultation process'* that specifically deals with our consultation process when developing new transmission lines. Our consultation report addresses concerns expressed by many, including landowners and equine enterprises, on how EirGrid engages with stakeholders during project development. The report is published on the EirGrid website.[13]

EirGrid is also committed to specific improvements in our approach to consultation that reflect the importance of landowners and the wider farming community to the development of the transmission network.

As outlined in more detail in section 6, we are appointing Agricultural Liaison Officers (ALOs). The liaison officers will be located regionally and will liaise with landowners on all agricultural and equine matters.

13 www.eirgrid.com

6. Commitments

Taking into account the concerns raised EirGrid is now proposing a series of commitments. EirGrid would welcome a dialogue with our stakeholders to help shape our relationship with the equine sector. This will ensure that the electricity transmission infrastructure - necessary to this country's economic progress - can be put in place.

Theme 1 – Provide Greater Recognition

- EirGrid recognises the value and important role of the equine sector to the Irish economy.
- EirGrid recognises that equine enterprises and landowners are key partners for grid development.
- EirGrid recognises that transmission infrastructure impacts on equine enterprises.

1. Develop a Landowner Charter

EirGrid, with the assistance of key stakeholders, will develop a Landowner Charter. This Charter will clearly outline the level of professionalism and the response time by which landowners can expect to have their queries answered.

It is important to note that there are existing codes of practice that apply to the relationships between landowners and the development of the electricity network. EirGrid's Landowner Charter will build on the success of these codes.

Theme 2 – Initiate Increased Engagement

- EirGrid will engage with key equine stakeholders to agree principles of engagement for future contacts with landowners to improve the effectiveness of our consultation process.
- EirGrid recognises the need to engage with landowners at a local level through personnel who understand the concerns of equine farmers and the broader equine sector.
- We will improve the quality and delivery of information to landowners.

2. Improve our Process for Consultation during Project Development

In line with the commitments made within our report *'Reviewing and Improving Our Public Consultation Process'*,[14] we will improve the effectiveness of our consultation process to clearly define consultation opportunities, to explain how feedback can be provided and to efficiently assess feedback received. In addition, we will review the approach to the various considerations (constraints) that must be taken into account in routing a power line or cable.

14 Report available at www.eirgrid.com

3. Appoint Agricultural Liaison Officers

EirGrid will appoint Agricultural Liaison Officers. The liaison officers will be located regionally and will liaise with landowners on all agricultural and equine matters. This liaison will take place at each stage of the process, from initial landowner identification, through construction and finally to the reinstatement of the land. Following construction, they will ensure all matters are closed out to the satisfaction of landowners.

4. Develop a Landowner's Handbook

EirGrid will develop a Landowner's Handbook, which will contain a full suite of information and provide clarity as is necessary to landowners and owners of equine enterprises to address the issues raised during consultation.

Theme 3 - Develop a Package of Measures

5. Develop a Package of Measures

EirGrid will work to develop a package of measures to address the practical concerns for landowners and equine enterprises resulting from the construction of electricity transmission infrastructure on their land. These include measures to minimise impact on the land and the enterprise and will include clarity around compensation.

7. Implementation

EirGrid is committed to working collaboratively with equine enterprises and their representatives in the development and construction of a stronger electricity transmission system.

It is currently envisaged that the majority of these recommendations will be implemented during 2015 recognising that a number of them will require further discussion and agreement with stakeholders to bring about their implementation. It is our intention to continuously review our approach to consultation to meet the evolving needs of those who participate in and engage with our projects.

Appendices

1. Entso-e survey regarding 'Approach of European Grid Operators to Agricultural and Equine Land Uses'.
2. Exponent Review of Research on Livestock and Crops in Relation to Electric and Magnetic Fields from High Voltage Transmission Lines.
3. Report on 'Equine Psychology and Behaviour'.
4. 'EirGrid Code of Practice in Relation to Access to Land and/or Premises'.

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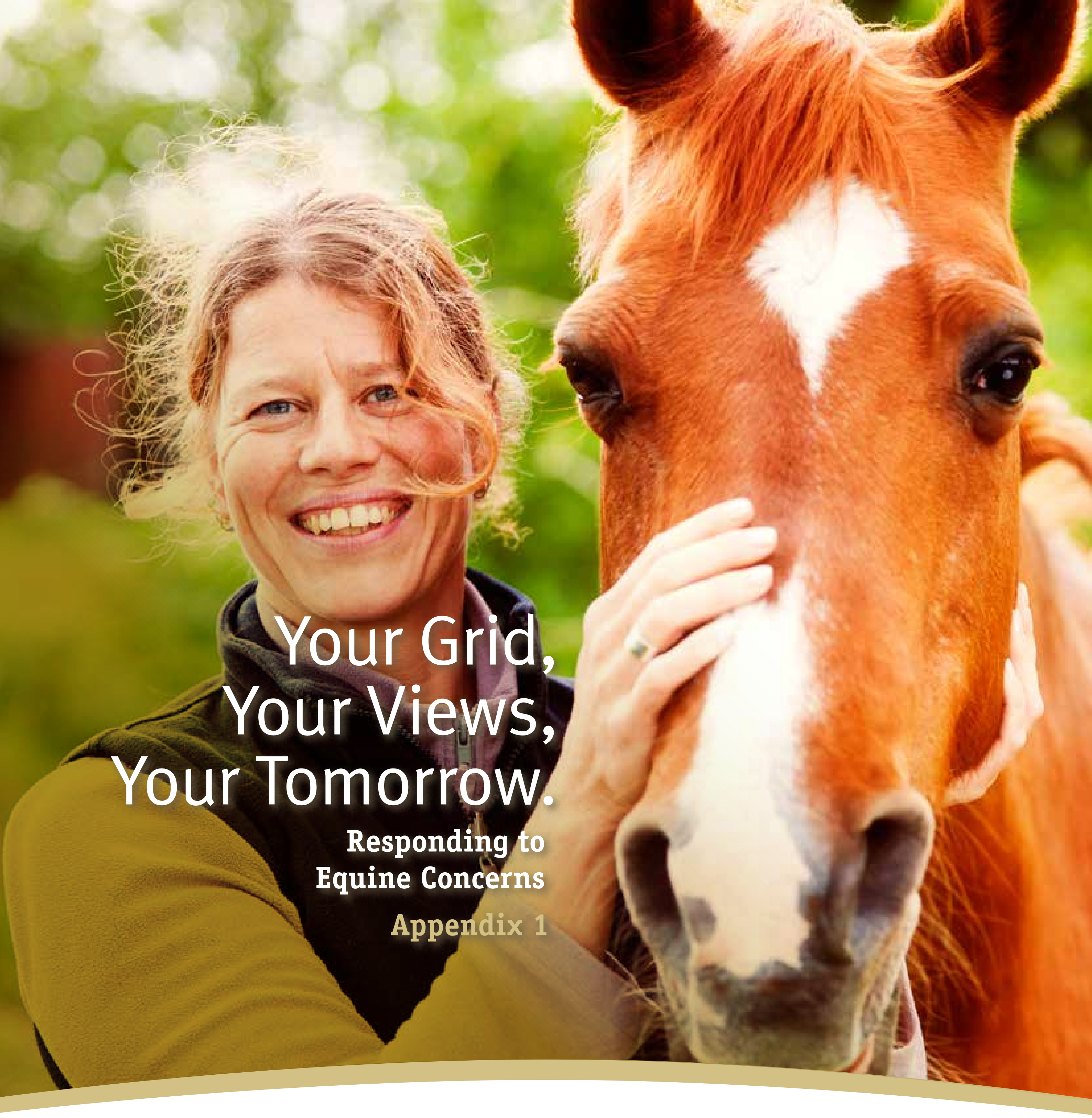

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Responding to Equine Concerns

Appendix 1

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Appendix 1

Approach of European Grid Operators to Agricultural and Equine Land Users

Introduction

The submissions received over the course of the recent consultations on proposed grid projects in Ireland relating to agriculture and equine raised many concerns about the approach taken to these activities at the route selection, construction and operational stages of electricity transmission lines.

But how does this approach compare with what is being done by other Grid operators in Europe for example? Is it in line with or different to that which is being done by them? Are there learning's that can be taken from the approach of others to agriculture and equine interests, which if applied by EirGrid, would improve the approach to developing overhead lines in Ireland?

It was felt that arriving at an understanding of the approach of other Transmission System Operator's (TSO's) with regard to how they treat agricultural and equine concerns would be very valuable in preparing the final report. At the same time it is recognised that agriculture as practiced in Ireland has unique differences from the way it is practiced in other European countries owing to farm size, field size, land quality, climate, culture etc. Nonetheless understanding the different approaches would provide a useful knowledge base against which to compare and determine if some of the measures identified could be applied to the Irish context to result in an improvement for landowners engaged in these activities. A survey of other European TSO's approach to these issues was undertaken through the representative body ENTSO-E.

ENTSO-E

ENTSO-E (The European Network of Transmission System Operators for Electricity) is the representative body for all electric TSOs in the EU and others connected to their networks, for all regions, and for all their technical and market issues. 41 TSOs from 34 countries are members of ENTSO-E.

ENTSO-E activities are focused on:

- reliable operation,
- optimal management,
- sound technical evolution of the European electricity grid,
- security of supply,
- meeting the needs of the Internal Energy Market and facilitating market integration,
- network development statements,
- network codes,
- promotion of relevant R&D and the public acceptability of transmission infrastructure,
- consultation with stakeholders and positions towards energy policy issues.

As a member of ENTSO-E, EirGrid took the view that it is the organisation best placed to facilitate the undertaking of a survey to gain an understanding of the approach taken by other TSO's to agricultural and equine operations while developing overhead transmission lines. ENTSO-E agreed to work with EirGrid to circulate a survey questionnaire among member TSO's.

The Survey

To encourage participation and a focused response, a concise survey questionnaire containing three questions was drafted to enable an understanding to the gained of the TSO' approach to the issues in question.

The questions were as follows;

Question 1.
At the corridor / route selection stage of a new transmission overhead line, are any agricultural land uses or any horse enterprises treated as a constraint to be avoided? YES /NO

If Yes, please describe in further detail.

Question 2.
Have you any policies for dealing specifically with agriculture and/or horse enterprises during the following stages?

A). Route Selection Stage	Yes/No
B). Construction Stage	Yes/No
C). Operational/Maintenance Stage	Yes/No

If Yes, please describe in further detail.

Question 3.
Do you have a code of practice for dealing with these matters or any published material outlining your approach to dealing with landowners [and landowners issues] in general? YES /NO

If yes, please describe further and provide links or references to published material.

The questionnaire was circulated by ENTSO-E to all members.

Table 1 lists those that responded to the survey, the country(s) in which they operate and the length (in km) of transmission lines which they operate.

TSO Name	Country of Operation	Length of Transmission System (km)
50hertz	Germany*	9,995 km
Amprion	Germany*	11,000 km
APG	Austria	6,777 km
Eles	Slovenia	2,682 km
Elia	Belgium	8,000 km
ESO	Bulgaria	14,727 km
REE	Spain	42,000 km
RTE	France	104, 684 km
Sepsas	Slovakia	2,863 km
Tennet	The Netherlands / Germany	21,000 km
Terna	Italy	63,500 km
Energinet	Denmark	6,800 km
Fingrid Oyj	Finland	14,300 km
National Grid	England & Wales	8,600 km

Table 1. Respondents to the survey, their country of operation and total length of transmission lines under their operation. *There are multiple TSO's in Germany.

The table shows that a response was received from most of the major TSO's operating in western Europe including the largest. In total, those responding to the survey operate in excess of 300,000 km of transmission lines. The Irish System operated by EirGrid extends to 6,500km.

Analysis of & Discussion on the responses.

Question 1 sought to establish clearly if agricultural land uses or horse enterprises are treated as a constraint to be avoided at the corridor / route selection stage of electricity transmission line routing.

The current EirGrid approach is that these land uses are not a constraint to be avoided but at the detailed line routeing stage, the aim is to minimise the impact on these enterprises through discussions with the owners of the enterprises to determine the least impacting line alignment and structure locations having regard to all the other constraints and line design guidelines.

What the responses to question one show is that this is very much the approach of the TSO's who responded to the survey. None of those that responded have a policy of avoiding agricultural land/enterprises or horse enterprises when routeing new transmission lines.

One TSO responded *"generally, yes"* to this question but go on to say,

"in these areas it would be preferable not to take action unless there are no other alternatives, or in the presence of alternatives with a lower environmental compatibility". In essence this is no different to the EirGrid approach in that the final route that is chosen is the one that represents the least environmental impact. Similarly another TSO commented that they try to avoid special crops such as vineyards and olive groves.

Another TSO made the comment that *"agricultural land is absolutely necessary when routeing new transmission lines".*

Having established in Q1 whether or not these land uses are treated as a constraint, questions 2 & 3 sought to understand how these land uses / enterprises are treated when it comes to the detailed line routeing across them and also at the construction and operational stages of the transmission line.

Question 2 enquired as to whether TSO's had a formal policy setting out their approach to agriculture and or horse enterprises at;

a. route selection stage
b. construction stage
c. operational / maintenance stage.

This question was interpreted differently by different respondents and in most cases accompanied by text explaining or qualifying the answer.

In response to part (a) – route selection stage – most TSO's have a policy of meeting with each landowner and occupier to discuss/consult on the route alignment so as to minimise the impact in the first instance and then to mitigate its effects on the enterprise as far as possible. Specific additional comments are as follows;

- *"We try to place our towers near to the boundaries between parcels of land to reduce the burden of the individual landowners".*
- *"For new transmission lines above 110 kV and more than 15 km route length an EIA is necessary, where all possible identified impacts along the route of the line are assessed – this includes also impacts on agricultural and/or horse enterprises".*
- *"No special treatment for agriculture and/or horse enterprises is done, unless these areas are also areas of sensitive use for people (see Question 1). For new transmission lines above 110 kV and more than 15 km route length an EIA is necessary, where all possible identified impacts along the route of the line are assessed – this includes also impacts on agricultural and/or horse enterprises".*
- *"We do treat each individual case on it's merits and as mentioned in the previous question, we would look to have meaningful discussion with each land owner/ Occupier at the route alignment stage to mitigate any effect as far as possible".*

- *"The legal requirement in (name of country) for selecting a route for a new power line is to assess thoroughly all the possible impacts of the project (environmental, financial, landscape, etc.). The selected route therefore results from a (long and somewhat lively) dialogue with local stakeholders which at final defines a compromise ("lowest impact route"). Agriculture representatives are one of these stakeholders. Impacts on livestock farms (including horses) are one of the possible identified impacts but not particularly weighted in the whole process, as this possible impact can be mitigated using good practices of electrical installations (grounding, etc.)".*
- *"Agriculture areas are more desired than forests".*

Again the approach being taken by the respondents is consistent with that being pursued by EirGrid. The EirGrid approach can be broadly outlined as follows;

1. As soon as the indicative line route within the corridor is identified, the owners of the land over which the line crosses are identified from a search of the Property Registration Authority of Ireland (PRAI) database.
2. A map showing individual landholdings and the line route across it is produced for each identified landowner and this is issued to each landowner for discussion as part of an information pack.
3. A meeting is organised with each landowner to discuss the proposal as it impacts their land. This is to get the landowners views on the alignment identified, give them an opportunity to suggest alternative alignments and indicate what would represent the least impacting locations for towers on the line route on their land.
4. All suggestions from landowners are fully investigated in arriving at a preferred line route which shows the proposed locations of towers. Proposed alterations to the route alignment are undertaken when they are shown to be technically feasible, do not result in a greater overall environmental impact and do not result in a greater adverse impact on the lands of neighbouring landowners. Landowners generally ask that towers be sited close to/on field boundaries and where this is possible this is done. However, the placing of towers on hedgerows requires that the hedgerow be surveyed by the environmental and technical team.
5. A map of the revised line route showing structure locations is issued to each landowner and again comments are sought from them. Again, where possible, landowner's wishes are delivered upon.
6. Where required a full Environmental Impact Assessment (EIA) is undertaken on the final line route to produce the Environmental Impact Statement (EIS) which is lodged with the planning application. Impact on agriculture and equine enterprises is considered as part of this process.
7. Throughout the process, landowner representatives locally are briefed on the project.

All of the items that have been identified by other TSO's as key in their approach to agricultural and equine enterprises at the route selection stage are being applied by EirGrid presently. Dealing directly with landowners at the route selection stage comes across clearly from the survey as a very important activity at this stage and is something that EirGrid also places great emphasis on. However, the impacted landowners cannot be determined until an indicative line route is known. Prior to that EirGrid makes every effort to ensure that people generally are informed that a line is required and the area within which the line will be located is widely consulted on.

