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# Engineering Recommendation G96

Issue 1 2014

# Use of Mechanical Harvesters in Vegetation Management

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# 1 INTRODUCTION

## 1.1 Purpose

The purpose of this Engineering Recommendation is to give guidance to **Network Operators** when mechanised tree felling operations are carried out within the **Red Zone** of live overhead power lines.

## 1.2 Limitations

Third Parties working independently of **Network Operators** must not use the methods described in this document, but instead should follow the guidance in FISA (Forestry Industry Safety Accord) 804 (Electricity at Work: Forestry).

Whilst accepting that in most cases mechanised tree felling with an appropriate harvester is preferable to manually felling, it should be acknowledged that live line felling is the exception, with the majority of work being undertaken with the lines made safe. Felling within the **Red Zone** of live overhead power lines should only be undertaken when it is unreasonable "in all circumstances" for a line to be made dead. A robust and thorough justification process as detailed in Section 4 should ensure that this is the case.

## 1.3 Background

It is estimated that in the UK there is around 5,000km of overhead network that is either adjacent to or passes through commercial forestry plantations. This equates to a potential additional volume of around 200,000 tonnes available to be harvested from the **Red Zone** annually. Forecasts show that the volume of timber available is likely to steadily increase over the next 20 years.

Two other factors are likely to increase the volume of timber to be felled in the **Red Zone**. Firstly, there is a legacy of a great deal of timber that has been left standing in the **Red Zone**. This is due mainly to the difficulties involved with making the network dead combined with additional costs of disruption to felling production plans resulting in the felling not being viable. In the event that timber markets improve then this remaining standing timber may become viable, adding to harvesting volumes. In any case this remaining timber will have to be removed at some time in the future to remove the hazard to the network of over mature, standing timber.

Secondly, Engineering Technical Report ETR 132 (Improved Network Performance Under Abnormal Weather Conditions By Use of a Risk Based Approach to Vegetation Management Near Electric Overhead Lines), places an additional requirement on **Network Operators** to ensure that a significant amount of the overhead network is made resilient to vegetation related faults over a twenty five year period. Although there are many possible ways of achieving resilience, it will inevitably lead to a large number of trees being removed in the **Red Zone**.

Current guidance on harvesting adjacent to overhead power lines is largely based on FISA 804. This guidance allows felling in the **Amber Zone** of a live line with suitable controls, but does not allow any felling within the **Red Zone** of a live line. This requirement results either in the line being made dead, to allow the third party to safely harvest the timber using conventional techniques, or the **Network Operator** carrying out the work with the line live in accordance with ENA Engineering Recommendations. Prior to the publication of this document the only guidance available is given in ENA Engineering Recommendation G55, Safe Tree Working in Proximity to Overhead Electric Lines. This guidance relates almost entirely to manual techniques and gives little or no advice on suitable controls for mechanised techniques which could offer less exposure to risk.

In the event that a line cannot be made dead, then the **Network Operator** may be forced to dismantle the trees, or carry out manual felling with suitable control measures in line with ER G55. Both of these options present significant hazards to operatives, including:

- Working at height to dismantle trees or attach ropes for felling
- Large amount of chainsaw work
- Falling or hung up timber

A review of incidents occurring on vegetation management work related to overhead power lines over the last 5 years shows that chainsaw usage and related activities account for nearly all of the incidents. Mechanical harvesting work does not feature in any incidents that involve injury, and there were very few electrical incidents. It is fair to say however that there have been several instances of third party work that have resulted in inadvertent contact with **Circuit Conductors** (either a falling tree, extraction works or direct contact by machine).

It is not possible to draw concrete conclusions from this review because the volume of work completed by chain saw has been much greater than by harvesters over this period. The initial indications are that the overall risks of felling or dismantling large volumes of trees using chain saws are much greater than felling them using harvesters, even when work in proximity to live lines is considered.

As part of the work of the Working Group producing this document, a limited amount of mechanised felling has been carried out within the **Red Zone** of live lines under the control and guidance of **Network Operators**. This work has been done where a full justification has been made and suitable control measures have been agreed and implemented. In these circumstances it is generally agreed that with the line live there is less risk to individuals by carrying out felling using mechanised means than there is by doing it manually. It is also appreciated that if the use of harvesters next to live lines is to be developed then most of the equipment currently used in the UK, although extremely sophisticated, does not satisfactorily address the issue of controlling the direction the tree falls, particularly with weight-biased edge trees next to the line. It therefore either cannot be used safely or must be used with additional controls in place as detailed in this document.

This Engineering Recommendation aims to consider the risks associated with live **Red Zone** harvesting and establish the limitations attached to this task. It will then identify the suitability of various available machinery combinations and identify areas of development that may be beneficial. It will also move on to establishing suitable control methods and harvesting techniques to allow the work to be carried out safely.

In summary, this Engineering Recommendation will propose that where it is justified to remove trees within the **Red Zone** of a live line, and there are a significant number of trees, then provided that a full hierarchy of suitable control measures are in place then felling with an appropriate mechanical harvester will provide a safer alternative than that presented by the use of manual methods.

## 1.4 Scope

This document aims to give guidance on work using mechanical harvesting methods within the **Red Zone** of live overhead power lines that is either instigated by the **Network Operator** (for enhanced network security for example) or by a Third Party (usually commercial harvesting). In either case these recommendations shall only be used where the work is managed by the **Network Operator.** In this respect the **Network Operator** will assume the role of **Forestry Work Manager** as defined in the FISA booklet "Guidance and Managing Health and Safety in Forestry". The **Network Operator** then accepts responsibility for the following tasks in respect of the work:

- Use information provided by the **Landowner** to prepare a risk assessment
- Select competent staff or contractors who have made adequate provision for health and safety
- Make the machine and system choice
- Specify the health and safety measures for staff or contractors working on the site and others who may be affected by the work activity
- Liaise with the **Landowner**
- Monitor health, safety and network security using a **Network Operator Site Supervisor** who will be permanently on the site during work

It is recognised that when the **Network Operator** accepts the role of **Forestry Work Manager** there will be instances where the work is happening concurrently with other work activities. In these cases provision must be made to ensure that the safety and contractual responsibilities of all parties are clear throughout the operations. Thorough consultation at the planning stage between the **Network Operator** and the **Landowner** is essential. This document does not seek to detail the variety of responsibilities that may need to be allocated nor does it seek to give guidance on the collaborative process required to achieve this.

If the **Network Operator** cannot competently deal with the responsibilities involved in taking on the role of **Forestry Works Manager** then they should not proceed.

This document will also give guidance on the following:

- Providing a suitable justification process for carrying out mechanised felling adjacent to live lines in accordance with Regulation 14 of the Electricity at Work Regulations
- The most suitable types of equipment to be used
- Risk assessment processes
- Suitable control measures and their limitations
- Emergency procedures
- Competencies required for key roles

Trials that have taken place as a result of compiling this Engineering Recommendation have identified methods that increase control over the felling direction. Works that take place as a result of this document will also identify techniques and equipment that will further improve control. Further development work by **Network Operators** should continue to take place to ensure that the best available techniques are being used.