In response to part (b) of question 2 (construction stage), the following were some of the main comments;

- *"Working methods shall be such that all unnecessary damage to the vegetation, trees and land will be avoided. Any changes to the land surface shall be minimal and any imprints left shall be levelled. Foundation work and other heavier work on fields shall be performed during ground frost or when the soil will bear a load, as far as possible. Any potentially injurious parts shall be covered to make them harmless to people or animals (e.g. stay wires in pasture land). At transmission line work sites, the contractor shall notify the residents, nursing institutions and educational establishments of the neighbouring area, as well as any other instance that may be disturbed by the work (such as horse farms or fur farms), in advance of any work that will cause a disruptive noise or vibration, regardless of the notification requirement stipulated by the authorities".*
- *"An agreement with the chamber of commerce for agriculture is established for landowners compensation. This agreement includes permanent crop loss and land use for tower foundation area. Crop damage during construction stage is compensated additionally".*
- *"Cause as small as possible impact on the environment in the construction stage".*
- *"There is a compensation policy for all damages towards agricultural users. We also currently have one case where we cross parcels (with cables, not an OHL) where a yearly horse jumping contest is held. The timing of the construction and the repair of the terrain will be adjusted such that there will be no effect on the contest".*
- *"We compensate the landowners if it is necessary to move horses or other farm animals to another field during construction and maintenance. We have agreements with the national interest group for agriculture about the prices for compensation – both for achieving the right of way and for compensation for the loss of income from crop".*
- *"There is a compensation policy for all caused damages".*
- *"Use of special technologies of construction not to concern special crops (vineyards, olive trees). Carrying out the work in stretches, on lines of a sizeable length, may allow the schedule works to be carried out in any particular areas of the year when the possible impacts on the horses or farming work are minimum, always providing that this be possible within the limitations imposed by need to reach agreements with the owners before moving on to any other work".*

- *"(TSO Name) is permanently discussing with farmers representatives in a permanent national committee. One of the objectives is to update regularly the refunding of loss of crops and of land use due to the grid development and maintenance in agricultural lands. There is no permanent discussion regarding livestock farming. Nevertheless specific measures can be agreed following the dialogue process related to a particular project when its possible impact on livestock is questioned by local farmers. For example, this recently happened in a 400 kV project. The particular agreement committed (TSO Name) to upgrade the electrical feeding and protection system of all neighbouring farm buildings (barns), which implied for example the grounding of all floating metallic elements (fences, etc.). The main concern was about dairy cows and no particular question rose from horse enterprises".*
- *"During the preparation of the lines construction based on the relevant legislation, lump rent for use as compensation for the temporary withdrawal of land is set. Price varies within the protection zone of the overhead lines (OHL) and the price is different under the towers of the OHL too. Compensation is paid for all the species of land whether it is arable land, forests or other. The determining factor is the price of land financial standing. It is also intended legislative treatment of topsoil".*
- *"We identify possible mitigation and compensation measures and we subscribe a Memorandum of understandings among (TSO Name) and the local authorities".*
- *"We don't have a special policy or code for dealing with equine enterprises. And we don't have a special code for dealing with agriculture when it is about routing or special measurements. We do have although, something special to do about landowners: 1. we have to make a deal/contract with every landowner about the price we have to pay for making use of his land and a price to compensate his losses because of our assets. 2. Before we are going to talk with every individual landowner, we try to make an agreement with the branch cooperation of the agricultural sector".*
- *"We have internal policies relating to the contact, maintaining contacts with agricultural enterprises, and the compensation for the use of agricultural land".*
- *"Special mitigation measures; using of existing trails, streets, if possible. If not a building of firm surface and/ or use of planks to avoid compaction, restriction of construction stripe, separation of topsoil and subsoil, separate storage (topsoil ‹ 2m, if stored more than 3 month a greening), professional back-filling, Guarantee of unimpaired runoff, backfilling and re-cultivation during dry weather conditions to avoid capping + compaction, scarifying of soil if necessary, passing of sensitive soil only under dry condition, building of firm surface if necessary (e.g. geotextiles following DIN 18915.)"*
- *"At construction we would negotiate (where possible) a solution which enables the enterprise (agricultural or equine) to operate as normally as possible during the works and we have, in extreme cases, arranged for horses to be moved to alternative training arrangements and paid compensation for this activity for the duration of the works".*

Question 2 set out to determine if TSO's had specific policies for dealing with agriculture and equine enterprises. Question 3 asked about codes of practice. In answering there is some overlap between Q2 & Q3. Responses are taken as given. Allowing for translation and interpretation of the question, it appears that in general, the only policy that applies at the construction stage of projects relates to compensation for losses arising from the works. Minimising the impact of construction works on farms, while not the subject of policy documents, is a major concern for TSO's. Most respondents appear to have extensive measures/practices in place to firstly minimise and secondly mitigate the impact from construction works.

Question 2 (c) sought to understand what policies TSO's have in place for dealing with agriculture and or horse enterprises during the operational phase of the project (i.e. after construction) for maintenance activities.

Many of the comments given in response to Q2(b) apply equally to this question in that TSO's aim to minimise impacts on these activities during any maintenance works. Additional comments include;

- *"Yes. Crop damage during maintenance is compensated".*
- *"Yes. The compensation policy for agriculture foresees both compensation of the owner (buying of the pylon area) and compensation of the users (for loss of usable land, extra costs, lower profits etc)".*
- *"Yes. There is a compensation policy for all caused damages".*
- *"Yes. There is a compensation policy for all damages towards agricultural owners. Another series of very diverse measures are simultaneously agreed upon, including those referring to the correction of damage and environmental protection".*
- *"Yes, compensation payment" with the other measures applying in response to Q2(b) applying here also.*
- *"In normal operation and maintenance we do not get any major issues but on the few occasions where the enterprise has been badly affected we have arranged for horses to be moved to alternative arrangements and paid compensation for the effect".*

Having ascertained in question 1 whether or not agriculture and equine enterprises are treated as a constraint at line routeing, and any policies applied to these activities in question 2, question 3 sought to understand if TSO's have codes of practice for dealing with these activities or what, if any, publications they have, outlining their approach to dealing with landowners.

The following are the comments received;

- *"We have published our land use and environmental policy"*
- *"Agreement with the chamber of commerce for agriculture. Different values in €/m² depending on the soil quality are defined. For each new transmission line project such agreements are negotiated with the local/regional chamber of commerce for agriculture".*
- *"Yes. All owners are met individually and a compensation offer is made. The compensation policy (for agricultural owners and users) has been agreed upon with the agricultural organisations. This is not binding for the owners and users but is in many (but not all) cases accepted.*

- *"Yes. There are meeting with all owners one by one in order to determinate a compensation.- The compensation policy (for agricultural owners and users) has been agreed upon with the agricultural organisations. The process of obtaining rights from landowners involves any economic agreements for setting up rights of way necessary for place the pylons and the OHL; this is usually done by friendly agreements with the owners for the payment compensation. When reaching agreements with owners, sometimes, motivation of owners not always are equal of the regional authorities statements. Due care should therefore be taken not to undertake to carry out any activities that flout the commitments entered into with the public bodies. This is particularly crucial when crossing protected natural sites".*
- *"(TSO Name) relationships with owners or farmers are framed by a number of agreements, signed by the transmission system operator and many organizations representing the agricultural profession. Regarding livestock farmers, (TSO Name), the State and agriculture representatives have established a common association. This association has three objectives: - The management of scientific work on the influence of electrical stray phenomena in agricultural areas; - Responding to requests concerning electrical safety and electrical phenomena in farms; - The promoting of good practices for electrical installations in farms".*
- *"No, we don't have a special policy or code of practice for dealing with equine enterprises".*
- *"We don't have a special policy or code for dealing with equine enterprises. And we don't have a special code for dealing with agriculture when it is about routing or special measurements. We do have although, something special to do about landowners: 1. we have to make a deal/contract with every landowner about the price we have to pay for making use of his land and a price to compensate his losses because of our assets. 2. Before we are going to talk with every individual landowner, we try to make an agreement with the branch cooperation of the agricultural sector. This agreement is the bases of all the individual negotiations".*
- *"No. But each landowner who is affected by the overhead line is contacted personally by us and we will try to achieve an amicable settlement on the topic of compensation".*
- *"Framework for compensation payment (not published), Concept for soil protecting construction work (not published yet) (non-exhaustive list)".*
- *"Whilst we do not have a specific Code of Practice we do have a number of "commitment" fact sheets which we have produced for use in specific circumstances as attached and these include: Working on Grid Assets on your land, Our Commitment to the Environment, Our Commitment to Safety.*
- *"These are broadly used for existing assets and for new construction we have a further suite of fact sheets including; Guidance on Land Rights for New Electricity Transmission Assets, Overhead Transmission Lines, Environmental and Engineering Surveys".*

Compensation is a major theme running throughout the survey responses but particularly in response to this question. The main point is that comprehensive agreements on compensation for the impact of new lines on farmland are put in place with the chamber of commerce for agriculture/farming organisations and these agreements frame all negotiations with individual landowners. Common among the responses received is that all landowners are met individually and final compensation agreed.

Closely tied to the compensation agreements are codes of practice setting out how works will be undertaken at the construction and operation stages and many of the TSO make reference to documents that they have available in this regard.

One TSO is very pro-active in the area of landowner concerns about stray voltage etc;

"Regarding livestock farmers, (TSO Name), the State and agriculture representatives have established a common association. This association has three objectives: - The management of scientific work on the influence of electrical stray phenomena in agricultural areas; - Responding to requests concerning electrical safety and electrical phenomena in farms.

Conclusions

The survey proved very interesting in getting an understanding of other European TSO's approach to agriculture and equine activities when routeing, construction and operating electricity transmission lines. It is recognised that agriculture as practiced in Ireland has unique differences from the way it is practiced in other European countries owing to farm size, field size, land quality, climate, culture, etc. Nonetheless, understanding the different approaches is a very useful first step in looking to see what improvements could be made to the approach currently being taken by EirGrid. The following conclusions and recommendations can be drawn from the survey;

1. Agricultural land and/or agricultural enterprises or equine enterprises are not treated as a constraint when it comes to routeing new electricity transmission lines.
2. TSO's have a policy of meeting with each landowner and occupier to discuss/consult on the route alignment so as to minimise the impact in the first instance and then to mitigate its effects on the enterprise as far as possible.
3. Some TSO's try to avoid special crops (vineyards & olive groves) or what might be termed "sensitive" land uses if it is possible, only routeing through them where there are no other alternatives.
4. Concerns regarding the equine industry are not a major issue for other TSO's.
5. Regular meaningful engagement between landowners and their representatives and the TSO's is an important feature of the industry in most countries.
6. Having a comprehensive compensation package in place addressing all of the issues that arise at the construction and operation stages is common among most TSO's.
7. Hand in hand with the compensation policy most TSO's have codes of practice or packages of measures setting out how works on their lands will be undertaken.
8. A notable feature highlighted by one TSO is the promotion of good practices for electrical installations in farms and responding to requests concerning electrical safety and electrical phenomena in farms.

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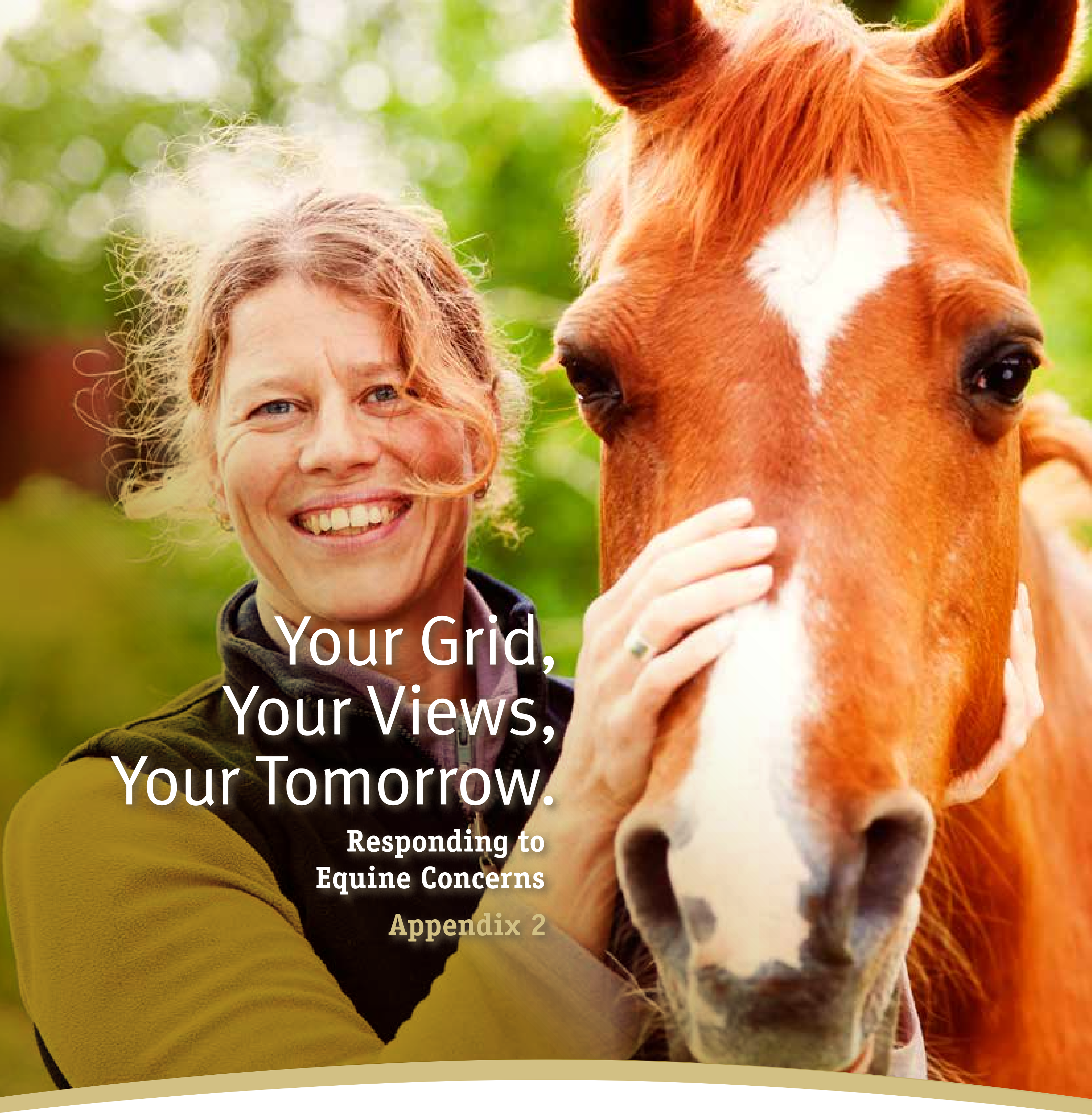

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Appendix 2

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Appendix 2

Review of Research on Livestock and Crops in Relation to Electric and Magnetic Fields from High Voltage Transmission Lines

Exponent

Health Sciences Practice

Exponent®

Review of Research on Livestock and Crops in Relation to Electric and Magnetic Fields from High Voltage Transmission Lines

Exponent®

Review of Research on Livestock and Crops in Relation to Electric and Magnetic Fields from High Voltage Transmission Lines

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December 17, 2014

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Contents

Acronyms and Abbreviations

μT	Microtesla
AC	Alternating current
CSF	Cerebrospinal fluid
DC	Direct current
DMI	Dry matter intake
EHC	Environmental Health Criteria
ELF	Extremely low frequency
EMF	Electric and magnetic fields
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IL-1	Interleukin-1
IL-2	Interleukin-2
kV	Kilovolt
kV/m	Kilovolt per metre
m	Metre
mT	Millitesla
PNNL	Pacific Northwest National Laboratory
T4	Thyroxine
WHO	World Health Organization

Executive Summary

A large scientific literature has accumulated since the 1970s investigating potential environmental and health effects of extremely low frequency (ELF) electric and magnetic fields (EMF). Most of the scientific research has focused on potential effects on human health. As part of human health risk assessments, the relevant scientific literature has been repeatedly and systematically reviewed by a number of international and national health, scientific, and government agencies. Perhaps most notably, based on its comprehensive review of the relevant research results, the World Health Organization (WHO) concluded that the available evidence does not confirm the existence of any health consequences from exposure to ELF EMF (WHO, 2007). Known adverse effects, such as nerve and muscle stimulation, which are temporary and reversible, may occur at high exposure levels. Current exposure guidelines applicable in Ireland are stated by the WHO to provide adequate protection for all known effects. Although these guidelines are intended to protect humans against potential adverse effects, there is no evidence to suggest that this protection would not apply to farm animals.

Economic considerations have led to a considerable amount of scientific research, although less systematic in nature, on the potential effects of ELF EMF on livestock and crops. The research studies on livestock tend to focus on species with sizable economic impact, such as cattle, sheep, and swine, and concentrate on outcomes of reproduction, milk production, and growth. ELF EMF research related to plants has been of less interest. Although sporadic associations with various measures from some of the studies on animals and plants were reported, overall, no consistent or convincing pattern of any harmful effects of ELF EMF has emerged in either livestock or crops that would have relevance to farm operations around 400 kilovolt transmission lines in Ireland or even transmission lines operating at higher voltages elsewhere.

This document provides an up-to-date overview and summary of the scientific literature on potential effects of ELF EMF on livestock and crops, including both field observations and experimental studies. Overall, the available scientific evidence summarised in the current report does not provide consistent or convincing evidence that either electric or magnetic fields associated with the Irish electric transmission system may adversely affect the livestock or crops produced on Irish farmlands.

Introduction

Since the late 1970s considerable scientific and public attention has been paid to potential environmental and health effects of extremely low frequency (ELF) electric and magnetic fields (EMF) associated with power generation, transmission, and use. The main focus of scientific research has been on potential human health effects. This resulted in a large body of scientific literature including epidemiologic studies of humans, laboratory studies conducted on various animal species, and studies conducted on cells and tissues.

Less and more sporadic attention was paid to potential ecological effects on wildlife and vegetation. EMF studies related to livestock and crops were primarily motivated by interest in potential effects of economic importance and typically focused on species with significant economic impact, such as cattle, sheep, and swine. The investigated outcomes were also chiefly determined by these economic drivers with attention focusing mainly on reproduction, milk production, and growth of livestock, and the growth and yield of crops.

The objective of this report is to review and summarise research on the effects of power frequency 50-60 Hertz (Hz) fields in the ELF range on livestock and crops to inform agricultural interests whose land might be crossed by existing transmission lines or proposed 400 kilovolt (kV) or lower voltage transmission lines as part of EirGrid's grid development programme.[1] EirGrid reports that a representative magnetic field level directly underneath 400 kV lines is 10.8 microtesla (µT) and a similar representative level of the electric field directly underneath these lines is 3.7 kilovolts per metre (kV/m).[2] It should be kept in mind that the research reviewed below frequently relates to lines operating at much higher voltages (i.e., 500 kV to 1100 kV) or to experimentally produced levels of EMF that are far higher than are characteristic of 400 kV transmission lines in Ireland.

[1] http://www.eirgrid.com/media/GRID25.pdf

[2] EMF & You, Information about Electric & Magnetic Fields and the electricity transmission system in Ireland, revised July 2014. http://www.eirgridprojects.com/media/EMF%20%20You%20Booklet%202014.pdf.

The significant amount of health studies conducted on humans and laboratory animals also provides scientific evidence that has relevance for evaluation of potential effects on farm animals. The relevant scientific literature has been repeatedly and systematically reviewed by international and national scientific, health, and government agencies in an effort to assess potential human health risk associated with exposure to ELF EMF. The organizations that completed health risk assessments include the World Health Organization (WHO, 2007), the International Agency for Research on Cancer (IARC, 2002), the National Radiological Protection Board in the United Kingdom (NRPB, 2004), the National Institute of Environmental Health Sciences in the United States (NIEHS, 1999), the European Union's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR, 2009, 2013), and the Department of Communications, Marine and Natural Resources in Ireland (DCMNR, 2007). None of these agencies has concluded that ELF EMF is the cause of any adverse health effects, including cancer and non-cancer outcomes. While the expert panels convened by these agencies acknowledged the limited evidence for a statistical association between childhood leukaemia and residential magnetic field exposure in epidemiologic studies, all other evidence from human and laboratory studies was judged to be inadequate (e.g., WHO, 2007). According to the WHO, the "current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields."[3] This scientific conclusion is also relevant to the health and wellbeing of livestock. The available scientific studies do not provide evidence to suggest that exposure to ELF EMF would have any different biological or health effects on farm animals than on humans or laboratory animals. Moreover, the exposure of four-footed livestock to ELF electric fields from transmission lines is considerably lower than humans because of differences in the body shapes and grounding of quadrupeds and bipeds. Based on modeling and some measurements, the average exposures of cows, horses, and swine to the electric field under a transmission line are about 56%, 56%, and 53%, respectively, of that experienced by a person (Kaune and Phillips, 1980; Kaune, 1981; Kaune and Gillis, 1981). For animals with bodies larger than humans, ELF magnetic fields will induce larger electric fields and currents in the body; smaller animals will have lower induced fields and currents. Magnetic field exposures, however, are not known to be perceptible to humans or livestock.

[3] http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html

At high exposure to electric fields (59kV/m according to Reilly, 2011) and magnetic fields (60 millitesla [mT] according to Kavet et al., 2008), which are substantially higher than exposure levels that could be experienced in the general environment or under 400 kV or even under higher voltage transmission lines, there are known biological effects in humans (Kavet et al., 2008). These effects, such as muscle and nerve stimulation, are immediate and reversible, and form the basis of current exposure guidelines. Exposure guidelines, such as the ones set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), are developed following extensive and comprehensive review of the relevant scientific literature to identify established effects. Exposure limits are then set well below exposure levels where these effects could be observed. The exposure limits set by ICNIRP (1998) are recognised and recommended for implementation by the WHO and are applied in the European Union, and consequently in Ireland. These limits, based on current scientific knowledge, provide sufficient protection of human health for all known adverse effects. The currently available scientific evidence does not suggest that this protection would not apply to livestock, as well.

Research Approaches

Similar to studies in humans, both observational and experimental study designs are employed to study potential biological and health effects in livestock and biological effects in plants. Observational studies have the advantage of following and monitoring animals in their natural environment at exposure levels to which they are typically exposed. Observational studies, however, have substantial limitations. They frequently rely on secondary sources for information gathering, sources not primarily designed for research purposes, resulting in potential misclassification of outcomes due to systematic, if unintentional, under- or over-reporting. Exposure assignments in observational studies are not random and any systematic differences between exposed and unexposed animals may bias and confound the observed pattern in the biological or health outcomes under investigation. Researchers in observational studies are not in control of the actual exposure of the animals, and the animals classified as exposed may receive a lower level of exposure than assumed or only exposed during part of the observation period (e.g., animals grazing on a pasture that is crossed by a transmission line may spend only a fraction of time directly under the line). Mobility is not an issue in observational studies of crops around a transmission line, but unrecognised differences in soil, microclimate, and other factors at varying distances from the line may potentially confound the interpretation of findings with regard to any relationship with EMF if any differences in biological responses are observed between locations.

In an experimental study, investigators typically randomly assign study subjects (animals or plants) to groups with or without exposure; thus, extraneous factors are less likely to influence the results other than chance variability. Exposure levels are also controlled and measured by the investigators in an experimental study, and thus, the actual exposure levels are known, which aids the correct interpretation of the studies. Exposure levels in experimental studies, however, are typically much higher compared with environmental exposure levels; therefore, any potentially observed effect may not be directly relevant for typical exposure scenarios in agricultural operations near 400 kV transmission lines. When potential effects of environmental EMF exposure on livestock, crops or any living organisms are evaluated it is important to consider all available evidence from various research approaches.

Methods

In this report, we provide a review of the available scientific literature relevant to assess potential effects of ELF EMF exposure on livestock and crops. Structured literature searches were conducted according to standard scientific criteria and using a well-defined search strategy to identify literature and publications in this area of interest.

The primary literature search utilised PubMed, a search engine provided by the United States National Library of Medicine and the National Institutes of Health that includes over 15 million up-to-date citations from MEDLINE and other life science journals for biomedical articles dating back to the 1950s (http://www.pubmed.gov). A supplemental literature search was conducted of agriculture, environmental and life sciences, and other scientific databases on the ProQuest DIALOG search service (included CAB Abstracts, Agricola, Agris, BIOSIS, Plant Science, Animal Behavior Abstracts, Zoological Records, PASCAL, and several others) to identify literature and publications that may not be indexed by PubMed. Results were limited to English-language publications for the period from 1960 through 2014.

The titles of more than 1,000 studies and publications were screened from the search results for studies pertaining to effects of EMF on farm animals and crops. From these results, over 200 abstracts were reviewed to determine relevance. Finally, the literature search results were additionally supplemented by a search of Exponent's substantial EMF resource library and by hand-searching the reference lists of the studies and publications selected for inclusion.

Electric and Magnetic Fields

Life in a modern society is unimaginable without electricity. Almost all aspects of life and economic activities, including education, health care, transportation, manufacturing, communications and entertainment, are dependent on the use of electricity. Alternating current (AC) electricity with a frequency of 50 cycles per second (measured in Hz) is the electricity supplied in Ireland by EirGrid and by other utilities in Europe. In other parts of the world, for example, in North America, 60Hz electricity is used. Electricity, whenever it is generated, transmitted, or used, either in residential or commercial settings, is associated with electric and magnetic fields.

Magnetic fields result from the flow of electric currents. Magnetic field strength is expressed in flux density and measured in the units of tesla (T). Levels of magnetic fields common in our environments are generally reported in smaller units of μT, where 1μT is equal to 0.000001T. Electric fields result from differences in voltage or voltage potentials. Electric field strength is expressed in units of volts per metre (V/m) or in kV/m, where 1,000V/m is equal to 1kV/m. Both electric and magnetic fields diminish quickly with distance away from the source. Electric fields are easily blocked by conductive objects, for example, trees, buildings, fences, or even the human body. Unlike electric fields, magnetic fields are not blocked easily by conductive objects.

The 50Hz EMF that is associated with electricity is part of the ELF range (3-300Hz) of the electromagnetic spectrum. The electromagnetic spectrum also includes frequencies of 0Hz (static fields, associated, for example, with direct current [DC] electricity and the earth's geomagnetic field) and higher frequency fields, such as radio waves and microwaves (frequencies in the several hundred of kilohertz to megahertz and gigahertz), visible light, and X-rays and gamma rays with frequencies of billions of Hz. The energy level of electromagnetic fields is dependent on the frequency of the fields. High frequency fields have high energy and are able to ionise atoms, that is, they are able to dislodge electrons from their path around their atomic nucleus, potentially causing damage in living cells (e.g., X-rays). Radio frequencies and microwaves may be able, at very high levels, to heat objects. Fields with lower frequencies at the bottom of the electromagnetic spectrum, such as ELF EMF, have very little energy and have no ionising or tissue heating effects.

Livestock

Cattle

In the scientific literature on EMF and livestock, potential effects of EMF related to health, behaviour, and productivity of cattle have been studied most extensively.

Observational studies

Farm surveys

Some of the early studies were surveys of farms located in close proximity to high voltage transmission lines. These studies typically relied on the farm operators' recall or observations or past records on animal health or productivity. Surveys of farms reported no effect on milk production, reproductive performance, or grazing habits on farms crossed by 765 kV transmission lines—lines with substantially higher voltage than the 400 kV transmission lines proposed by EirGrid—in Indiana, Michigan, and Ohio (Busby et al., 1974; Ware, 1974; Amstutz and Miller, 1980). Studies that compared the rate of adverse effects on cattle living on farms near high-voltage transmission lines before and after the lines were energised (Williams and Beiler, 1979; Martin et al., 1986) reported no association in milk production or reproduction. Several studies in Sweden and the United States compared various animal health measures on farms located close to transmission lines to those on farms farther away from transmission lines. An early survey of dairy farms in Sweden reported some evidence that decreased fertility was associated with extended exposure to 400 kV transmission lines (Algers et al., 1982). A later nationwide survey in Sweden by these same investigators that included 106 dairy cattle herds exposed to a 400 kV transmission line that crossed their pasture reported no differences in reproductive success or milk yield when compared to similar farms where the cattle grazed on land not crossed by a 400 kV transmission line (Hennichs, 1982; Algers and Hennichs, 1985). As Algers and Hennichs (1985) concluded, fertility "was not significantly different between exposed and unexposed groups" (p. 351).

Field studies of grazing animals

Studies with direct observations of animals grazing under high-voltage power lines were conducted to provide more sensitive and reliable evidence on potential adverse health effects associated with exposure to EMF from transmission lines. Although these studies were not experimental in nature, there was a direct assessment of EMF exposure of the animals in these studies and the animals were continuously exposed; thus they provided more direct evidence on a potential association between exposure and any behavioural or biological changes compared with the previously described farm surveys. In a Swedish study, 58 heifers were continuously exposed in pens under a 400 kV transmission line for an average of 120 days to levels of approximately 2 to 6 kV/m and 2μT (Algers and Hultgren, 1986, 1987). The animals were examined throughout the study for reproductive performance (e.g., regularity and intensity of oestrus cycle, progesterone concentrations, and proportion of animals conceiving). Exposure to the high-voltage line was not reported to affect reproductive functions or pregnancy outcomes in the 58 exposed heifers, compared to 58 unexposed heifers. According to the authors, "[n]one of the parameters were found to be influenced by the exposure of the heifers to the 400-kV, 50-Hz transmission line" (Algers and Hultgren, 1987, p. 21).

Scientists at Pacific Northwest Laboratory (PNNL), a U.S. Department of Energy research laboratory in Washington, conducted a series of observations to determine if steers' behaviour is affected by EMF in the immediate vicinity of a 1,100 kV transmission line. The electric field varied between the study years, increasing from about ~ 8kV/m in the earlier years to 13kV/m in the last study year. These electric field levels are substantially higher than those that could be encountered under the 400 kV transmission lines proposed by EirGrid. In each of the five successive years, five steers were released under the power lines and their grazing patterns were observed within strata of various distances from the transmission line during periods with and without the line being energised.

While in the first 3 years of the study, grazing patterns showed no differences between energised and unenergised periods, in the later study years there were some statistical tendencies for the steers to graze farther away from the lines while they were energised compared with unenergised periods. The authors could not determine if the subtle changes were due to audible noise, hair stimulation, shocks, or foraging availability (Rogers et al., 1979; 1980; 1982; Warren et al., 1981).

More recently, Italian scientists compared a number of immunological and haematological parameters between five cows housed in the immediate vicinity of a 380-kV transmission line and exposed to magnetic fields in the range of 2-3μT to five unexposed cows at a different farm (Stelletta et al., 2007). While some differences were observed in concentrations of various leukocyte differentiation antigens among the exposed compared to unexposed cows (e.g., increased CD8+ numbers), these differences appeared to be within or close to the physiological range. Since the study was based on a very small number of animals (five exposed and five unexposed animals on two different farms), and the design was not experimental in nature, any conclusions from the study should be taken as preliminary.

Behavioural studies of orientation to the geomagnetic field

Two recent studies on cattle orientation, published by the same research team, have received considerable media attention (Begall et al., 2008; Burda et al., 2009). Both studies used publicly available satellite images to identify cattle on various pastures in Africa, Asia, Australia, Europe, North America, and South America. In the first study, the researchers reported that cattle tend to orient themselves in the north-south direction, which—according to the authors' hypothesis—is due to a magnetic alignment to the earth's geomagnetic field. Based on direct observations and observations of snow prints of resting animals, similar conclusions were made about observations of a predominately northerly orientation of red deer and roe deer. This argument appeared to be further supported by the observation that body orientation was more aligned with the magnetic North Pole rather than with the geographic North Pole. The potential influence of time of day, position of the sun, wind direction, while discussed, was not accounted for in the analyses.

In the second publication, the authors reported that in the immediate vicinity of presumably AC high-voltage power lines (within 150 metres [m]) this alignment becomes random. The authors suggest that the ELF- EMF from the power lines may explain this observation but no mechanism exists to explain a potential basis for perception of the static geomagnetic field or ELF fields by cows, the former of which is proposed by the authors as a basis for the reported north-south behavioural orientation. These papers were later criticised by other investigators who performed their own analyses (Hert et al., 2011) and were unable to replicate the initial findings. They also pointed out methodological shortcomings, such as the limited quality of the publicly available satellite images, the un-blinded nature of herd and animal selection and evaluation, and that potential alternative explanations to magnetoreception were ignored. As Hert et al. (2011) concluded, these shortcomings "could easily have led to an unsubstantiated positive conclusion about the existence of magnetoreception" (p. 677).

A recently published work designed to replicate the original findings reported mixed results (Slaby et al., 2013). Solitary cows or cows in small groups showed a tendency for north-south alignment, but cows in larger herds did not. The Slaby et al. (2013) study used similar methodology as the original one (Begall et al., 2008), relying on limited quality satellite images, and did not explore potential alternative environmental explanations for alignment (e.g., wind, topography, or the position of the sun).

Experimental studies

Although observational studies on cattle provide valuable input to the evaluation of the potential for adverse health effects, well-controlled experiments, in which the EMF exposure levels and other environmental parameters can be carefully regulated and monitored and various physiological parameters of the animals can be closely observed by the investigators, provide more direct evidence on a potential association between exposure and potential adverse outcomes.

A group of investigators at the McGill University and the Hydro-Québec Research Institute in Québec, Canada designed and conducted a large number of controlled experiments using standardised methods to estimate potential influence of EMF exposure on various physiological parameters of dairy cows. The investigated outcomes included measures of reproductive function (e.g., oestrus cycle and gestational hormone concentrations), quantity and quality of milk production, feed intake, blood concentrations of pineal gland and thyroid hormones, and circadian rhythm. The Québec researchers were the first to test these associations in controlled experiments and their efforts have not yet been replicated or matched by others.