It is important to note that this Engineering Recommendation gives guidance on tree felling with specific regard to the electrical hazard associated with tree felling operations and does not seek to advise on managing the non-electrical hazards.

## 1.5 Definitions

Defined terms are in bold text throughout the document. For the purposes of this ER the following definitions will apply:

**Amber Zone** The area from the **Red Zone** up to a distance of one further tree length from overhead **Circuit Conductors** (see Figure 1).

**Circuit Conductor** An electrical conductor arranged to be electrically connected to a network.

**Forestry Work Manager**

As defined in the FISA publication "Guidance and Managing Health and Safety in Forestry", the person who commissions work on a forestry site and is responsible for selecting the right contractor for the job, specifying the measures for the contractor to do the work safely and making sure those measures are followed during the work.

**Landowner** As defined in the FISA publication "Guidance and Managing Health and Safety in Forestry", the person in control of the land on which the forestry work takes place. (This can be a forestry management company or land agent working on behalf of a public or private owner).

**Operator** The harvester operator that has been authorised in writing by the **Network Operator** as being suitably experienced and competent to carry out **Red Zone** harvesting and also to be competent in the use of the particular machine chosen for a particular work site. The **Operator** must have a detailed knowledge of emergency procedures and have a proven means of communication with the Control Engineer.

**Network Operator** The organisation that operates and/or owns a distribution network and is responsible for keeping vegetation clear of overhead lines. A **Network Operator** might also be referred to as a Distribution Network Operator (DNO) or Transmission Systems Operator (TSO).

**Red Zone** The area adjacent to the line containing all trees within falling distance of the **Vicinity Zone** of any **Circuit Conductor** and all trees which could cause damage to any support structure (see Figure 1).

In normal circumstances and for ease of measurement the extent of the **Red Zone** is measured on the ground from a point on the ground vertically below the outer **Circuit Conductor** to the centre of the tree (this results in a larger **Red Zone** than shown in Figure 1). Only when specifically dealt with in the risk assessment and agreed by the **Forestry Work Manager** or **Landowner** and the **Network Operator** can a more specific assessment of tree falling distance to the **Vicinity Zone** of any **Circuit Conductor** be made. It is important to note that this takes full account of variations in line height, cross arm widths, steep slopes, valleys and variations in tree heights. The extent of the **Red Zone** could therefore vary greatly along the length of the line. It is essential where this more precise definition is used that the measurements are taken using accurate methods and suitably trained personnel (see Figures 2 and 3).

**Site Supervisor** A supervisor who is provided by the **Network Operator** who has been authorised in writing and has overall responsibility for site safety in respect to the electrical, site and tree related hazards presented by the operation. As specialist knowledge is required it would be appropriate if this role is contracted out. The **Site Supervisor** must have a suitable level of knowledge of the capabilities of the machine and **Operator** and also of the characteristics, size and species of the trees to be worked on. The **Site Supervisor** should be able to demonstrate a thorough understanding of the issues covered in the FISA booklet "Guidance and Managing Health and Safety in Forestry". The **Site Supervisor** must be in a position of safety and be able to observe the felling operations and be capable of stopping work immediately where necessary. The **Site Supervisor** must be in immediate contact with the **Operator** and have a proven means of communication with the Control Engineer. (Note that where further knowledge is needed to fulfil the role of **Site Supervisor** fully then a Senior Authorised Person can be used to assist on site)

**Vicinity Zone** The zone around an exposed live **Circuit Conductor** which, if maintained, will ensure that the danger of burn or electric shock is prevented. The distances, which depend on Voltage, are shown in Table 1.

**Table 1 Vicinity Zone Distances**

| System Voltage | Vicinity Zone |
|---|---|
| Up to and including 1 kV | 1m |
| Up to and including 11 kV | 2m |
| Up to and including 33 kV | 2.5m |
| Up to and including 66 kV | 3m |
| Up to and including 132 kV | 3.5m |
| Up to and including 275 kV | 4m |
| Up to and including 400 kV | 5m |