For these series of experiments, the researchers specifically designed and constructed exposure chambers (Nguyen et al., 2005). The exposure chambers could house eight cows at the time in wooden stalls similar to conditions used in dairy farming with confined housing. The exposure chambers were designed to provide uniform exposures similar in magnitude to those the cows would experience standing directly beneath 735 kV AC (60Hz) transmission lines. Electric fields up to 10kV/m and magnetic fields up to 30μT could be generated. These electric and magnetic field exposure levels are substantially higher than those that could typically be encountered under the 400 kV transmission lines proposed by EirGrid. The experimental design (switch-back experimental protocol) typically included groups of eight animals that were exposed for a 28-day period, followed by a second 28-day period with no exposure, and a third 28-day period with exposure turned on again (on-off-on). In some of the experiments a second group of eight cows were exposed in a reverse pattern (off-on-off). Various health, reproductive, and milk production parameters were measured at predetermined intervals and the concentrations at the exposure periods were compared to concentrations at the unexposed periods using various statistical techniques.

Milk production and feed intake

Several of the experiments investigated various metrics of milk production and feed intake as one of the most important outcomes of interest in dairy cows (Burchard et al., 1996; Rodriguez et al., 2002; Burchard et al., 2003; Burchard et al., 2004; Burchard et al., 2007). Dry matter intake (DMI) was investigated in five studies. The three earlier studies reported a slight (about 4-6%) but statistically significant increase in DMI with exposure (Burchard et al., 1996; Rodriguez et al., 2002; Burchard et al., 2003). These variations were well within the reference range and well within the variation between the experiments. The last two experiments that exposed the cows to either electric or magnetic fields did not show a difference in DMI between the exposed and unexposed groups (Burchard et al., 2004; Burchard et al., 2007). Three studies investigated milk yield; two of them reported no statistical change with exposure (Burchard et al., 1996; Rodriguez et al., 2002), while one reported a moderate decrease (~5%) in the exposed group (Burchard et al., 2003). For fat-corrected milk yield, the same three studies showed inconsistent results, one showing an increase, one showing a decrease, and another showing no change with exposure. Other measures that were also investigated in some of the studies, such as fat yield, protein yield, crude protein, and energy consumption showed no consistent changes with exposure.

Reproduction

Reproductive measures, including the length of the estrous cycle and blood progesterone levels, were also investigated as key outcomes in dairy cattle in several studies. The hormone progesterone, which is mostly produced by the ovaries, plays a key role in the estrous cycle and in the maintenance of pregnancy after impregnation. Five studies looked at the potential influence of EMF exposure on blood progesterone concentrations (Burchard et al., 1996; Burchard et al., 1998a; Rodriguez et al., 2003; Burchard et al., 2004; Burchard et al., 2007). While the initial experiment indicated a slight (~9%), but statistically significant increase of progesterone concentrations with exposure in pregnant cows, all of the four follow-up experiments failed to replicate this finding and showed no statistically significant change in the average blood progesterone levels, or at the maximum value, the rate of change and the total cumulative concentration of progesterone hormones. These follow-up experiments that failed to replicate previously published results by this laboratory included both pregnant and non-pregnant cows exposed to either electric or magnetic fields or to both at the same time.

Two studies (Burchard et al., 1998a; Rodriguez et al., 2003), each including 16 non-lactating, non-pregnant, multiparous cows in the experiment, investigated the potential effect of EMF on the length of estrous cycle. They reported slightly longer (~2-3 days) estrous cycles among the exposed cows than the unexposed cows. One of these studies also reported slightly longer (~2 days) luteal phases in exposed cows. These differences were well within the normal range of variation and were not associated with corresponding changes in progesterone concentrations as discussed above.

Hormone concentrations

Melatonin plays a central role in hormone regulation and it has been hypothesised that in humans, similar to light at night, exposure to EMF may suppress melatonin production. Although this hypothesis has not been supported by reviews of a wealth of human and laboratory animal studies (AGNIR, 2006; WHO, 2007), initial preliminary publications describing the hypothesis may have motivated the McGill researchers to examine potential effects of EMF exposure on melatonin concentrations in cattle. The authors further hypothesised that the slight increase in DMI observed among the EMF exposed cows in the early studies may be due to melatonin suppression. This would be, the authors argued, analogous to increased DMI during longer daylight periods in summer when the shorter nights are associated with shorted periods of melatonin increase. One experiment (Rodriguez et al., 2004) reported lower concentrations of melatonin among the exposed cows but only during the day, when the melatonin concentrations are already normally reduced due to daylight. No differences due to EMF exposure were observed, however, in the nighttime concentrations of melatonin in either pregnant or non-pregnant cows (Burchard et al., 1998b; Rodriguez et al., 2004). When electric and magnetic fields were studied separately, no associations between exposure and melatonin concentrations were observed (Burchard et al., 2004; Burchard et al., 2007).

Prolactin, as the main hormone responsible for lactation, was also investigated, but no consistent associations were reported with EMF exposure. Prolactin concentrations also were hypothesised to be influenced by EMF via changing melatonin concentrations. One experiment showed an increase, while another experiment showed a decrease in circulating levels of prolactin among EMF exposed pregnant cows compared to unexposed (Rodriguez et al., 2004; Burchard et al., 2007). Two additional experiments showed no statistically significant change among pregnant and non-pregnant cows (Burchard et al., 2004; Rodriguez et al., 2004). Insulin-like growth factor-1, playing a role in growth and thus of importance to cattle producers, showed no consistent association with exposure electric and magnetic fields separately or in combination (Burchard et al., 2004; Rodriguez et al., 2004; Burchard et al., 2007) . The thyroid hormone, thyroxine (T4), was investigated in one study (Burchard et al., 2006). Overall, average T4 concentrations showed no association with exposure in either pregnant or non-pregnant cows. Among non-pregnant cows, sub-analyses showed somewhat higher T4 concentrations among EMF exposed cows, but only during certain days (day 4 through day 10) of the 28-day exposure periods. The authors concluded that the association was "very moderate" and "does not represent health hazard [*sic*] for dairy cows."

Central Nervous System

The potential effect of EMF on the function of the central nervous system was assessed in studies that examined the cerebrospinal fluid (CSF). CSF surrounds the brain and the spinal cord for variations in fairly stable concentrations of various neurotransmitter metabolites, and macro and trace elements. EMF exposure was not associated with changes in metabolites of neurotransmitters such as dopamine, serotonin, β-endorphin, tryptophan, and norepinephrine. There was, however, a statistically significant increase of quinolinic acid concentrations in the CSF, which according to the authors may indicate the increased permeability of the brain-blood barrier (Burchard et al., 1998c). The authors concluded that this increase was "small" and it is unclear if it has "any functional significance." The concentration of a number of macro and trace elements were investigated in blood plasma and CSF by Burchard et al. (1999). Exposure to EMF was associated with decreased magnesium concentration in plasma. In the CSF, both increases (for calcium and phosphorus) and decreases (for iron and manganese) were observed. None of these findings were ever replicated and, according to the authors, "it is difficult to speculate about the physiological implication of such variations, if any" (p. 363).

Summary of Studies on Cattle

Cattle have been the most extensively investigated species among farm animals in the ELF EMF literature. Farm surveys and field observation of grazing cattle reported no consistent differences in behaviour or productivity on farms intersected by high-voltage transmission lines compared to farms away from transmission lines. A small number of studies with methodological limitations examined cattle orientation in relation to the earth's geomagnetic field and EMF from power lines, but reported no consistent findings. Researchers in Québec conducted a series of well-designed experimental studies to assess the potential effects of exposure to electric fields (up to 10kV/m) and magnetic fields (up to 30μT) separately and in combination on various behavioural, reproductive, and productivity parameters in dairy cattle. While some small differences (a few percent) in some of the investigated parameters were observed (e.g., feed intake, length of oestrus cycle), these differences appeared to be within physiological ranges and showed no consistent pattern. There were no consistent differences in various measures of milk yield (e.g., fat corrected milk yield, fat yield, protein yield), hormone concentrations (e.g., melatonin, prolactin, thyroxine), or neurotransmitter concentrations in the cerebrospinal fluid. As the Québec researchers concluded in one of their most recent papers (Burchard et al., 2007), "[t]he absence of abnormal clinical signs and the absolute magnitude of the significant changes detected during MF [magnetic field] exposure, make it plausible to preclude any major animal health hazard" (p. 471).

Sheep

Observational Studies

The survey of farm animals near transmission lines by Amstutz and Miller (1980) included one sheep farm. Details regarding the sheep were not provided other than that the average weight of 4.5-year-old sheep on the farm was comparable to the state average in Indiana and that some of the sheep received prizes at county and state fairs. Thus, no adverse effects on sheep were reported.

Experimental Studies

To study the potential effects of EMF on the immune system, scientists at the Oregon Health Sciences Center placed 14 8-week-old sheep in a pen under a 500 kV power line for 10 months (McCoy and Hefeneider, 1993). The sheep were exposed to a mean of 5.5kV/m electric fields and 3.77µT magnetic fields. As controls, 15 age-matched sheep were placed in a similar pen away from the transmission line with ambient EMF exposure. In this pilot study, the researchers measured circulating concentrations of an immune regulatory cytokine, interleukin-1 (IL-1), in the sheep blood 2, 5, and 6 months after the start of the exposure, and observed statistically lower IL-1 levels in the exposed group. The investigators also assessed the production of antibodies following vaccination and observed no differences between this immune response of exposed and unexposed groups. Thirteen of the 14 exposed animals also developed fungal dermatitis, and it is unclear if it was related to exposure since the animals were not randomised into the treatment groups. It is also unclear if the observed IL-1 decrease was related to or potentially explained by the skin infection. Two to three months after removal of the sheep from the exposed and unexposed pens, there were no differences in IL-1 concentrations between the two groups.

In a larger follow-up experiment by the same research group, 45 sheep were randomly allocated into 3 groups with 15 animals in each (Hefeneider et al., 2001). The first group was placed in a pen directly under the 500 kV transmission line (exposed to both electric and magnetic fields), the second group was placed under the transmission line with shielding to eliminate or minimise the electric field component resulting in magnetic field exposure only, and the third group, serving as a control group, was placed several hundred metres away from the line in ambient exposure levels. Both IL-1, which is produced by epithelial cells, and interleukin-2 (IL-2) blood concentrations were monitored monthly during the 27-month study period. IL-2, which is secreted by T-cells, was measured as a marker of T cell activity. As the authors concluded, “[w]hen the data were analyzed collectively over time, no significant differences between the groups were found for IL-1 or IL-2 activity” (Hefeneider et al., 2001, p.170). Thus, the initial findings were not replicated in the follow up-study. During the first 12 months of the follow-up study, however, magnetic field levels were lower (~1.1μT) than in the previous study or during the rest of the study (~3.5μT).

Researchers in two separate studies assessed the circulating blood melatonin concentrations and onset of puberty in female lambs (Lee et al., 1993; Lee et al., 1995). In the first study, 20 8-week-old lambs were randomly assigned in equal numbers into either exposed or unexposed groups and followed until age 10 months. The exposed group was housed in a pen under a 500 kV transmission lines (with mean electric field exposure of 6kV/m and with mean magnetic field exposure of 4μT) and the unexposed group was placed in a pen more than 200m away from the power lines (with mean electric fields of <0.01kV/m and magnetic fields <0.03μT). Melatonin concentrations were determined during eight 48-hour periods from blood samples collected every 3 hours. Puberty was determined from blood progesterone levels taken every 2 weeks after age 19-weeks. No differences between the two groups were observed in daytime or night time melatonin concentrations, in the amplitude, phase, or duration of night time melatonin increase, or in the onset of puberty. As the authors concluded, “[t]hese data suggest that chronic exposure of developing female sheep to 60-Hz environmental EMF does not affect the mechanisms underlying the generation of the circadian pattern of melatonin secretion or the mechanisms involved in the onset of reproductive activity” (Lee et al., 1993, p. 857). The second study was a replication of the first study with larger number of animals (15 lambs in each group). As in the first study, no differences were observed in melatonin concentrations or onset of puberty between the exposed and unexposed animals. The replication study, as the authors put it, “produced essentially the same results” as the previous one.

The potential effect of EMF on cortisol secretion, which can be elevated in 'stressful' situations, and growth was investigated in 20 ewe lambs randomly assigned into exposed and unexposed groups in equal numbers between the age of 2 and 10 months (Thompson et al., 1995). Exposed animals were housed under a 500 kV transmission line while unexposed animals were housed more than 200 metres away from the line. Cortisol concentrations were determined from blood samples collected during eight 48-hour periods. No differences were noted in cortisol concentrations and weight gain during the study period between the exposed and unexposed lambs.

In an experimental study to examine whether exposure to EMF may contribute to more frequent or more rapid development of tumours, 88 sheep previously inoculated with bovine leukaemia virus were randomly assigned into two groups in equal numbers (Miller and Lamont, 1996). One group was housed under a 345 kV transmission line, while the other group was housed 500 feet from the line. During the first 5.5 years, no differences were noted in the number of animals removed due to diseases (22 in the exposed and 28 in the unexposed group) or in the number of animals with lymphosarcoma or lymphatic leukaemia (14 in the exposed and 17 in the unexposed group).

Summary of Studies in Sheep

Several experimental studies investigated potential effects of EMF on the immune system, hormone concentrations (melatonin, cortisol), and onset of puberty and tumor development in sheep. No consistent differences between sheep exposed to EMF from transmission lines and unexposed control sheep were reported in these studies.

Swine

A survey of 11 farms near a 765 kV transmission line reported no influence of the line on the health, performance and behaviour of livestock (Amstutz and Miller, 1980). Although two of these farms had pigs, no separate analyses for swine were provided. No adverse effects on pigs were mentioned in the report.

Hjeresen et al. (1982) monitored the behavioural responses of 32 miniature swine exposed to 30kV/m electric fields during a 21-hour test period. The animals tended to spend more time in shielded areas, where the exposure was <1kV/m, than in unshielded areas exposed to 30kV/m electric fields. This effect was primarily observed in swine that were previously exposed to 30kV/m electric fields and not in previously unexposed animals. The effect was also restricted to the dark period and to non-pregnant swine. The electric-field exposure levels in the study were far higher than exposures that could be observed in the environment under a 400 kV transmission line.

Hanford miniature swine was used to evaluate the potential reproductive, developmental, and teratologic effects of chronic, long-term (20 hours per day, 7 days per week) exposure to 30kV/m electric fields in a multi-generation study (Phillips, 1980; Sikov et al., 1987). Reproductive (e.g., implants per litter, prenatal deaths) and developmental (e.g., weight and size of foetus) measures tended to show no consistent differences between exposed and unexposed animals across the three generations. There appeared to be more malformations in the exposed group compared to the unexposed group, but only in some of the generations. As there was an outbreak of *Campylobacter spp.* infection among the study animals prior to rebreeding, the authors also discuss the possible role of this infection in the development of the observed malformations. Since the incidence of malformations also varied between generations, the authors concluded that it was "impossible to conclude unequivocally" whether the observed differences in the frequency of malformations were due to high electric field exposure.

To assess potential effects of EMF on production and reproductive parameters in swine, scientists in Iowa randomly assigned 60 cross-bred pigs in equal numbers to an exposed group (housed under a 345 kV transmission line) and to an unexposed group (housed about 809 m away from the transmission line) (Mahmoud and Zimmerman, 1983, 1984). Electric-field levels in the exposed groups were about 4kV/m, no magnetic-field values were provided. No statistically significant differences were noted between the groups in behaviour during the experiment or in backfat thickness and other carcass quality measures after slaughter of the animals. The offspring of the exposed and unexposed animals were also examined. No statistically significant differences were observed between the exposed and unexposed groups in weight gain, feed intake, feed-to-gain ratio, or carcass yield, grade, and backfat thickness in the offspring. In a follow-up experiment, reproductive parameters were further assessed (Mahmoud and Zimmerman, 1984). The authors concluded that “the results indicate no effects” due to exposure on the rate of pregnancy, litter size, and the number of pigs born alive.

Summary of Studies on Swine

One study showed avoidance of very high electric fields (30kV/m) in miniature swine. The electric field exposure levels in the study were far higher than could be observed in the environment under a 400 kV transmission line. A study of production and reproductive parameters in swine reported no effects of EMF exposure from a 345 kV transmission line. A multi-generation study of miniature swine and electric fields exposure reported inconsistent findings when developmental effects were evaluated. These observations could not be replicated in other species.

Horses

A survey of 11 farms near a 765 kV transmission line reported no influence of the line on the health, performance, and behaviour of livestock (Amstutz and Miller, 1980). Although one of the included farms also had horses, no separate analyses for horses were provided. No additional studies examining potential effects of EMF from transmission lines on horses were identified in the literature. Several studies identified in the literature search used horses to study and demonstrate the beneficial effects of electromagnetic stimulation on bone healing (Collier et al., 1985; Cane et al., 1991; Cane et al., 1993; Zucchini et al., 2002), which is also a recognised therapeutic application in humans.

Summary of Studies in Horses

No scientific studies of potential adverse EMF effects on horses were identified in the literature.