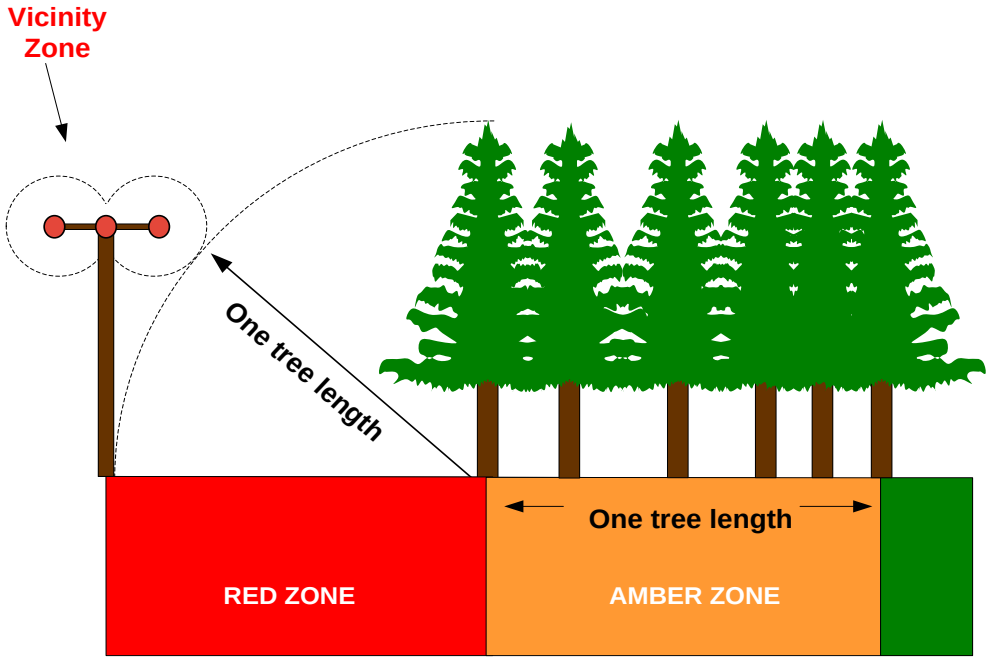



Figure 1 – Red/Amber Zones

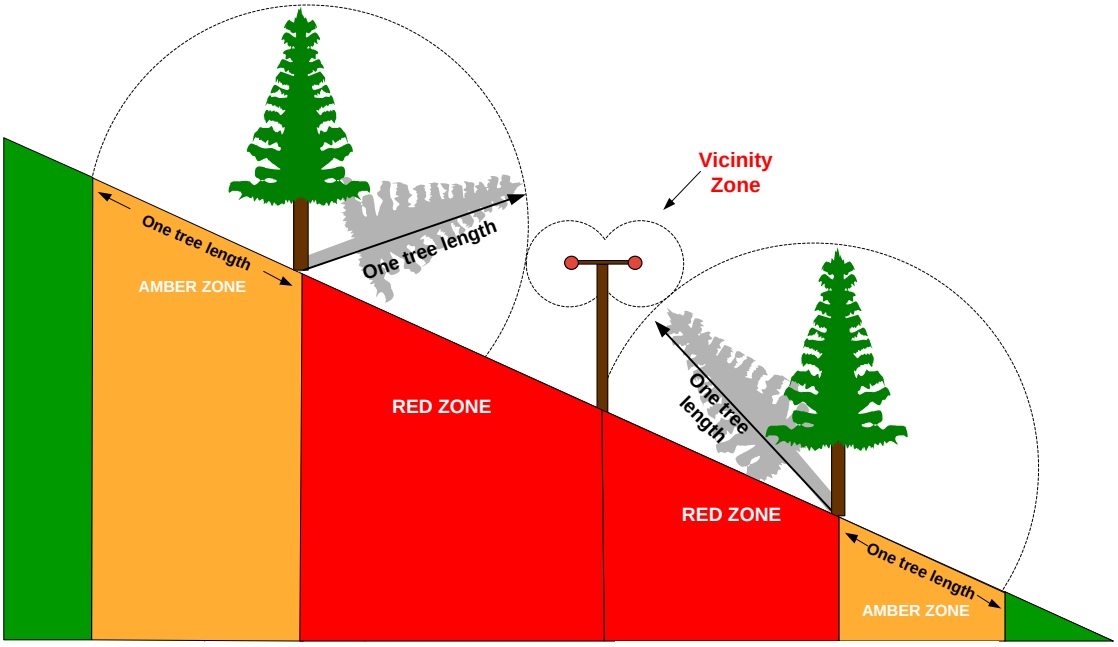



**Figure 2 Red and Amber Zones on a side slope**

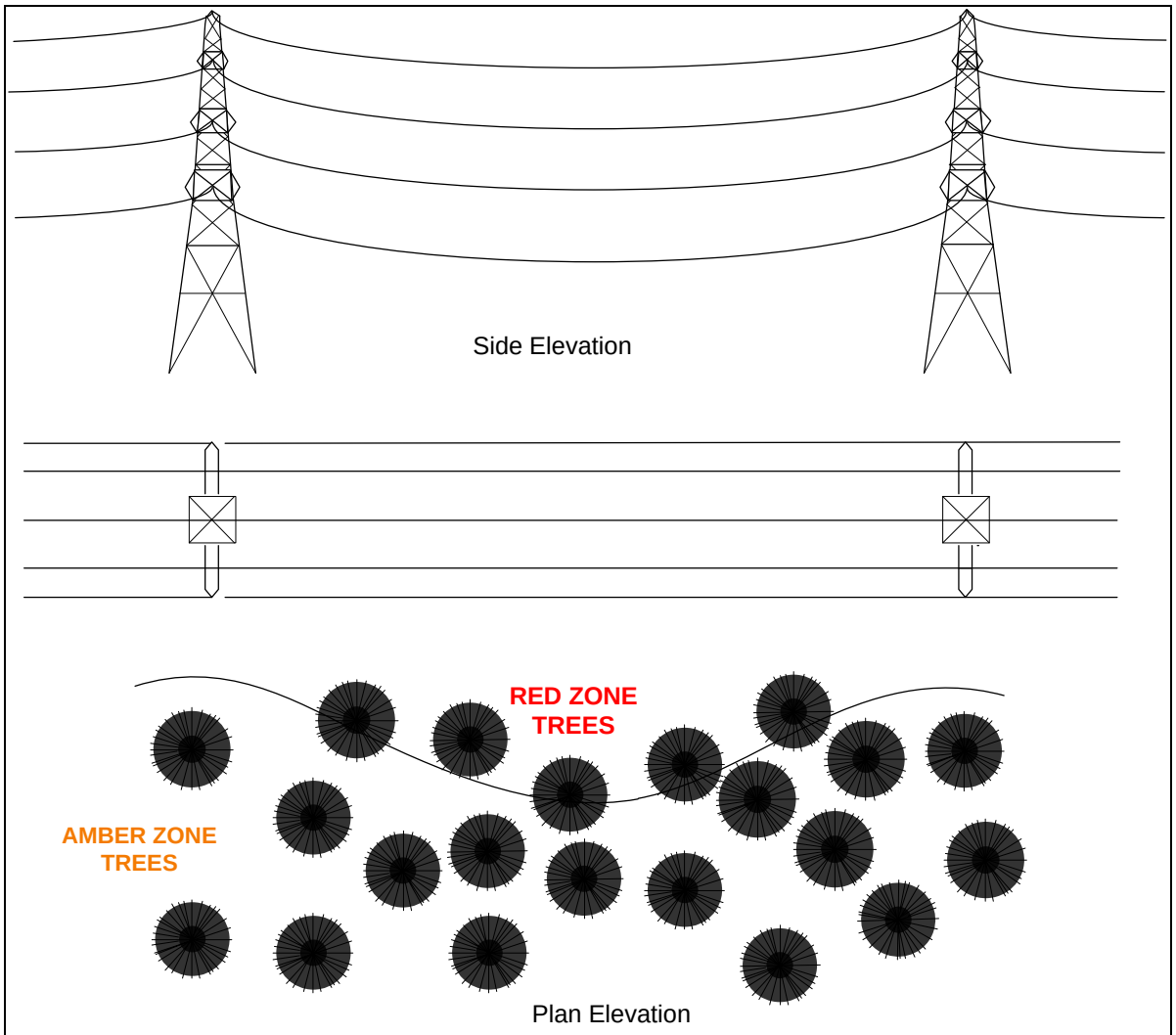



**Figure 3 Example of how the Red Zone can vary along the length of an overhead power line (when accurately measured by trained personnel)**

## 2 LEGISLATION AND GUIDANCE NOTES

This section is not intended to provide references to all the legislation and guidance that would provide a comprehensive guide to Health and Safety or the management of Electricity Networks. It is assumed that companies using this guidance already have a comprehensive Health, Safety and Environment management system in place dealing with all other risks. The documents referred to below are only those which have a specific bearing upon the issue of vegetation management work in proximity to live overhead electric lines.

1. ENA Engineering Recommendation G55 - Safe Tree Working in Proximity to Overhead Electric Lines.
2. ENA Engineering Technical Report ETR 132 - Improved Network Performance Under Abnormal Weather Conditions By Use of a Risk Based Approach to Vegetation Management Near Electric Overhead Lines
3. ENA Engineering Technical Report 136 – Vegetation Management Near Electricity Equipment – Principles of Good Practice
4. The Electricity Safety, Quality and Continuity Regulations 2002, as amended 2006 and 2009.
5. The Electricity at Work Regulations 1989
6. ENA SHE Standard 008 - Notes of Guidance on the Principles of High Voltage Overhead Line Live Working
7. The Management of Health and Safety at Work Regulations 1999
8. Forest Industry Safety Accord (FISA) booklet – Guidance and Managing Health and Safety in Forestry
9. Forest Industry Safety Accord (FISA) Safety Guide 804: Electricity at work: Forestry
10. HSE Guidance Note GS6 (Fourth edition) - Avoiding danger from overhead power lines

## 3 ADVANCE WORK PLANNING

It is recognised that a considerable amount of **Red Zone** harvesting can be avoided with thorough, long term planning. This can be as long as five years ahead of planned felling or planned outages. Where the felling is required by third parties or by a **Network Operator** there should be a two way process with **Network Operators** communicating long term outage plans for strategic circuits to major stakeholders. Stakeholders should also provide detailed information on constraints and long term felling plans.

## 4 JUSTIFICATION PROCESS

It is always preferable from the point of view of safety that any tree felling work in the **Red Zone** is carried out with the line made safe in accordance with the **Network Operator's** Distribution Safety Rules and this document.

As the background to this document describes, there are significant risks involved in felling or dismantling trees using traditional chainsaw methods, whether working near to a live line or not. It is therefore accepted that mechanical harvesting can eliminate or as a minimum reduce the non-electrical risks. Where it is possible to undertake part of any tree felling operation by using a suitably configured mechanical tree harvester then this should be the preferred option, providing that site conditions allow its safe use and the procedures detailed in this document are complied with in full.

The use of mechanical harvesting methods, or any other method, within the **Red Zone** with the line live can only be permitted when the duties imposed by Regulation 14 of the

Electricity at Work Regulations 1989, are fully met; this is because **Red Zone** harvesting involves working *adjacent* to a live line and would be regarded as being live work. It is important to note that **Red Zone** Harvesting is not considered to be "Live Line Work" as defined in the ENA document SHEC 009 (Notes of Guidance on the Principles of High Voltage Overhead Line Live Working) as this refers to work *on* the network.

This means that Regulation 14's three conditions need to be satisfied i.e.:

(a) it is unreasonable in all the circumstances for the line to be dead; and
(b) it is reasonable in all the circumstances for the work to be carried out while the line is live: and,
(c) suitable precautions are taken to prevent injury.

**Condition (a)**

A written justification must be produced in every case when deciding whether it is unreasonable for an overhead power line to be made dead. A flowchart which assists in making this decision is shown in Figure 4.

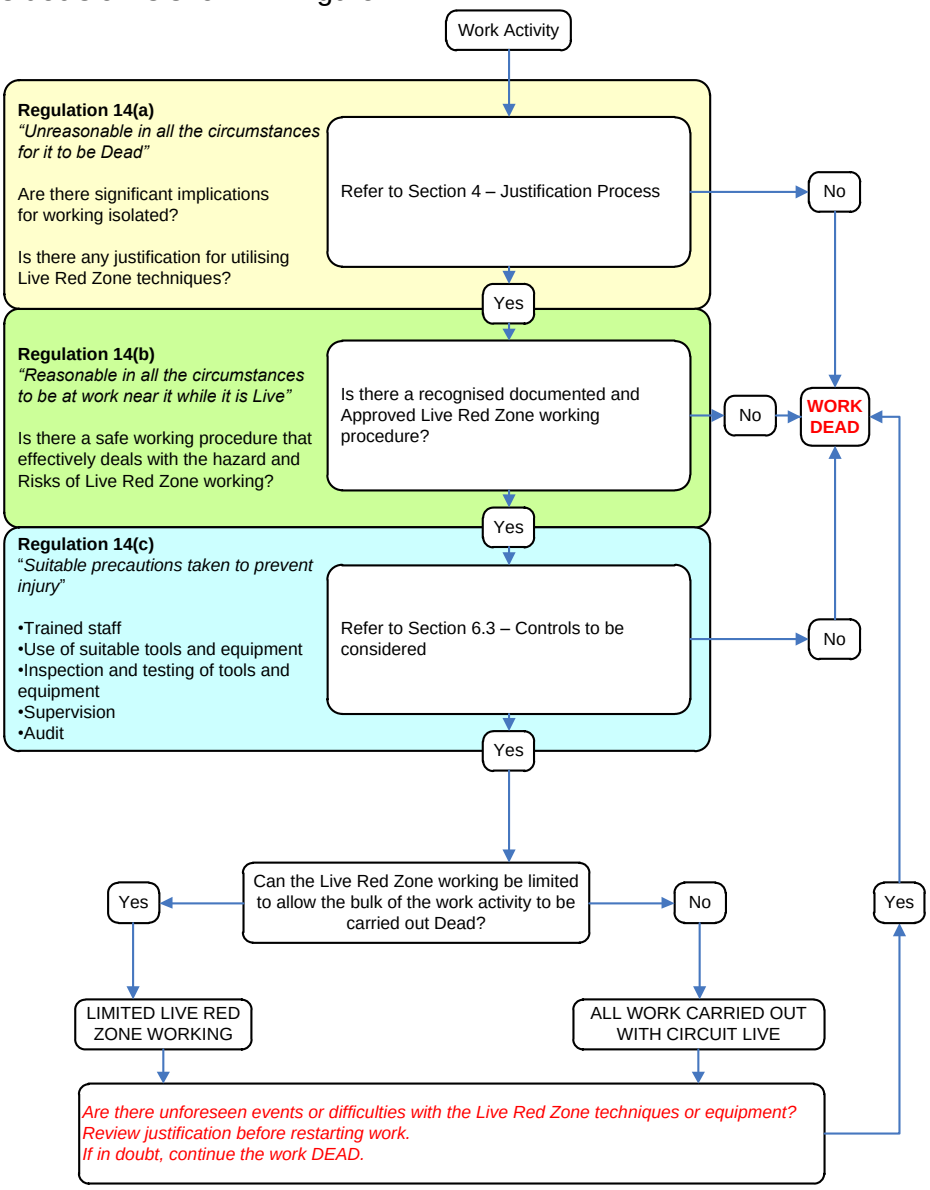



**Figure 4 – Regulation 14 Decision Flowchart**

Factors to be considered when making the decision include:

- Supplies to more than 15 customers will be affected by making the line dead.
- Supplies to any customer(s) will be affected for longer than 8 hours by making the line dead.
- Any of the affected customer(s) affected by making the line dead have had 3 or more interruptions within the previous 12 months.
- Any of the affected customer(s) rely on supply for essential medical or disabled access equipment.
- Interruption to supplies will result in unacceptable interruption to commercial, industrial or agricultural operations, or public services.
- Interruption to supplies will have a significant adverse impact on public safety e.g. loss of traffic signals, fire alarm systems etc.
- Isolation of a circuit will result in unacceptable reduction to system security.
- Supply voltage cannot be maintained within statutory limits with alternative feeds.
- Costs and risks, including environmental risks, associated with all stages in the use of standby generation, connection, running, refuelling, paralleling, interruptions and security.
- Hazards arising from switching and applying local earthing.