Poultry

Two experiments investigated growth and fertility of poultry in a laboratory environment exposed to 60Hz electric and magnetic fields (Krueger et al., 1972; Krueger et al., 1975). The first study examined the growth experience of male chicks during the first 4 weeks of their life when exposed to extremely low frequency electric or magnetic fields (60Hz and 45Hz) and compared them to the growth experience of unexposed chicks during the same interval (Krueger et al., 1972). Exposure to 60Hz electric (~3.4kV/m) or magnetic fields (~120μT) was not associated with changes in livability, activity, behaviour, or feed utilization. According to results presented by the authors, chicks exposed to 60Hz electric fields also did not statistically differ in weight at any of the four time periods investigated (day 1, 9, 21, 28) from unexposed controls. Chicks exposed to 60Hz magnetic fields had statistically lower weight (a decrease of approximately 8.6%) compared to the unexposed controls at day 21, but not on other days. Overall, no consistent pattern was observed with exposure 60Hz electric and magnetic fields. The 60Hz magnetic field exposure in the study was significantly higher than exposure levels that could be expected under a 400 kV transmission line.

The second experiment investigated various variables of layer hen fertility with exposure to 60Hz electric (~1.6kV/m) and magnetic fields (140μT) during three consecutive 4-week exposure periods (Krueger et al., 1975). Exposure to 60Hz electric fields resulted in statistically significant reduction in egg production during the first two 4-week periods, but egg production returned to levels comparable to controls during the last 4-week periods. In contrast, exposure to 60Hz magnetic fields was not related to egg production during the first two 4-week periods, but was associated with a statistically significant decrease in the last periods. No consistent associations were reported between exposure and fertility, hatchability, or macroscopic abnormalities in hatched chicks. The 60Hz magnetic-field exposure in the study (140μT) was significantly higher than exposure levels that could be expected under a 400 kV transmission line.

Motivated by prior evidence suggesting that the earth's geomagnetic field may play a role in orientation, navigation, and migration of certain avian species, an experimental study using two roosters and two hens (all 10 weeks of age) was carried out to examine the potential for perception of strong 60Hz (1.7mT) or static (4mT) magnetic fields by domesticated chickens (Clarke and Justesen, 1979). Variability in feeding behaviour was assessed during repeated short (90 second) periods of exposure and compared to variability during periods of sham exposure. The investigators chose to examine variability in behaviour, as opposed to frequency of feeding responses, because prior observations showed both suppression and acceleration of feeding responses during the exposure periods. The authors reported increased variability in feeding behaviour while exposed to either ELF or static fields compared to unexposed periods and concluded that chicken may sense the presence of magnetic fields. The authors, however, were unable to rule out the possibility that the observed changes were in response to “artifactual sensory cueing borne of vibration or heating” from the exposure system.

A study by Durfee et al. (1975) investigated potential effects of 60 Hz magnetic (up to 3mT) and electric fields (up to 3.6kV/m) on embryonic and post-hatching growth and development in domestic chickens. The authors reported no consistent or significant effects on hatchability of fertile eggs, embryonic mortality, or growth, development, and memory consolidation of chicks after hatching, up to 10 weeks of age. Smith (1975) examined, in three experiments of 10 chickens each, the potential effects of 45Hz magnetic field (800μT) on social behaviour (pecking order) of domestic chickens. The author reported no consistent pattern based on the results of the three experiments, and concluded that “no clear statement could be made” on any potential effect.

Numerous studies have used chicken eggs as test organisms in laboratory studies, but no consistent pattern of effects of exposure to EMF has been reported across a range of field intensities and such studies, unless very well controlled, are subject to artifacts. While reviewing relevant research studies to evaluate potential reproductive and developmental effects of exposure to EMF, the WHO’s Environmental Health Criteria (EHC) has also reviewed experimental studies conducted in non-mammalian species, including chick embryos (WHO, 2007). The WHO EHC observed that while some of the studies may have raised the possibility of a potential effect, “findings of non-mammalian experimental models generally carry less weight in the overall evaluation of developmental toxicity than those of corresponding mammalian studies." Overall, the WHO concluded that the evidence from animal studies for any reproductive or developmental effect attributed to EMF was inadequate.

Summary of Studies on Poultry

A small number of studies investigated potential effects of EMF on growth, development and fertility in poultry. In most of the studies, magnetic field exposure levels were far higher than that could be observed in the environment under a 400 kV transmission line. Overall, these studies showed no consistent effects.

Crops

Field Studies

There is a long history of agricultural experimentation to assess the beneficial effects of electricity on crop yields, yet the studies were typically poorly controlled (Lee, 1996). A review by biologists at the U.S. Department of Energy concluded that the "[o]verall results of the studies indicated that the transmission lines had no noticeable influence on the growth or productivity of the crops" (Lee, 1996, p. 4-55). Better-controlled studies began in the 1970s in which scientists conducted field studies of a variety of crops grown near 500 kV and 765 kV transmission lines. Unfortunately, most of these studies were not published in scientific journals and are therefore unavailable for independent review and evaluation. In general, the later field studies described below were better controlled than these earlier studies.

Studies conducted by PNNL in Washington State investigated plant responses to ultrahigh voltage test lines charged to 1100 kV. Such test lines are a source of electric fields because of the voltage applied, but since they carry virtually no current, they are not a source of magnetic fields.

Rogers et al. (1979) reported on the first partial year of data collected in 1977 on peas and barley in treatment and control conditions after the 1100 kV test line was energised. No differences in seed pod or seed production of peas were noted but pod and seed biomass of exposed pea plants was significantly increased. Statistically significant differences between treatment and control plots for barley were reported; the barley stem length and seed head lengths were slightly greater and the leaf lengths slightly shorter in the treatment plot than in the control plot.

Rogers et al. (1980) summarised the 3 years of data (1977-1979) collected on peas and barley grown in electric fields between 7-11kV/m (field levels far higher than those that could be encountered under 400 kV lines) and control conditions. Lee and Clark (1991) also reported on data collected in 1977-1980. There were no consistent differences reported for barley or peas, except that the growth of barley leaves was slightly lower in all 3 years. The authors suggested that this may be related to the electric field, particularly because the pots containing the barley were elevated above the ground to prevent damage by rodents, which further increased the electric field, but no damage to leaf parts was observed. Similar assessments of the growth of velvet and bent grasses (leaf length, seed head length, stem lengths, biomass) by Rogers et al. (1980) in zones about the line with maximum electric field strengths of about 7.0, 4.0, and 1.0kV/m were made during a 3-year period. Overall, Rogers et al. (1980) stated “no substantial effects were noted” (p. 8.7) and there was “no evidence that the 1200-kV line affected the leaf tips in any way” (p. 8.3), but a reduced growth response was noted in the last year when the electric field increased by 3kV/m in the highest exposure zone (i.e., to 10kV/m).

Based on suggestive findings regarding peas in earlier years, PNNL continued research on peas in 1980 (Warren et al., 1981). In that year, the exposures in plots near the 1100 kV test line were higher, averaging 12kV/m. Pea seed and pod production and weights did not differ between control and exposed sites, but stems and leaves were significantly smaller at the exposed site. Pasture grass studies reported significant differences between velvet and bent grass growth and velvet grass stem length in some zones that was not clearly related to the intensity of the electric field, but no differences in seed head lengths. For velvet grass, the investigators noted that growth of seed heads was greater in the exposure zone than the control zone in the year before the test line was energised, indicating that the interpretation of differences in crop growth after energization needs to consider factors unrelated to electric field exposure. An additional crop, Ladino clover, was studied in this year and no differences were found in seed weights of the most exposed clover and the clover grown in control sites.

To address the possibility that the differences between exposure zones around the 1100 kV test line reflected subtle differences in their microclimate, the design of the crop studies was changed in 1981 so that crop plants at each field location were compared to plants at the same location, but which were totally shielded from the electric field by Faraday cages (Rogers et al., 1982). No differences between shielded and unshielded peas in any parameter within distance zones from the line were observed despite a four-fold increase in the number of samples collected over previous year, which increased the statistical power to detect an effect. Significant differences between the number of pods and seeds and weight of seeds between shielded pea plants in treatment and control areas were found. Since these differences cannot be due to differences in exposure to the electric field (the electric field is zero in both these shielded groups), the investigators suggested that the differences arose because of differences in the microclimate between the line zone and control zone locations.

In 1981, more barley straw was produced in exposed zones than the control zone as in previous years, which also was suspected to be due to differences in microclimates (Rogers et al., 1982). Barley seed head and straw production was greater in the exposed zone than in the control zone, a difference that was eliminated by shielding plants. The shielding itself, however, was suggested to have an effect, as the seed head and straw production of shielded barley plants in the control zone was greater than in unshielded plants. With respect to the pasture grass growth studies, differences in exposure to electric fields at 12kV/m, 2kV/m, and 1kV/m did not affect seed head length in 1981 or in any previous year. No consistent differences in leaf length or stem length in either grass species across exposure zones were apparent, but the stem lengths of bent grass shortened with distance from the line and associated lower electric fields. Shielded velvet grass in all three exposure zones had longer leaf lengths than unshielded grass, whereas a greater stem length of shielded bent grass over unshielded bent grass was observed.

The results of plant studies in 1982 prompted investigators to test the hypothesis that the shielding itself enhanced growth conditions and accounted for the differences described above in the 1982 studies. The studies conducted in 1983 were designed to test the hypothesis. Plots of velvet and bent grass were planted at nine locations at varying distances from the test line at which the measured electric field varied from 12kV/m closest to the line to 0.4kV/m furthest from the line. At each location the plots of plants were surrounded by grounded metal screens, identical simulated screens made of plastic, or no screens. The growth of stems or leaves of the grasses in the electrically shielded and simulated shielded plots were quite similar but the growth of grasses in both shielded plots was significantly greater than the growth observed in the unshielded plots. The authors concluded that the electric field did not influence the growth rate of the grasses but the shielding *per se* did enhance growth. No specific factor was identified that increased growth in the shielded plots, the authors suggested that the shielding created a micro-habitat that was more favorable to growth.

A field study from the University of Notre Dame in Indiana (Greene, 1983) reported on the growth of yellow onions for 5, 10, and 15 days in flats placed on the ground or on top of a 1 m-high wooden post at 6.1, 12.2, and 23m from the centerline of an experimental 765 kV test line. Electric fields of 15.5kV/m, 12.5kV/m, and 7.8kV/m, respectively, were measured at these locations. These electric field levels are far higher than those that could be encountered under 400 kV lines. Other flats of onions placed at 6.1 and 12.2m from the line were covered with a grounded Faraday cage that reduced the electric field to 0kV/m. Two flats of onions were placed 274m from the line where the electric field was measured to be <0.13kV/m. At the end of each of the three sampling periods, the root tips from three to four bulbs were removed, stained, and examined under a microscope to assess the percentage of dividing cells (mitotic index). The data were collected in three separate experiments. Although the authors found statistically significant differences between the mitotic indices of the nine exposure conditions, they did not report that the differences were related to the strength of the electric field. The authors also summarised the results of another investigator, K.S. Rai, who exposed onions to this same transmission line but "found no evidence of altered mitotic rate, change in present of chromosomal abnormalities, or percent of heteropycnotic nuclei" (p. 360).

Investigators from the University of Arkansas sampled 7 cotton fields, 12 rice fields, and 15 soybean fields crossed by a 500 kV transmission line (Parsch and Norman, 1986). The average dried weight of 60 cotton samples and 75-76 soybean and rice samples collected under the transmission line were compared to the average weights of the same number of samples collected 150 feet from the line. No significant differences were reported between the yields of rice and soybeans in the zones under and away from the line, but the yield of cotton was 15% lower in the zone under the line. The investigators indicated that the study could not determine if the EMF from the line or ineffective aerial spraying of chemicals might have explained the difference in cotton yields. Other factors to be considered included soil compaction by construction equipment when the line was installed, differences in microclimate as suggested in the (Warren et al., 1981) study, or sampling error. The latter is a factor because far fewer cotton fields and fewer samples in each cotton field were tested than for rice and soybeans. The methods and results were only briefly summarized in this publication.

A team of investigators from several Italian institutions published preliminary findings from a series of studies on several generations of wheat plants grown with exposure to electric fields of 5kV/m and 20kV/m near a 1000 kV experimental test line (Conti et al., 1989). No differences in indicators of plant development (stem length, number of nodes, number of stems, spike length, spikelets to spike ratio, or dry weight at four developmental stages), chlorophyll or germination capacity (seedling growth; enzymatic activity, and embryo protein, polyamine and RNA concentrations) were reported. The data and methods reported were not sufficient to permit a detailed evaluation.

The most recent field study was published by Austrian environmental and agricultural scientists in 2003 (Soja et al., 2003). Winter wheat and corn was planted at distances of 2, 8, 14, and 40m from a 380 kV transmission line at which average electric field strengths of 3.9, 2.2, 1.0, and 0.2kV/m and average magnetic field strengths of 4.5, 3.7, 2.6, and 0.8μT, respectively, were measured. The growth and yield of these crops between 1993 and 1997 in these four areas was recorded. Two layers of soil were removed in the test area and mixed to achieve a homogeneous soil matrix, which was confirmed by nutrient and elemental analysis, and the plants were planted within circular concrete rings.

No statistically significant differences between the grain or straw yields of winter wheat grown in the highest and lowest exposure zones were reported at the $p = 0.05$ criterion level. No trend was reported for parameters of corn yield or soil microbial biomass to vary with distance (and hence EMF strengths) from the line. *Post hoc* analyses of wheat productivity based on segregating years with dry and wet weather suggested "a minor trend towards lower grain yields nearer to the transmission line" in years of drought stress, but an opposite trend was apparent in the yield of corn in drought years with distance from the line. Given that the reported variation of yields was reported to be 11% with zones at the same distance from the transmission line and yield differences of 57% between drought and humid years, the authors cautiously concluded that "the results of 5 years of field experiments were combined, [and] no unequivocal relation between the high voltage transmission line and crop yield was demonstrated" (p. 100).

Experimental Studies

Seeds and plant shoots have been studied in laboratories *in vitro* as a model for cellular processes for many decades. More than 40 studies of this type were identified for this review in which the effects of 50-60Hz applied electric current, electric fields, or magnetic fields were investigated. Unfortunately, these studies do not provide information useful to assessing the potential effects of EMF on field crops because the nature and conditions of exposure are not directly relevant to agricultural conditions. For example, the application of strong electric currents directly to seeds or shoots does not replicate the exposure of plants in a field near a transmission line. Seeds and early shoots have limited exposure to electric fields from power lines whilst underground. Even 2.5 centimetres of earth will reduce the electric field by a factor of more than 100 for very dry soil and more than 6.5 million for wet soil. The earth does not shield seeds from the magnetic field, but the strengths of the magnetic fields applied in most all of these studies ranged from about 2- to 20,000-fold higher (with more studies at the higher end of this range) than EirGrid reports directly under a 400 kV transmission line. Nevertheless, although the results of these studies were not very consistent, increased germination and growth of exposed plants are reported in many of these studies.

Experimental studies more relevant to the assessment of EMF from transmission lines on plants are those undertaken in environmentally-controlled greenhouses or growth chambers. As opposed to *in vitro* studies, these studies assess the potential effects of EMF on the growth and development of plants, including commercial crop plants under conditions more similar to those encountered in agriculture.

Pilot studies at Hazelton Laboratories in the State of Virginia in the United States in 1970 explored the early response of corn, buckwheat, and sunflower seeds to combined electric fields and magnetic fields at both lower (10V/m; 100µT) and higher (20V/m; 200µT) levels at both 45Hz and 75Hz (Coate, 1975). No dose-related responses were reported on viability or growth of any of the three seed types, but lowered growth of sunflowers altogether under all exposure treatments was reported. Full follow up studies conducted in a laboratory at the Illinois Institute of Technology and in a greenhouse at the University of Chicago (Rosenthal, 1975) could not replicate the pilot study finding. Under their conditions, Rosenthal et al. reported no overall effects on germination and early sunflower growth, stem length, or chlorophyll content. The author concluded “we have not observed any sunflower trait which appears regularly and clearly affected by the electromagnetic environments imposed in these experiments” (p. 31).

A research program at Pennsylvania State University in the United States performed exploratory studies on 74 species of green plants including food, fiber, and feed crops, weeds, native plants, and several tree species (Bankoske et al., 1976; McKee et al., 1978). The main focus was field alfalfa, field corn, and red winter wheat. Plants were exposed to 60Hz electric fields up to 50kV/m or to control conditions (achieved by screening the plants from the electric field by a grounded-screen Faraday cage). The investigators reported no differences in the dry weights of plants from these groups (McKee et al., 1978) or any tissue damage, except when the applied electric field exceeded 20-25kV/m. The damage was limited to the sharp points or tips of the plants; damage was not noted on other parts of the plant and the plants were reported to continue to grow and flower normally. This observation is consistent with an earlier study by Murr (1963) who analyzed the damage to the tips of orchard grass grown under direct current (DC) electric fields of 40kV/m.

Subsequently, a larger, better-controlled, study was carried out by these investigators at Pennsylvania State University and described in detail (McKee, 1985). The study of five plant species was conducted over 2 years in a large greenhouse in which plants were exposed to uniform electric fields or to field-free conditions in two concurrent replications. The electric field, air temperature, relative humidity, carbon dioxide, and light were monitored. The exposure conditions are summarised in Table 1.