Where any of the above factors are identified then specific details must be given in the live line justification document.

Note - The above guidance is based upon ENA SHEC009 Notes of Guidance on the Principles of High Voltage Overhead Line Live Working.

**Condition (b)**

When it is unreasonable to make a line dead then any work should still be carried out at a safe distance from any live conductor, if it is at all reasonable to do so. This will be the case for any person whose work is not directly involved in felling, e.g. the **Site Supervisor** as it would usually not be reasonable for them to be working where there is any danger from the live **Circuit Conductors**. Planning of the work should therefore be undertaken to ensure that this is the case.

People directly involved with the tree felling work in the **Red Zone**, whether harvester operators, supervisors or chainsaw operators, will be required to work where the risk of electrical injury may arise. This work must therefore be subject to a suitable and sufficient site specific risk assessment carried out by people who are competent to carry out such assessments. The live working activity should proceed only if this risk assessment indicates that it is reasonable to do so and that the risks can be adequately controlled using suitable precautions to prevent injury, as required by condition (c). The decision should not be taken lightly, bearing in mind that the electric shock or burn risks associated with working live can result in fatality or serious injury.

**Condition (c)**

If conditions (a) and (b) are met final authorisation for the work can only be given once the **Network Operator** is satisfied that all the necessary site specific precautions are in place to prevent injury. As the precautions rely, to a degree, on the site conditions at the time of the

intended work, final authorisation can only be given on site and for that specific period of time.

The selection of a safe system of work should be the outcome of a thorough risk assessment process and requires detailed planning before the work starts. Precautions should include:

- the use of people who are properly trained and competent;
- the provision of adequate information and instruction to the people carrying out the work including the risks involved, the safe methods of work to be followed, and the emergency procedures to be followed in the event of mishaps;
- the use of suitable machinery and equipment and protective clothing
- the use of accompanying persons if their presence contributes significantly to ensuring that safe systems of work can be, and are, followed;
- the disabling of auto-recloser functions for the duration of the work;
- plans to cater for changes in circumstances, such as communications failure and deteriorating weather conditions; and
- effective control and supervision of the work area.

## 5 RISK ASSESSMENT PROCESS

If the management of the risks involved in **Red Zone** harvesting is to be successful then it must be a collaborative activity. This is particularly true of the processes for carrying out both the preliminary and site specific risk assessments. To ensure that these assessments are both suitable and sufficient they should involve, as necessary, the **Landowner**, the **Network Operator**, the original **Forestry Work Manage**r (for any adjacent works not covered by this document), the **Site Supervisor** and **Operators**. All parties should have input into the risk assessment processes rather than it being the responsibility of a single person. Such a collaborative approach will help to ensure that all the substantial risks are identified and that there is a thorough understanding amongst those undertaking and managing the work of the risks and the precautions that are required if the work is to be completed safely.

It is the **Network Operator's** responsibility to ensure that a suitable Preliminary Risk Assessment has been carried out and is in place before engaging any mechanical harvesting work in the **Red Zone**. A model Preliminary Risk Assessment to assist in this process is included in Appendix II. Although this document only deals with hazards associated with the electrical risk the **Network Operator** may choose to incorporate this in to other Preliminary Risk Assessments that may cover all other aspects of the work.

The Preliminary Risk Assessment shall be available to all staff and stakeholders and will be used along with a detailed site survey to ensure that the correct decisions are made concerning machinery selection and work methods to be used.

It is also the **Network Operator's** responsibility to ensure that a suitable and sufficient Site Specific Risk Assessment is then completed and agreed between all parties before works commence. Again this may be incorporated in to other risk assessments that cover the electrical hazards.

## 5.1 Overview of Red Zone Harvesting Hazards

The hazards associated with **Red Zone** harvesting can be considered as being either primary or secondary hazards. Primary hazards are those that could lead to contact with a power line and secondary hazards are those that could result in injury following an electrical contact.

Clearly the risk assessment process must result in suitable machinery and methods being chosen with sufficient control measures in place to either eliminate the risks associated with primary hazards or reduce them to an extremely low level. In other words the likelihood of an electrical contact must be extremely low; if this cannot be demonstrated then **Red Zone** harvesting must not take place regardless of any live line justification process.

Despite the possibility of an electrical contact being extremely low the secondary hazards must be fully considered with suitable controls in place where necessary.

A summary of the main hazards is shown in Table 2:

| Primary Hazards (could result in an electrical contact) | Secondary Hazards (could result in injury following an electrical contact) |
|---|---|
| Lean and weight distribution of tree | Failure of network protection to operate |
| Size of tree | Failure of communications to the control engineer |
| Ground conditions | Touch potential (touching the ground and machine simultaneously) |
| Wind conditions | Step potential (potential difference on the ground) |
| Health and condition of tree (and surrounding trees) | Tyre pyrolysis (explosion caused by decomposition in the absence of oxygen within the tyre material at elevated temperatures (heating caused by electrical discharge)) |
| Harvester suitability | High energy release at the point of vegetation contact at higher voltages |
| Harvester proximity to the line | |
| Operator error (or lack of competence) | |
| Machinery malfunction | |

**Table 2 Summary of Primary and Secondary Hazards**

## 5.2 Preliminary Risk Assessment Principles

The Preliminary Risk Assessment will identify common hazards associated with the electrical hazard on all **Red Zone** harvesting sites. A range of suitable controls will then be identified that can then be incorporated in to any method statement used for the work. A model document is included for reference in Appendix II. The Preliminary Risk Assessment must include reference to the following (this list is an example and not exhaustive):

- Electrical apparatus/ Overhead lines:
  - Assessment of the Network and risk in the event of an incident

  - Required Documents (Permits /Limitation/Isolations)
  - Auto-reclose facility in place.
  - Specific **Network Operator's** instructions.
- Felling head:
  - Control of tree
  - Processing ability
- Base unit:
  - Stability
  - Fault path to ground
  - Tyre pyrolysis
- Tree felling procedures/operations:
  - **Operators'** Training/Competence
  - Reference to Barrier trees
  - Control measures in place
- Ground / terrain:
  - Identify road crossings
  - Ground conditions, roughness and slope
  - Goalposts in place
- Wind speed / direction:
  - Pre-planning to include weather forecast
  - Wind speed/direction thresholds for additional control measures
  - Wind speed/direction thresholds when harvesting should be stopped
  - Methods of measuring and monitoring wind conditions
- Public:
  - Signs/barriers/banksmen in place
  - Visibility throughout the planned working hours
- Emergency Procedures

### 5.3 Site Specific Risk Assessment Principles

A Site Specific Risk Assessment must also be carried out in addition to the Preliminary Risk Assessment.

It is essential that the Site Specific Risk Assessment is reviewed throughout operations and at the start of each day. This allows control measures to be altered if necessary as a result of any unexpected changes in circumstances such as the weather, machinery performance, terrain or variations in crop size. If suitable control measures cannot be applied then the works must be suspended until a safe solution can be found, or circumstances return to those manageable under existing controls.

The Site Specific Risk Assessment must include all principles contained in the Preliminary Risk Assessment section (5.2) and also include the following (this list is by way of example and not exhaustive):

- Justification for working with the line live

- Access and egress to site including continuous monitoring for any alteration/changes to the site

- Electrical Risks: evaluation of any relevant electrical risks specific to the site. In particular is the voltage to be worked on acceptable to the **Network Operator**?

- Work methodology
- Harvesting head and base including capability and capacities
- Means of marking any appropriate zones or barrier trees
- Safe position of **Site Supervisor**
- Hazardous trees
- Crop size and species and any variations
- Ground conditions and terrain variation
- Position that timber produce is to be left to enable safe extraction
- Acceptable weather limits. (For example, felling should not take place if wind conditions are such that control over felling direction might be lost)
- Continual assessment of Public Safety and Public exclusion (as appropriate)
- Emergency procedures specific to the site including emergency contact numbers
- Location and phone number of nearest A&E hospital.
- Designated meeting place (useful in remote areas to guide the emergency services to the worksite)
- Nearest access point
- Type of access (public road/light vehicles, four wheel drive)
- Suitable helicopter landing area
- Contact details for all relevant parties, particularly:
    - **Site Supervisor**
    - **Operator**
    - Control Engineer
    - **Forestry Works Manager(s)**

It is essential that satisfactory control measures are in place for all identified hazards before works start.

All staff involved in the works should be suitably briefed in the contents of the Site Specific Risk Assessment to be able to understand the risks and the control measures. It is suggested that a formal sign-off should be carried out following this briefing. In the event that any member of the working party identifies concerns that are not adequately addressed then work should not continue unless suitable control measures can be agreed and implemented.

**Any visitors to site or any additions to the working party must also be fully briefed on the Site Specific Risk Assessment.**

### 5.4 Risk to Operators

In the event of an incident it is likely that the **Operator** will be most at risk. It is therefore essential that sufficient control measures are implemented such that it would require multiple control measures to fail before the **Operator** is exposed to significant risk. An example of an analysis of possible failure scenarios is shown in Appendix III. No attempt has been made to assign likelihoods to each event but it can be seen that with sufficient controls in place the possibility of the **Operator** being placed in a position of danger is extremely low.

Each **Network Operator** should ensure that they undertake a similar analysis and they are satisfied that the likelihood of the **Operator** suffering injury is extremely unlikely.

## 6 SAFE METHODS OF WORK

### 6.1 Work Planning Principles

It is essential that sufficient time and resource is allowed to suitably plan any **Red Zone** harvesting. The comments in Section 3 must also be noted in that forward planning and early two way communication between third parties and **Network Operators** will avoid the need for **Red Zone** harvesting in many instances.

For all works involving the use of mechanical harvesting methods within the **Red Zone** of live overhead power lines then the **Network Operator** will take on the role of the **Forestry Works Manager**. This document does not give guidance on the collaborative process required to ensure that site safety and commercial responsibilities are understood and agreed before works start.

Although outwith the scope of this document, it is expected that works will generally be carried out in accordance with the ENA Engineering Technical Report 136 (Vegetation Management Near Electricity Equipment – Principles of Good Practice).

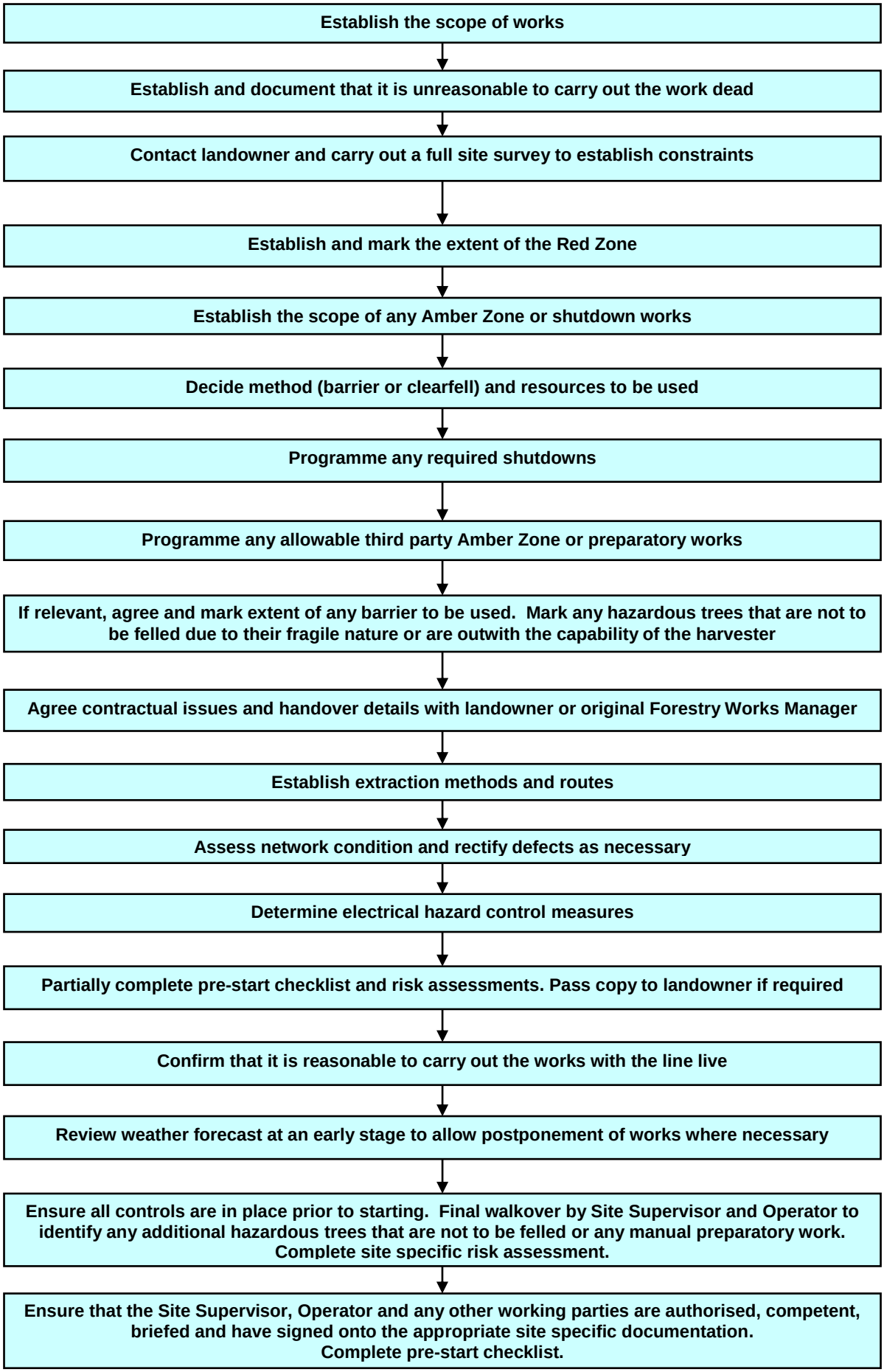
Although outwith the scope of this document, any relevant Estates and Wayleaves issues must be considered at the planning stage. It is especially important that any plans for new planting adjacent to overhead power lines are considered at an early stage to avoid unnecessary risk during harvesting operations in the future. Consideration should be given at this point to securing a wider wayleave where appropriate.