Table 1. Summary of intensity and duration of exposure of plant species to 60Hz electric field (McKee, 1985)

Plant Species	Electric Field (kV/m)		Duration of Exposure (days)
	Exposed Plants	Control Plants	
Alfalfa	30-32	0	74
Tall fescue	12-14	0	93
Sweet corn	30-43	0	91
Soft red winter wheat	30-35	0	112
Hard red spring wheat	10-13	0	112

The exposures of tall fescue and hard red spring wheat were lower than for the other crops to simulate exposures expected under a 765 kV transmission line.

Extensive measurements were made of plant growth and composition including:

- Seed germination
- Seedling growth and establishment
- Vegetative growth
- Reproductive growth
- Flowering
- Seed set
- Seed maturation
- Germination of seed produced on exposed plants
- Biomass production
- Nodulation and nitrogen fixation (alfalfa)
- Feed quality
- Forage content of 11 essential elements
- Leaf area
- Longevity

No statistically significant differences in any of the above measures were reported indicating neither an adverse nor a beneficial effect of exposure to electric fields. Minor but statistically significant differences in plant height were observed in crops grown in different parts of the greenhouse, but neither exposed plants nor control plants were favored. A consistent observation, however, was that plants in electric fields above 30kV/m incurred limited damage (< 2 millimetres) only to the sharp tips of leaves, awns, etc. (<1% of leaf tissue), particularly in sweet corn and soft red winter wheat. The tips of tall fescue and hard red spring wheat of average height were not affected, but the few tallest plants, which experienced higher electric fields, approaching 20-25kV/m, did show discoloration and effects indicative of higher field exposure as reported by McKee et al. (1978).

Smith et al. (1993) reported preliminary experiments in which they exposed radish seeds to AC or AC and DC magnetic fields in four groups and recorded the time to germination. After 21 days the plant height, weight of the root and upper plant, stem diameter, leaf length, and width were measured and the ratio length/width was computed. One group was exposed to a 40μT, 60Hz magnetic field and a 0Hz DC geomagnetic field; a second group was exposed to a 40μT 60Hz magnetic field and a DC magnetic field of 78.3μT along the x-axis; the third group was exposed to a 40μT 60Hz magnetic field and a DC magnetic field of 153.3μT along the x-axis; and the fourth group was an unexposed control group. The authors reported that measured aspects of plants exposed to the AC magnetic field alone did not differ from control plants except for a 25% increase in root weight of the seeds exposed to the AC magnetic field alone. Delays in germination and increased plant height, weight, stem diameter, root weight and leaf length were reported for plants exposed to AC magnetic fields + a 78.3μT DC field, whereas generally opposite or no effects were reported for these parameters except root weight when the DC magnetic field was increased to 153.3μT.[4] The purpose of the study was to test the hypothesis that AC magnetic fields produced biological effects only when aligned with DC magnetic fields of certain intensities. While the authors expressed the opinion that the results were consistent with their hypothesis, they state "[t]hese preliminary studies do not reveal what is responsible for the effects seen" (p. 74). The intensities of the DC magnetic field tested are considerably higher than the ambient DC geomagnetic field in Ireland, which is ~ 49μT.

Subsequently, Davies (1996) compared radish, mustard, and barley seeds exposed to control conditions or to one of the AC-DC field combinations (40μT 60Hz magnetic field + 78.3μT DC field) applied by Smith et al. The measurements of the mustard and barley plants in control and exposed groups did not differ. Differences were reported in three experiments for radish plants with increased dry stem weight and plant height in exposed plants with other parameters less consistently affected, which Davies interpreted as a partial replication of the Smith et al. study. Parkinson (1997) criticised the Davies study for its poor control over experimental variation and

[4] A study of *in vitro* exposures of barley seeds exposed for 5 days has reported that a 0.5μT, 50Hz magnetic field applied in parallel to a DC magnetic field at 65.8μT caused less water loss and shorter shoot lengths compared to control conditions. When combined with DC magnetic fields of 55, 60, 70, and 76μT, however, the 50Hz magnetic field had no significant effect on shoot growth or formation of photosynthetic pigments. While this finding would appear to support the Smith et al. hypothesis, it has not been replicated and has no practical significance with regard to predicting effects of 50Hz magnetic fields on plants in Ireland where the DC magnetic field is ~49μT.

aspects of the statistical analyses to which Davies replied (Davies, 1997), but his arguments are not convincing. Potts et al. (1997) also repeated the Smith et al. study under the conditions Smith et al. reported, but these investigators were unable to confirm any effect of combined AC and DC magnetic fields (40μT 60Hz magnetic field and a DC magnetic field of 78.3μT) on 15 developmental parameters that they measured to characterise the growth of radish seedlings.

A study of strawberry plants raised in a greenhouse at Atatürk University in Turkey reported that plants exposed to 50Hz magnetic fields at 96mT showed an 18% increase in the strawberry yield per plant, had no effect at a 192 mT exposure level, and decreased strawberry yield by 3% with exposure to 384mT (Eşitken and Turan, 2004). Average fruit weight increased very slightly in plants exposed to 96mT, 192 mT, and 384mT relative to the control groups. In addition, small increases and decreases in 11 chemical components of the strawberries were reported across the exposure conditions. The authors stated that their study suggests the application of magnetic fields had benefits on strawberry yield and some components of the strawberries' nutrition. The practical relevance of these findings, however, is unclear as the lowest applied magnetic field was almost 20,000-fold higher than the magnetic field that could be experienced under a 400 kV transmission line.

Summary and Conclusions

A large scientific literature has accumulated since the 1970s investigating potential environmental and health effects of ELF EMF. Most of the scientific research has focused on human health effects. As part of human health risk assessments, the relevant scientific literature has been repeatedly and systematically reviewed by a number of international and national health, scientific, and government agencies. Perhaps most notably, based on its comprehensive review of the relevant research results, the WHO concluded that the available evidence does not confirm the existence of any health consequences from exposure to ELF EMF (WHO, 2007). Known adverse effects, such as nerve and muscle stimulation, which are temporary and reversible, may occur at high exposure levels, at levels much higher than that could be experienced even directly under 400 kV transmission lines. Current relevant exposure guidelines applicable in Ireland are stated by the WHO to provide adequate protection for all known effects. Although these guidelines are intended to protect humans against potential adverse effects, **there is no evidence to suggest that this protection would not apply to farm animals.**

Economic considerations have led to a considerable amount of scientific research, although less systematic in nature, on the potential effects of ELF EMF on livestock and crops. The research studies on livestock tended to focus on species with sizable economic impact, such as cattle, sheep, and swine, and concentrated on outcomes of reproduction, milk production, and growth. ELF EMF research related to plants was even less consistent. Although sporadic associations with various measures from some of the studies on animals and plants were reported, overall, no consistent or convincing pattern of any harmful effects of ELF EMF has emerged in either livestock or crops that would have relevance to farm operations around 400 kV transmission lines in Ireland or even transmission lines operating at some higher voltages elsewhere.

While electric fields potentially may result in perception by animals under 400 kV transmission lines, research does not indicate that exposure to electric fields results in adverse effects in animal health, productivity, or reproduction. Magnetic-field levels that could be encountered around 400 kV transmission lines have no consistently demonstrated adverse effects, even if dosimetric differences due to anatomical and size differences are considered between farm animals, humans, and laboratory animal species, such as rodents.

Among farm animals, cattle have been the most investigated species in the ELF EMF literature. Farm surveys and field observation of grazing cattle conducted mostly in the United States and Sweden reported no consistent differences in behaviour or productivity between farms intersected by high-voltage transmission lines (ranging between 380 kV and 765 kV) and farms away from transmission lines. Following a suggestion that cattle may tend to naturally orient themselves in the north-south direction, which orientation may be affected by power lines, several studies, mostly examining low-quality satellite imagery, investigated cattle orientation and reported inconsistent results. A series of well-designed experiments in Québec examined various behavioural, reproductive, and productivity parameter in dairy cattle in response to exposure to electric fields (up to 10kV/m) and magnetic fields (up to 30μT) separately and in combination. While some of the studies reported small differences (a few percentages) in some of the parameters investigated (e.g., feed intake, length of oestrus cycle), all of these differences appeared to be within physiological ranges and showed no consistent pattern. There were no consistent differences in various measures of milk yield (e.g., fat corrected milk yield, fat yield, protein yield), hormone concentrations (e.g., melatonin, prolactin, thyroxine), or neurotransmitter concentrations in the cerebrospinal fluid.

Several experimental studies of sheep have investigated immunological parameters (IL-1 and IL-2 concentrations) and hormone concentrations (melatonin, cortisol) in animals housed under a 500 kV transmission line, and reported no consistent differences when comparisons were made to sheep housed away from the high-voltage lines. No differences were reported in tumour development in sheep in a study, which compared animals housed under a 345 kV line to animals housed away from the line.

A study of potential effects of a 345 kV line in swine reported no statistically significant results in behaviour, productivity (e.g., backfat thickness, carcass quality) or effects in the offspring between exposed and unexposed animals. Avoidance of very high electric fields (30kV/m) was reported in miniature swine. These electric fields, however, are significantly higher than fields that could be encountered under a 400 kV or even a 765 kV transmission line. A multi-generation study of miniature swine showed inconsistent results when examining developmental effects due to 30kV/m electric fields.

While a farm survey that included horses reported no impact on them, horses were not a subject of experimental studies of EMF. Growth, fertility, and behaviour of chickens were investigated in a small number of studies, but no consistent effects of ELF EMF were reported.

There is a long history of agricultural experimentation to assess the effects of electricity or EMF on crops. Field studies of crop responses to 1100 kV test lines that produce electric fields far greater than 400 kV and lower transmission lines and field studies of operating 380 kV and 500 kV transmission lines that produce both electric and magnetic fields were reviewed. These studies included field observations of peas, barley, alfalfa, grasses, corn, and wheat over multiple years, and single-year field studies of onions, rice, soybeans, and cotton. Comparisons of exposed and unexposed crops in these studies did not indicate that EMF exposures caused adverse or beneficial effects on crop growth or yield. A variety of other potential environmental factors including weather, microclimate, and soils were identified as the source of sporadic differences between crop plants located under or around test and transmission lines. In the one study where a reduction in cotton yield of plants under a 500 kV line during one season was observed, the cause was not determined. A 5-year study of crops around a 380 kV transmission line, where the highest field levels were 3.9kV/m and 4.5µT, did not report impaired crop performance. Hence, field studies do not report that EMF at levels associated with 400 kV transmission lines harm crop plants of any species studied.

Most experimental *in vitro* studies of EMF effects on crop seeds and shoots in the laboratory involved exposures and conditions that have little or no relevance to exposures that crops experience near transmission lines. This lack of relevance derives from the type of exposure applied and the often astonishingly high fields applied. In contrast, the few research studies that exposed alfalfa, field corn, winter wheat, and spring wheat to electric fields in greenhouses, however, did study more relevant exposures at levels closer to those produced by transmission lines, albeit those operating at 765 kV and 1100 kV. In addition, the greenhouse environment allows for better control of potentially confounding factors, and so provides better models from which to predict effects in the agricultural environment. These studies did not report adverse effects of high electric field exposures on these crops except for damage to the sharp tips of leaves of some crops for exposures to electric fields generally above 20-25kV/m. Several laboratory studies examined the effects of 50 or 60Hz magnetic fields on plant growth. No effects on corn, buckwheat, or sunflowers could be confirmed at 100 and 200μT. No effects of 40μT 60Hz magnetic fields on mustard or barley seed growth were observed. Two laboratories attempted to replicate a single report of increased growth of radish seeds, but the results were mixed; a partial replication claimed by one laboratory and a total failure to replicate by the other. These latter laboratory studies, which concern specific intensities and orientation of the DC magnetic field to ELF fields, are of scientific interest but do not have any direct relevance to the assessment of potential effects of EMF from transmission lines on crop performance or health.

Together this review of field and experimental studies of crops exposed to electric fields, magnetic fields, or both does not provide any reliable evidence for effects that would be harmful to crop yield or production, even for test lines operating at voltages up to 1100 kV. The levels of electric fields associated with transmission lines at voltages up to 400 kV have not been reported to produce even minor damage to plants.

In conclusion, the available scientific evidence summarised in the current report does not provide consistent or convincing evidence that either electric or magnetic fields associated with the Irish electric transmission system may adversely affect the livestock or crops produced on Irish farmlands.

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Limitations

At the request of EirGrid plc, Exponent summarised research on the potential effects of electric and magnetic fields on livestock and crops. This report summarises work performed to date and presents the findings resulting from that work. In the analysis, we have relied on published scientific research and agency reports. The findings presented herein are made to a reasonable degree of engineering and scientific certainty. Exponent reserves the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available, through any additional work, or review of additional work performed by others.

The scope of services performed during this investigation may not adequately address the needs of others than the intended users of this report, and any re-use of this report or its findings, conclusions, or recommendations presented herein for other purposes is at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation. No guarantee or warranty as to future life or performance of any reviewed condition is expressed or implied.

Notes

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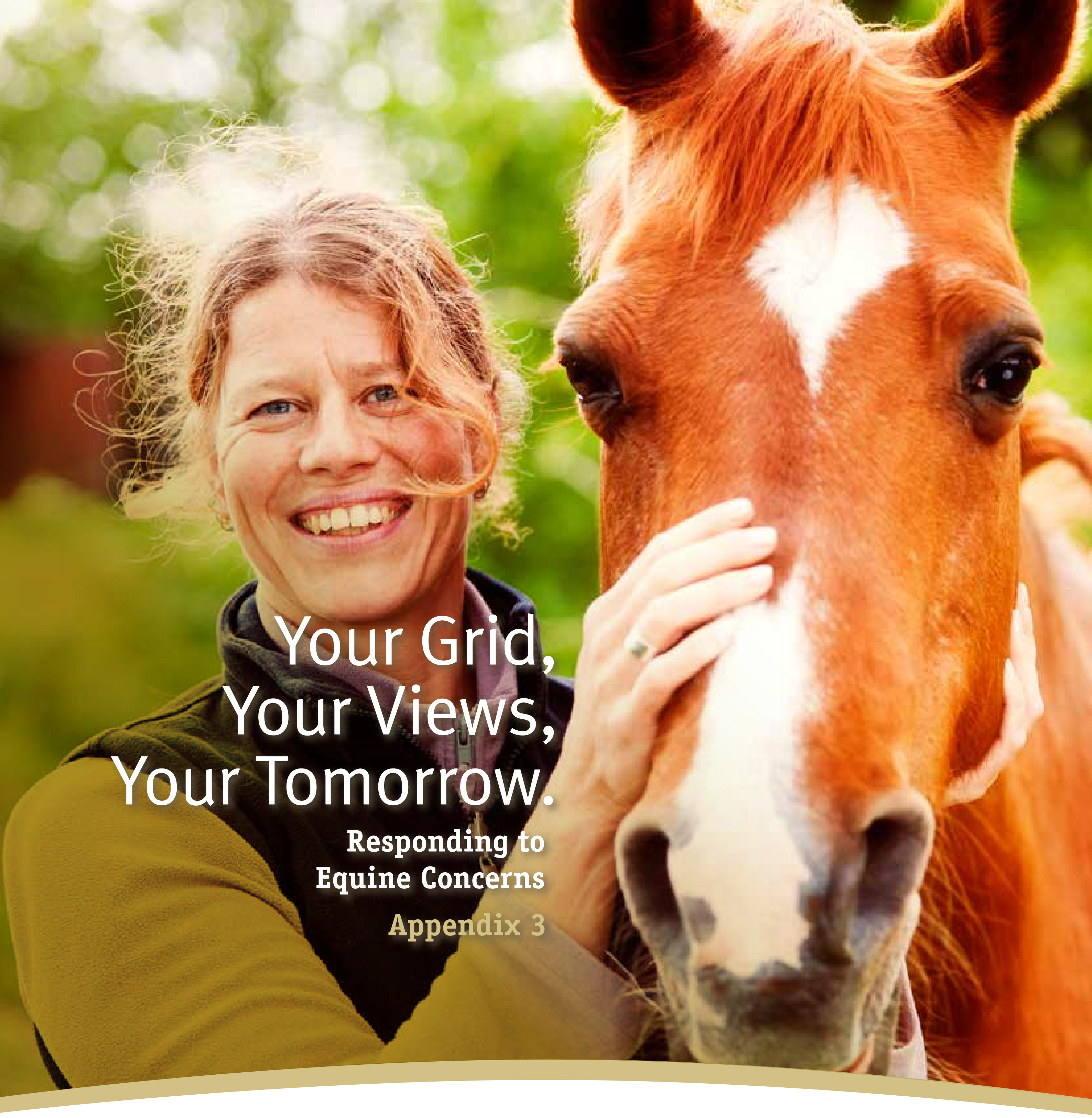
EIRGRID



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Responding to Equine Concerns

Appendix 3

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Appendix 3

Equine Psychology and Behaviour

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Introduction

This report has been commissioned by EirGrid. The report was prepared to inform and assist EirGrid in responding to the concerns raised by the equine sector during public consultations on major electricity transmission projects. The report is based on an independent review of literature and professional expertise. The report provides information relating to Equine Psychology and Behaviour.