Irrespective of who is initiating the work, it is essential that all key parties are notified at an early stage and made aware of the proposed method of work.

Where it is established that **Red Zone** harvesting is to be carried out then the **Network Operator** is responsible for the planning which should take place in line with the guidance illustrated in Figure 5 on the following page:

It is recommended that a pre-start checklist similar to that in Appendix VI is used to ensure that all steps have been taken. This checklist should be started at an early stage in the process and then revisited immediately prior to works starting to ensure that all control measures are in place.

Figure 5 – Work planning guidance (see overleaf)


Establish the scope of works
Establish and document that it is unreasonable to carry out the work dead
Contact landowner and carry out a full site survey to establish constraints
Establish and mark the extent of the Red Zone
Establish the scope of any Amber Zone or shutdown works
Decide method (barrier or clearfell) and resources to be used
Programme any required shutdowns
Programme any allowable third party Amber Zone or preparatory works
If relevant, agree and mark extent of any barrier to be used. Mark any hazardous trees that are not to be felled due to their fragile nature or are outwith the capability of the harvester
Agree contractual issues and handover details with landowner or original Forestry Works Manager
Establish extraction methods and routes
Assess network condition and rectify defects as necessary
Determine electrical hazard control measures
Partially complete pre-start checklist and risk assessments. Pass copy to landowner if required
Confirm that it is reasonable to carry out the works with the line live
Review weather forecast at an early stage to allow postponement of works where necessary
Ensure all controls are in place prior to starting. Final walkover by Site Supervisor and Operator to identify any additional hazardous trees that are not to be felled or any manual preparatory work. Complete site specific risk assessment.
Ensure that the Site Supervisor, Operator and any other working parties are authorised, competent, briefed and have signed onto the appropriate site specific documentation. Complete pre-start checklist.

## 6.2 Site factors to be considered

Determining the suitability of a tree felling site for **Red Zone** harvesting will not always be a straightforward process. It is up to each **Network Operator** to ensure that all relevant variable factors have been considered before either deciding not to use mechanisation or going ahead or developing a suitable method statement.

The choice of suitable machinery and method of felling must be considered during any site surveys, taking into account the following (this list is not exhaustive):

- Height of trees
- Diameter of trees
- Volume of trees
- Species of trees (Characteristics)
- Variability of the crop
- Health of the crop
- Stability of the trees
- Presence of any dead or hazardous trees
- Spacing of the trees
- Evidence of recent thinning operations
- Ground conditions including soil type and depth
- Exposure of site to wind
- Slope
- Environmental constraints
- Voltage of line (and **Vicinity Zone**)
- Height profile of line (taking account of sag and sway)
- Condition of the network
- Distance of base of nearest trees to the line
- Accessibility of the crop (for example has the Amber Zone been felled)
- Availability of suitable, safe position for the **Site Supervisor**
- Manual preparatory work that may be required such as brashing (removal of lower branches), pruning of any branches in the Vicinity Zone or debuttressing (removing buttresses to improve ability to make felling cuts)
- Presence of fences, roads, paths and buildings
- Access routes for any machinery
- Third party access

There is clearly a great deal of experience and considered judgement needed here. It is unlikely that a single person will have all the skills necessary to suitably assess all of these factors. So it is recommended that the site survey is compiled by the **Site Supervisor** (or Forestry expert employed by or contracted to the **Network Operator**) with contributions from a combination of personnel, including the **Network Operator** Engineer, the **Landowner** (or representative) and the Harvesting Contractor (preferably the **Operator**),

When considering the voltage of the line adjacent to any **Red Zone** harvesting it is important to note that in the event of an inadvertent contact with **Circuit Conductors** then the energy that could potentially be released is proportional to the square of the voltage (Figure 6).

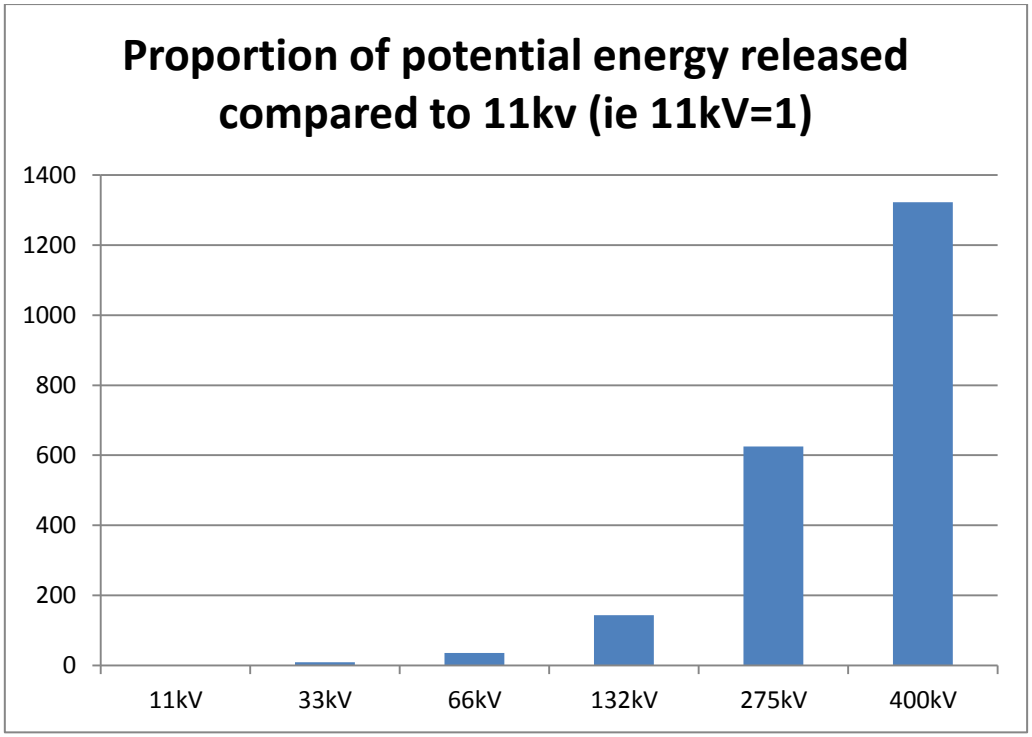



**Figure 6 Energy Multiplication Derived From Network Voltage**

Where there are also multiple control measure failures and given certain conditions then it may be possible that there is a risk to site staff from the release of this energy in the form of fire or explosion. This risk is significantly increased at voltages of 275kV and 400kV.