Social Organisation

Horses are social herd animals that follow a leader and conform to a dominance hierarchy. For their own safety they choose to be part of a group. A horse is a grazing animal, never the predator and always the prey. In order to escape predators, horses have evolved an extreme sensitivity to any perceived threats in their immediate environment and when alarmed, they either prepare to fight or use speed to try and escape - the "fight and flight mechanism".

In the wild, herds of feral horses are usually made up of several separate small bands that share a territory. A band (or harem) of horses is an organised social group normally containing a dominant stallion, mares and juveniles. A dominant stallion, usually 6 years old or older will be in the company of a group of mares (usually between 4-7) 24 hours a day, 365 days a year. He sires the offspring and these foals are with the band for a minimum a year and most usually two years. (1)

Occasionally a two or three year old will still be with the band, but generally the stallion will discourage a young male who is coming of age from consorting with the band. Colts driven out from several herds usually join together in small bachelor groups until those who are able establish dominance over an older stallion in another herd. Young females may be driven off by their mothers, or they simply may choose to leave when they reach puberty. They may select or be selected by another stallion who will breed with them and guard them vigilantly from rivals. By encouraging their offspring to leave the band, wild horses avoid inbreeding. (2)

Hierarchical Matrix

Horses have evolved to live in herds. As with many animals that live in large groups, establishment of a stable hierarchical system or pecking order is important to reduce aggression and increase group cohesion. This is often, but not always, a linear system. In non-linear hierarchies horse A may be dominant over horse B who is dominant over horse C, yet horse C may be dominant over horse A. Dominance can depend on a variety of factors, including an individual's need for a particular resource at a given time. It can therefore be variable throughout the lifetime of the herd or individual animal. Some horses may be dominant over all resources and others may be submissive for all resources. Once a dominance hierarchy is established, horses more often than not will travel in rank order. (3)

Aggressive interactions risk causing injury. Therefore, once the dominance hierarchy is established, aggressive behaviour is reduced between herd members. Higher-ranked animals often will assume a role of exercising control and moderating aggressive behaviour in the herd.

The centre of the herd offers the most protection from the elements and is further away from predators than the periphery. Because of this, punishment of misbehaving members is sometimes delivered in the form of temporary expulsion from the herd, or sometimes permanently.

Rejection teaches a horse to be submissive and dependent upon the leaders for survival and food. This complex social dynamic holds the wild horse bands together and each individual knows his or her place in the order. Rules of band behaviour are carefully followed and punishment is swift.

Role of Dominant Mare

Every herd has leaders, followers and a well defined pecking order known as a dominance hierarchy. The Alpha Horse is the dominant leader in a band. Horses instinctively seek leadership. The Alpha Horse provides leadership and security in a band. It is quite common for the Alpha Horse to be a mature mare, familiar with the territory and food resources. The members of the band are submissive to the Alpha Horse when it's time to eat or drink. (4)

Role of Stallion

Stallions tend to stay on the periphery of the herd where they fight off both predators and other males. When the herd travels, the stallion is usually at the rear and drives straggling herd members forward, keeping the herd together. Mares and lower-ranked males do not usually engage in this herding behaviour. (4) During the mating season, stallions tend to act more aggressively to keep the mares within the herd, however, most of the time, the stallion is relaxed and spends much of his time "guarding" the herd by scent-marking manure piles and urination spots to communicate his dominance as herd stallion. (5)

Communication

Horses communicate in various ways, including vocalizations such as nickering, squealing or whinnying; touch, through mutual grooming or nuzzling; smell; and body language. Horses use a combination of ear position, neck and head height, movement, and foot stomping or tail swishing to communicate. Discipline is maintained in a horse herd first through body language and gestures, then, if needed, through physical contact such as biting, kicking, nudging, or other means of forcing a misbehaving herd member to move. In most cases, the animal that successfully causes another to move is dominant, whether it uses only body language or adds physical reinforcement.

Horses can interpret the body language of other creatures, including humans, whom they view as predators. If socialized to human contact, horses usually respond to humans as a non-threatening predator. Humans do not always understand this, however, and may behave in a way, particularly if using aggressive discipline, that resembles an attacking predator and triggers the horse's fight-or- flight response. On the other hand, some humans exhibit fear of a horse, and a horse may interpret this behaviour as human submission to the authority of the horse, placing the human in a subordinate role in the horse's mind.

This may lead the horse to behave in a more dominant and aggressive fashion. Human handlers are more successful if they learn to properly interpret a horse's body language and temper their own responses accordingly. Some methods of horse training explicitly instruct horse handlers to behave in ways that the horse will interpret as the behaviour of a trusted leader in a herd and thus more willingly comply with commands from a human handler. Other methods encourage operant conditioning to teach the horse to respond in a desired way to human body language, but also teach handlers to recognize the meaning of horse body language.

Horses are not particularly vocal, but do have four basic vocalizations: the neigh or whinny, the nicker, the squeal and the snort. They may also make sighing, grunting or groaning noises at times.

Ear position is often one of the most obvious behaviours that humans notice when interpreting horse body language. In general, a horse will direct the pinna of an ear toward the source of input it is also looking at. Horses have a narrow range of binocular vision, and thus a horse with both ears forward is generally concentrating on something in front of it. Similarly, when a horse turns both ears forward, the degree of tension in the horse's pinna suggests if the animal is calmly attentive to its surroundings or tensely observing a potential danger. However, because horses have strong monocular vision, it is possible for a horse to position one ear forward and one ear back, indicative of similar divided visual attention. This behaviour is often observed in horses while working with humans, where they need to simultaneously focus attention on both their handler and their surroundings. A horse may turn the pinna back when also seeing something coming up behind it.

Due to the nature of a horse's vision, head position may indicate where the animal is focusing attention. To focus on a distant object, a horse will raise its head. To focus on an object close by, and especially on the ground, the horse will lower its nose and carry its head in a near-vertical position. Fear or anger is often indicated when the eyes are rolled to the point that the white of the eyes are visible.

Ear position, head height, and body language may change to reflect emotional status as well. For example, the clearest signal a horse sends is when both ears are flattened tightly back against the head, sometimes with eyes rolled so that the white of the eye shows, often indicative of pain or anger, frequently foreshadowing aggressive behaviour that will soon follow. Sometimes ears laid back, especially when accompanied by a strongly swishing tail or stomping or pawing with the feet are signals used by the horse to express discomfort, irritation, impatience, or anxiety. However, horses with ears slightly turned back but in a loose position, may be drowsing, bored, fatigued, or simply relaxed. When a horse raises its head and neck, the animal is alert and often tense. A lowered head and neck may be a sign of relaxation, but depending on other behaviours may also indicate fatigue or illness.

Tail motion may also be a form of communication. Slight tail swishing is often a tool to dislodge biting insects or other skin irritants. However, aggressive tail-swishing may indicate either irritation, pain or anger. The tail tucked tightly against the body may indicate discomfort due to cold or, in some cases, pain. The horse may demonstrate tension or excitement by raising its tail, but also by flaring its nostrils, snorting, and intently focusing its eyes and ears on the source of concern.

The horse does not use its mouth to communicate to the degree that it uses its ears and tail, but a few mouth gestures have meaning beyond that of eating, grooming, or biting at an irritation. Bared teeth, as noted above, are an expression of anger and an imminent attempt to bite. Horses, particularly foals, sometimes indicate appeasement of a more aggressive herd member by extending their necks and clacking their teeth. Horses making a chewing motion with no food in the mouth do so as a soothing mechanism, possibly linked to a release of tension, though some horse trainers view it as an expression of submission. Horses will sometimes extend their upper lip when scratched in a particularly good spot, and if their mouth touches something at the time, their lip and teeth may move in a mutual grooming gesture. A very relaxed or sleeping horse may have a loose lower lip and chin that may extend further out than the upper lip. The curled lip flehmen response, noted above, most often is seen in stallions, but is usually a response to the smell of another horse's urine, and may be exhibited by horses of any sex. Horses also have assorted mouth motions that are a response to a bit or the rider's hands, some indicating relaxation and acceptance, others indicating tension or resistance.

Sleep Patterns

Horses are able to sleep both standing up and lying down. They are able to doze and enter light sleep while standing, an adaptation from life as a prey animal in the wild. Lying down makes an animal more vulnerable to predators. Horses are able to sleep standing up because a stay apparatus in their limbs allows them to relax their muscles and doze without collapsing. In the front limbs, their equine forelimb anatomy automatically engages the stay apparatus when their muscles relax. The horse engages the stay apparatus in the hind limbs by shifting its hip position to lock the patella in place. At the stifle joint, a hook structure situated on the inside bottom end of the femur cups the patella and the medial patella ligament, preventing the leg from bending. (8)

Horses do not need a solid, unbroken period of sleep time. They obtain needed sleep by means of many short periods of rest. This is to be expected of a prey animal, one that needs to be ready on a moment's notice to flee from predators. Horses may spend anywhere from four to fifteen hours a day in standing rest, and from a few minutes to several hours lying down. However, not all this time is the horse actually asleep; total sleep time in a day may range from several minutes to a couple of hours. Horses require approximately two and a half hours of sleep, on average, in a 24-hour period. Most of this sleep occurs in many short intervals of about 15 minutes each.

Horses must lie down to reach REM sleep. They only have to lie down for an hour or two every few days to meet their minimum REM sleep requirements. However, if a horse is never allowed to lie down, after several days it will become sleep-deprived, and in rare cases may suddenly collapse as it involuntarily slips into REM sleep while still standing.(8) This condition differs from narcolepsy, though horses may also suffer from that disorder.

Horses sleep better when in groups because some animals will sleep while others stand guard to watch for predators. A horse kept entirely alone may not sleep well because its instincts are to keep a constant eye out for danger.

Fight and Flight

Horses evolved from small mammals whose survival depended on their ability to flee from predators. This survival mechanism still exists in the modern domestic horse. Humans have removed many predators from the life of the domestic horse. However, its first instinct when frightened is to escape. If running is not possible, the horse resorts to biting, kicking, striking or rearing to protect itself. Many of the horse's natural behaviour patterns, such as herd-formation and social facilitation of activities, are directly related to the fact that they are a prey species.

The fight-or-flight response involves nervous impulses which result in hormone secretions into the bloodstream. When a horse reacts to a threat, it may initially "freeze" in preparation to take flight. The fight-or-flight reaction begins in the amygdala which triggers a neural response in the hypothalamus. The initial reaction is followed by activation of the pituitary gland and secretion of the hormone Adreno-Cortico Trophic Hormone (ACTH).The adrenal gland is activated almost simultaneously by this hormone and releases the neurotransmitters epinephrine (adrenaline) and norepinephrine (noradrenaline). [(6)] The release of chemical messengers results in the production of the hormone cortisol, which increases blood pressure, blood sugar, and suppresses the immune system. [(7)]

Catecholamine hormones, such as epinephrine and norepinephrine, facilitate immediate physical reactions associated with a preparation for violent muscular action. The result is a rapid rise in blood pressure, resulting in an increased supply of oxygen and glucose for energy to the brain and skeletal muscles, the most vital organs the horse needs when fleeing from a perceived threat.

However, the increased supply of oxygen and glucose to these areas is at the expense of "non- essential" flight organs, such as the skin and abdominal organs. [(6)]

Once the horse has removed itself from immediate danger, the body then returns to more 'normal' conditions by the parasympathetic nervous system. This is triggered by the release of endorphins into the brain, and it effectively reverses the effects of noradrenaline - metabolic rate, blood pressure and heart rate all decrease and the increased oxygen and glucose being supplied to the muscles and brain are returned to normal. [(13)] It is also a recognised fact that horses will adapt and familiarise themselves to repeated aural and visual stimuli, initially perceived as a threat, providing they are not directly affected. Thus, horses will happily graze beside airports, motorways, etc., once they have become accustomed to the aural and visual stimuli.

Eating Behaviour

Horses are herbivores with a strong grazing instinct, preferring to spend most hours of the day eating forage. Horses and other Equids evolved as grazing animals, adapted to eating small amounts of the same kind of food all day long. In the wild, the horse adapted to eating prairie grasses in semi-arid regions and traveling significant distances each day in order to obtain adequate nutrition. Thus, they are trickle eaters, meaning they have to have an almost constant supply of food to keep their digestive system working properly.

Horses can become anxious or stressed if there are long periods of time between meals. When stabled, they do best when they are fed on a regular schedule; they are creatures of habit and easily upset by changes in routine. When horses are in a herd, their behaviour is hierarchical; the higher-ranked animals in the herd eat and drink first. Low-status animals, who eat last, may not get enough food, and if there is little available feed, higher-ranking horses may keep lower-ranking ones from eating at all. (10)

Horses and Man

Horses are creatures of habit and have excellent long-term memory, which makes consistent training extremely important to the horse. Humans are normally viewed by wild horses as potential predators. However, horses are also innately curious and may investigate any creature that is interesting but not threatening.

Any domesticated horse with some experience of humans usually views people as generally harmless objects of curiosity worth at least minor notice, especially if they know that humans may bring food or treats. Rarely will any domestic horse become truly vicious unless it has been spoiled or abused by humans, though many stallions have a great deal of naturally aggressive, dominant behaviour that requires that they be managed only by knowledgeable handlers. However, any horse is a large animal that retains some wild instincts, so can react unpredictably by running, biting, striking, or kicking. Thus humans must always be alert around horses because they can accidentally harm people.

The ability of humans to work in cooperation with the horse is based on both the natural curiosity of the horse and the strong social bonds that horses have with each other. Horses do not like to be separated from their herd, because to be alone is to be exposed to predators on all sides. Also, in a herd, less dominant horses tend to gravitate toward the most mature and confident members. Therefore, many horse-training principles are based upon having the horse accept a human as the dominant herd member. Ideally this is not done by force, but by the horse developing trust in the ability of the human and confidence that the human will be a responsible herd leader. (8)

Horses are also adapted to covering large amounts of territory and must have a certain boldness to do so. A horse that is afraid more than necessary will expend energy needlessly and then may not be able to escape when a threat is real. Thus, horses have an ability to check out the unusual and not immediately flee from something that is merely different.

This willingness to consider new things can also be used by a human trainer to adapt the horse's behaviour to an extraordinary range of activities that are well outside the range of instinctive horse behaviour, including acts considered naturally dangerous by the average horse such as bullfighting, jumping off cliffs, diving into water, jumping through a ring of fire, or walking into an airplane and tolerating take off, flight, and landing, race meeting, indoor arenas with large excited crowds complete with enclosed space, bright lights, and tremendous noise and police work in crowd control.

People who train horses first have to educate them that some normal herd behaviour is inappropriate around humans. For example, biting and shadow boxing (rearing, striking) that is common play among young horses, colts in particular, could be injurious or fatal to people. Other instinctive traits, such as running away when frightened, bucking off anything that lands on a horse's back (like a mountain lion or other predator), or never entering a small and enclosed area, also have to be overcome before the horse is useful to humans.

Even when trained, most horses will still test boundaries, at least mildly, and some horses with dominant personalities will openly challenge a weak or inexperienced handler. For example, if handled with incompetence or abuse, a horse may ignore its training and attempt to nip, bite, kick, refuse to be led, or try other ways to challenge human dominance. Without consistent handling, some horses, especially young ones, will revert to their untrained ways. However, due to their good memory, horses with solid training from trustworthy handlers often retain what they have learned, even after a gap of many years.

Horse Breaking

Horse training refers to a variety of practices that teach horses to perform certain behaviours when asked to do so by humans. Horses are trained to be manageable by humans for everyday care as well as for equestrian activities from horse racing to therapeutic horseback riding for people with disabilities.

Historically, horses were trained for warfare, farm work, sport and transport. Today, most horse training is geared toward making horses useful for a variety of recreational and sporting equestrian pursuits. Horses are also trained for specialized jobs from movie stunt work to police and crowd control activities, circus entertainment, and equine-assisted psychotherapy.

There is tremendous controversy over various methods of horse training and even some of the words used to describe these methods. Some techniques are considered cruel, other methods are considered gentler and more humane. However, it is beyond the scope of this report to go into the details of various training methodology, so general, basic principles are described below.

The range of training techniques and training goals is large, but basic animal training concepts apply to all forms of horse training. The initial goal of most types of training is to create a horse that is safe for humans to handle and able to perform a useful task for the benefit of humans

A few specific considerations and some basic knowledge of horse behaviour helps a horse trainer be effective no matter what school or discipline is chosen:

- Safety is paramount: Horses are much larger and stronger than humans, so must be taught behaviour that will not injure people.
- Horses, like other animals, differ in brain structure from humans and thus do not have the same type of thinking and reasoning ability as human beings. Thus, the human has the responsibility to think about how to use the psychology of the horse to lead the animal into an understanding of the goals of the human trainer.
- Horses are social herd animals and, when properly handled, can learn to follow and respect a human leader.

- Horses, as prey animals, have an inborn fight or flight instinct that has to be adapted to human needs. Horses need to be taught to rely upon humans to determine when fear or flight is an appropriate response to new stimuli and not to react by instinct alone.
- Like most animals, a young horse will more easily adapt to human expectations than an older one, so human handling of the horse from a very early age is generally advised.

Breaking Process

Regardless of the goal of training, most horses go through a predictable series of steps on their way to being broken in for a given discipline.

Training of foals and younger horses

Most young domesticated horses are handled at birth or within the first few days of life, though some are only handled for the first time when they are weaned from their mothers. Advocates of handling foals from birth sometimes use the concept of imprinting to introduce a foal within its first few days and weeks of life to many of the activities they will see throughout their lives. Within a few hours of birth, a foal being imprinted will have a human touch it all over, pick up its feet, and introduce it to human touch and voice. (11)

Others may leave a foal alone for its first few hours or days, arguing that it is more important to allow the foal to bond with its dam. However, even people who do not advocate imprinting often still place value on handling a foal a great deal while it is still nursing and too small to easily overpower a human. By doing so, the foal ideally will learn that humans will not harm it, but also that humans must be respected.

While a foal is far too young to be ridden, it is still able to learn skills it will need later in life. By the end of a foal's first year, it should be halter-broken, meaning that it allows a halter placed upon its head and has been taught to be led by a human at a walk and trot, to stop on command and to stand tied. (12)

The young horse needs to be calm for basic grooming, as well as veterinary care such as vaccinations and de-worming. A foal needs regular hoof care and can be taught to stand while having its feet picked up and trimmed by a farrier. Ideally a young horse should learn all the basic skills it will need throughout its life, including: being caught from a field, loaded into a horse trailer, and not to fear flapping or noisy objects. It also can be exposed to the noise and commotion of ordinary human activity, including seeing motor vehicles, hearing radios, and so on. More advanced skills sometimes taught in the first year include learning to accept blankets placed on it, to be trimmed with electric clippers, and to be given a bath with water from a hose. The foal may learn basic voice commands for starting and stopping, and sometimes will learn to square its feet up for showing in in-hand or conformation classes. If these tasks are completed, the young horse will have no fear of things placed on its back, around its belly or in its mouth. (11)

Some people, whether through philosophy or simply due to being pressed for time, do not handle foals significantly while they are still nursing, but wait until the foal is weaned from its dam to begin halter breaking and the other tasks of training a horse in its first year. The argument for handling and halter-breaking at weaning is that the young horse, in crisis from being separated from its dam, will more readily bond with a human at weaning than at a later point in its life. Sometimes the tasks of basic gentling are not completed within the first year but continue when the horse is a yearling. Yearlings are larger and more unpredictable than weanlings, plus often are easily distracted, in part due to the first signs of sexual maturity. However, they also are still highly impressionable, and though very quick and agile, are not at their full adult strength.

Rarer, but not uncommon even in the modern world, is the practice of leaving young horses completely unhandled until they are old enough to be ridden, usually between the age of two and four, and completing all ground training as well as training for riding at the same time. However, waiting until a horse is full grown to begin training is often far riskier for humans and requires considerably more skill to avoid injury.

Ground Work

After a young horse is taught to lead and other basic skills, various tasks can be introduced to the horse as it matures while it is still too young to be ridden. Some schools of training do a great deal of work with young horses during their yearling and two-year-old years to prepare them for riding, others merely reinforce the basic lessons taught to the horse as a foal and simply keep the horse accustomed to the presence of humans. Many times, a young horse did not have all necessary basic skills described above taught to it as a foal and its next two years are spent learning or re-learning basic lessons.

Several ground training techniques are commonly introduced to a young horse some time after it is a year old, but prior to being ridden. All horses usually have some or all of this ground work done prior to being ridden, though the time spent can range from hours to months. While a foal or yearling can be introduced to a small amount of ground work, a young horse's bones and joints are quite soft and fragile. So, to prevent joint and cartilage injury, intense work, particularly intense work in a confined circle (lungeing), should wait until the horse is at least two years old. Common ground training techniques include:

- Free work - The process of working a loose horse in a small area (usually a round pen 15–20 meters in diameter) with the handler holding only a long whip or a rope lariat, teaching the horse to respond to the voice and body language of the handler as he or she asks the horse to move faster or slower, to change direction, and to stop.
- Lungeing - The training of a young horse to move in circles at the end of a long rope or line, usually about 25 to 30 feet long.
- Desensitisation - The process of introducing a horse to flapping objects such as blankets, teaching the horse to allow itself to be touched by an object and not to fear things that people move about a horse.
- Tacking-Up - Introduction to a saddle and bridle or harness, without actually getting on the horse or hooking up a cart.

- Long-reining - Teaching a young horse to move forward with a person walking behind it, a precursor to both harness driving and having reins used by a mounted rider.
- Bitting - The process of accustoming a horse to a bit and bridle, sometimes with the addition of side reins that attach to a saddle, harness, or surcingle (a wide leather or nylon band that goes around the horse's barrel) and accustom the horse to the feel of pressure on the bit.

A horse is not ready to be ridden until it is accustomed to all the equipment that it needs to wear and is responsive to basic voice, and usually rein, commands to start, stop, turn and change gaits.

For some disciplines, ground work is also used to develop specific types of muscling as well as to instil certain behaviours. When ground work incorporates both mental and muscular development, it may take considerably longer for the horse to be ready to be ridden, but advocates of these methods maintain that the additional time on the ground allows the horse to advance more quickly or with better manners once under saddle. (13)

Riding (Backing) the Young Horse

The age that horses are first ridden, or "backed" varies considerably by breed and discipline. Many Thoroughbred race horses have small, light riders on their backs as early as the autumn of their yearling year. Most horses used in harness have a cart first put behind them at age two, and even some horses not ridden until age three will be trained to pull a light cart at two, in order to learn better discipline and to help develop stronger muscles with less stress. The vast majority of horses across disciplines and throughout the world are first put under saddle at the age of three. However, some slower-maturing breeds, such as Warmbloods, are not ridden until the age of four. (12)

The act of getting on a horse for the first time goes by many names, including backing, breaking, mounting, and simply riding. There are many techniques for introducing the young horse to a rider or to a harness and cart for driving, but the end goal of all methods is to have the horse calmly and quietly allow a rider on its back or behind it in a cart and to respond to basic commands to go forward, change gaits and speed, stop, turn and back up.

Ideally, a young horse will have no fear of humans and view being ridden as simply one more new lesson. A properly handled young horse that had adequate ground work will seldom buck, rear, or run away when it is ridden, even for the very first time. Horses that are unbroken, can be broken at any age, though it may take somewhat longer to teach an older horse. An older horse that is used to humans but has no prior bad habits is easier to put under saddle than is a completely feral horse caught wild off the open range as an adult. However, an adult feral horse may be easier to train than a domesticated animal that has previously learned to treat humans with disrespect.

Horse Management

Humans will manage horses in many ways but one can readily separate these management interactions in two very different ways - intensive and extensive management.

Intensive management is where human and horse work in close company - this can range from humans handling mares and foals, to exercising yearlings, to breaking horses, riding horses, driving horses, transporting horses etc. In this instance, any adverse reaction by the horse to external stimuli could have serious health and safety implications on the horse handler. (14)

Extensive management is where humans turns horses out to paddock, and although humans will monitor these horses frequently, they will not be in direct contact with them. Thus if a horse has an adverse reaction to any stimuli that will cause the horse to take flight, although the horse may get injured, the health and safety implications on the horse handler are minimal.

However, as discussed previously, horses will adapt and familiarise themselves to repeated aural and visual stimuli. Thus horses that graze in paddocks adjacent to any physical infrastructure, such as roads, airports, airfields, helicopter pads, telephone poles, electricity pylons, cell phone masts etc, become rapidly acclimatised to their presence and the noise and visual effects of these physical infrastructures rarely if ever result in injury to these acclimatised horses. (17)

Conclusion

Man has used the equine social dynamic to successfully domesticate horses for many centuries by breaking the horse into a submissive state and then by clearly defining the rules of their required interaction by training and taking on the role of the Alpha Horse. With repeated exposure to threatening situations (sight, smell, sound, touch or a combination of these stimuli), most horses will acclimatise - this is one of the main reasons that man has used horses in many roles effectively down through the centuries.

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Notes

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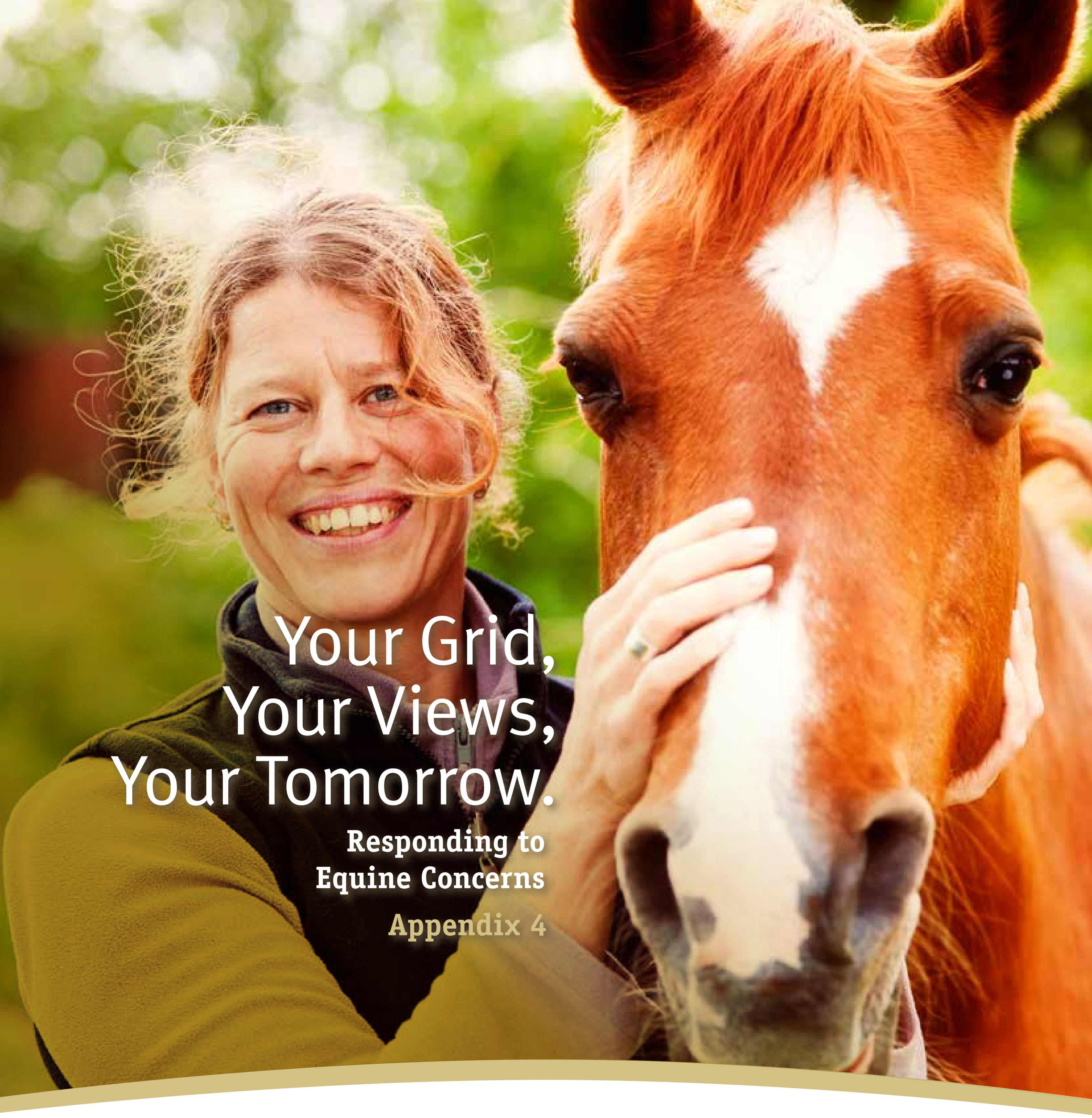

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Responding to Equine Concerns

Appendix 4

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Appendix 4

Code of Practice in Relation to Access to Land and/or Premises

Table of Contents

Introduction.

This Code of Practice has been prepared to set out the principles and procedures that EirGrid as Licensee will follow in respect of any person acting on its behalf who requires access to land and/or premises as required under the terms of the Transmission System Operator licence issued by the Commission for Energy Regulation (CER) to EirGrid plc (EirGrid).

This Code of Practice includes procedures calculated to ensure that persons visiting land and/or premises on behalf of the Licensee:

a. Possess the skills necessary to perform the required duties; and
b. Are readily identifiable to members of the public; and
c. Are appropriate persons to visit and enter land.

This Code of Practice will be reviewed periodically and any revision of the Code of Practice shall be subject to the approval of the CER.

Background

On 29 June 2006, the CER issued a Transmission System Operator Licence to EirGrid pursuant to Electricity Regulation Act, 1999, as inserted by Regulation 32 of Statutory Instrument (SI) No. 445 of 2000 (modified by Statutory Instrument 60 (2005)).

On 01 July 2006, this Licence became effective and EirGrid assumed responsibility for operating Ireland's national electricity transmission system - otherwise known as the Transmission Grid. This includes planning, developing and ensuring the maintenance of the transmission grid, scheduling and dispatching generation, operating the electricity market and promoting system security.

Under Regulation 8(1)(a) of Statutory Instrument 445 (2000), the Transmission System Operator is assigned the following exclusive function:

To operate and ensure the maintenance of and, if necessary, develop a safe secure, reliable, economical, and efficient electricity transmission system, and to explore and develop opportunities for interconnection of its system with other systems, in all cases with a view to ensuring that all reasonable demands for electricity are met having due regard for the environment.

In order to enable EirGrid to discharge its functions, the legislation required that the ESB in its capacity as Transmission Asset Owner (TAO) and EirGrid enter into a contract to be known as the Infrastructure Agreement, which defined the functions to be assigned to the TAO, as owner of the transmission assets, and EirGrid, as Transmission System Operator.

Under the Infrastructure Agreement EirGrid is responsible for identifying feasible solutions (projects) required to develop the transmission system. In this regard it must carry out the required designs to enable planning applications to be submitted for such projects and to conclude a project agreement with the TAO in respect of projects which are intended to proceed to construction stage. Client Engineers appointed by EirGrid for each development project will represent the interests of EirGrid in relation to ensuring that the projects are constructed in accordance with the appropriate standards required to ensure EirGrid can fulfil its statutory obligations.

EirGrid's Principles Relating to Access to Land

To fulfil these functions assigned to EirGrid under Statutory Instrument 445/2000, access to land will be required at different stages by the staff and agents of EirGrid.

The following list includes but is not limited to the typical duties where EirGrid staff, its representatives, consultants, client engineers etc will require access to land when carrying out this work:

- Route/site selection, survey and design work for new high voltage overhead lines/cables/substations.
- Inspection works associated with the construction of the above.
- Route/site selection, survey and design works associated with the alteration and maintenance of existing high voltage overhead lines/cables/substations.
- Inspection works associated with the maintenance of the transmission system.
- Inspection works associated with connections by parties to the transmission system.

EirGrid's own desire is to ensure the maintenance of good relationships with the owners of land and premises for which access is required. In this regard EirGrid requires that its staff and representatives show courtesy to the landowner (or premises owner) e.g. by notifying the owner of the intention to enter land or premises, by the staff member or representative identifying themselves before entry onto private land or premises etc.

Prior to EirGrid representatives accessing lands for the purposes outlined above EirGrid will ensure:

a. It employs suitably qualified staff to carry out the required duties.

b. The CVs of agents or representatives are checked to ensure they have the necessary experience to carry out the duties assigned to them.

c. EirGrid staff or representatives will carry identification cards and produce this to the owner of the land (or premises) when introducing themselves.

d. That EirGrid staff or representatives entering land on behalf of EirGrid will have read, and be familiar with, this Code of Practice.

EirGrid's Procedures Relating to Access to Land and/or Premises

The following are EirGrid's requirements and minimum standards and procedures in relation to access to land and premises by EirGrid staff and its representatives:

- EirGrid staff and representatives acting for EirGrid will be briefed on their responsibilities before entering private lands (or premises) or dealing with owners.
- EirGrid will take reasonable steps to contact the owner of the land (or premises) before entering private lands (or premises). The owners of land (or premises) will be dealt with honestly and fairly.
- EirGrid will, where practicable, inform the landowner of what work is proposed and, as far as possible, a timetable for its completion.
- Queries from the owner of the land (or premises) will be dealt with promptly and courteously.
- EirGrid staff or representatives will only enter lands or premises for legitimate purposes related to its activities and duties.
- EirGrid staff and representatives will take reasonable steps to ensure that land (or premises) is left in as good state as when EirGrid staff or representatives arrived.
- EirGrid staff and representatives will endeavour to ensure that restrictions on the use of the land (or premises) during investigative works are minimised.
- EirGrid staff and representatives shall ensure due care and attention is taken to minimise the risk of spreading disease to or from farmland
- EirGrid staff and representatives shall take particular care to close all gates behind them and not to damage fences or hedges
- In the event of queries from the owner of the land (or premises) for further information, a contact telephone number for EirGrid will be advised to allow for such queries to be dealt with.
- A copy of this Code of Practice is available on EirGrid's website, www.eirgrid.com

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