There are clearly several factors that can affect the likelihood of such an energy release including:

- The quality of electrical contact between any tree and conductor
- The resistance of the tree which may be dependent on moisture content and timber characteristics
- The distance between any conductor contact and the ground
- The nature of the fault path to earth which could be through the tree, through the harvester or a combination of both. Factors that affect this include whether or not the harvester head is touching the ground, whether the harvester is mounted on rubber tyres or metal tracks and the resistivity of the ground or soil type
- The protection settings on the circuit
- The length of time that the tree has been in contact with a conductor (the tree will dry out and carbonise as the impedance reduces)
- Weather conditions

There are also factors that will have a significant effect on the severity of any outcome of such an energy release, such as the distance of **Site Supervisor** or **Operator** to any point of contact and the degree of protection offered by the harvester cab.

It is the responsibility of the **Network Operator** to assess the likelihood and severity of all identified risks as part of their decision making process: if it is considered that the risk is significant then **Red Zone** harvesting should not proceed.

### 6.3 Control Measures to be Considered

Having surveyed the site, the **Network Operator** must ensure that suitable control measures can be implemented before deciding to continue with **Red Zone** harvesting. The primary consideration must be to have robust and sufficient control measures to ensure that it is extremely unlikely that a tree held by the harvester could contact or come close to a live line. To achieve this a far greater degree of control is needed than in normal harvesting operations. With this in mind there are certain control measures that will be mandatory in order that **Red Zone** Harvesting can be carried out in accordance with this Engineering Recommendation.

These are:

- Works must be personally supervised at all times by a **Site Supervisor.**
- There must be an immediate method of communication between the **Site Supervisor** and **Operator**. This should be an “open mic.” and headphones type system or better allowing continuous hands free communication. The only exception to this is for barrier felling where a less immediate and continuous form of communication may be appropriate, in this instance a walkie talkie system would be appropriate.
- The Control Engineer must be aware of the work taking place and must have a reasonable understanding of **Red Zone** harvesting practices and procedures in general and a thorough understanding of communication and emergency procedures.
- There must be a tried and tested method of communication between the **Site Supervisor** and the Control Engineer.
- Trees that have been identified during site surveys as being unsuitable for **Red Zone** harvesting must be marked clearly by an agreed method.
- Wind speed and direction thresholds are established at levels where additional controls are needed and where **Red Zone** Harvesting must be suspended.
- Weather forecast should be checked before arranging machinery to be sent to site and again the day before and the morning of works commencing
- Wind speed and direction is monitored and recorded on a regular basis to be determined by the **Network Operator**.
- Any auto reclose facility on the network must be disabled during the works.
- There must be no possibility of a machine being positioned such that it could breach the **Vicinity Zone**, this should be ensured by measuring the full reach of the machine and then physically identifying a line that the machine must not cross.
- There must be a position of safety available to the **Site Supervisor** with particular reference to the chain shot hazard and any risk presented by broken **Circuit Conductors** or electrical discharge.
- The **Operator** must be authorised in writing by the **Network Operator**.
- The **Operator** must be capable of contacting the Control Engineer.

Of the many other control measures available, it is strongly recommended that the following are considered:

- Back up systems of communication between the **Site Supervisor** and the Control Engineer are available (such as multiple network mobile phones, or satellite phones)
- Suitable maximum daily working times are in place
- Suitable regular breaks are scheduled during the day for the **Site Supervisor** and **Operator**
- Dielectric footwear and insulated rubber gloves are available to the **Operator** in the event that an emergency exit from the cab is necessary before it has been confirmed that the line has been isolated and earthed
- Simulated emergencies have been practiced on site with actual communication tests with the Control Engineer

### 6.4 Method of Work

#### 6.4.1 General

Before a **Network Operator** embarks on any mechanised felling within the **Red Zone** of a live line then they must have a well considered and approved method statement or work procedure in line with this Engineering Recommendation. Where requested this method statement should be made available to the **Landowner** for information and comment. A model method statement is presented in Appendix V; note that this is an *example* of an appropriate method statement and indicates where variations could be made by individual **Network Operators**.

In addition any techniques and machinery used must have been suitably trialled in a non-live environment and be approved by the **Network Operator**.

Having carried out the planning steps in Section 6.1 and considered all the site factors in Section 6.2, the chosen method of work (either barrier felling or clearfell as discussed in section 6.4.2) must be fully detailed, recorded and agreed between the **Site Supervisor** and the **Operator** before works commence. It is recommended that the method of working is recorded on a document such as the Pre-Start Checklist (an example is shown in Appendix VI). Any deviations from the agreed method must be discussed between the **Operator** and **Site Supervisor** and be recorded before the work method is altered.

The Pre-Start Checklist will not be completed until immediately before works start. However, much of the information such as location, method of working, machinery choice, control measures and contact details will be established at an early stage. At this point a partially completed Checklist should be offered to the **Landowner** for their information. At least two weeks prior to the start date is suggested allowing sufficient time for any relevant feedback to be given incorporated in to the work planning process.

Methods of work must be established solely on the basis of minimising the risks of working adjacent to a live line and not on the basis of cost, speed or any timber production considerations.

As **Red Zone** harvesting is a closely supervised task requiring the full concentration of the **Operator** and **Site Supervisor** it is important that as much associated work as possible is done either before the supervised operation or left until afterwards.

### 6.4.2 Choice of Method

In general there are three distinctly different approaches to **Red Zone** harvesting:

- **Barrier felling** (Figure 7) relies on standing edge trees acting as a physical barrier in the event of a harvester losing control of the tree. The emphasis here is on ensuring that a sufficiently robust barrier is in place and is much less dependent on the capability of the harvester. This method will obviously result in the barrier trees having to be removed by another method at a later stage; this must be done within a reasonable timescale to avoid any unnecessary risk of damage to the network from falling trees.

- **Clear felling** (Figures 8 and 9) is used where the harvester used is capable of clearing trees adjacent to a live line (including the edge trees). With clear felling the emphasis is more on choosing a harvester that is capable of providing enough directional control and ensuring that the trees have been assessed as being within the capabilities of the harvester and **Operator**.

- **Mechanised topping** could be an approach where **Red Zone** trees can be cut at height. This may be to avoid any possibility of breaching the **Vicinity Zone** as the top would not be within falling distance; it could be used to reduce the size of the tree to be felled or to overcome difficulties presented by the base of the tree, such as a sweeping stem presenting weight bias problems. This approach particularly relies on having manufacturer's or other competent body's written confirmation of machine suitability for the task.

#### 6.4.2.1 Barrier felling

The basic principle of this method is to fell trees with a harvester using standing edge trees as a physical barrier in the event that a harvester were to lose control of a tree (Figure 7).

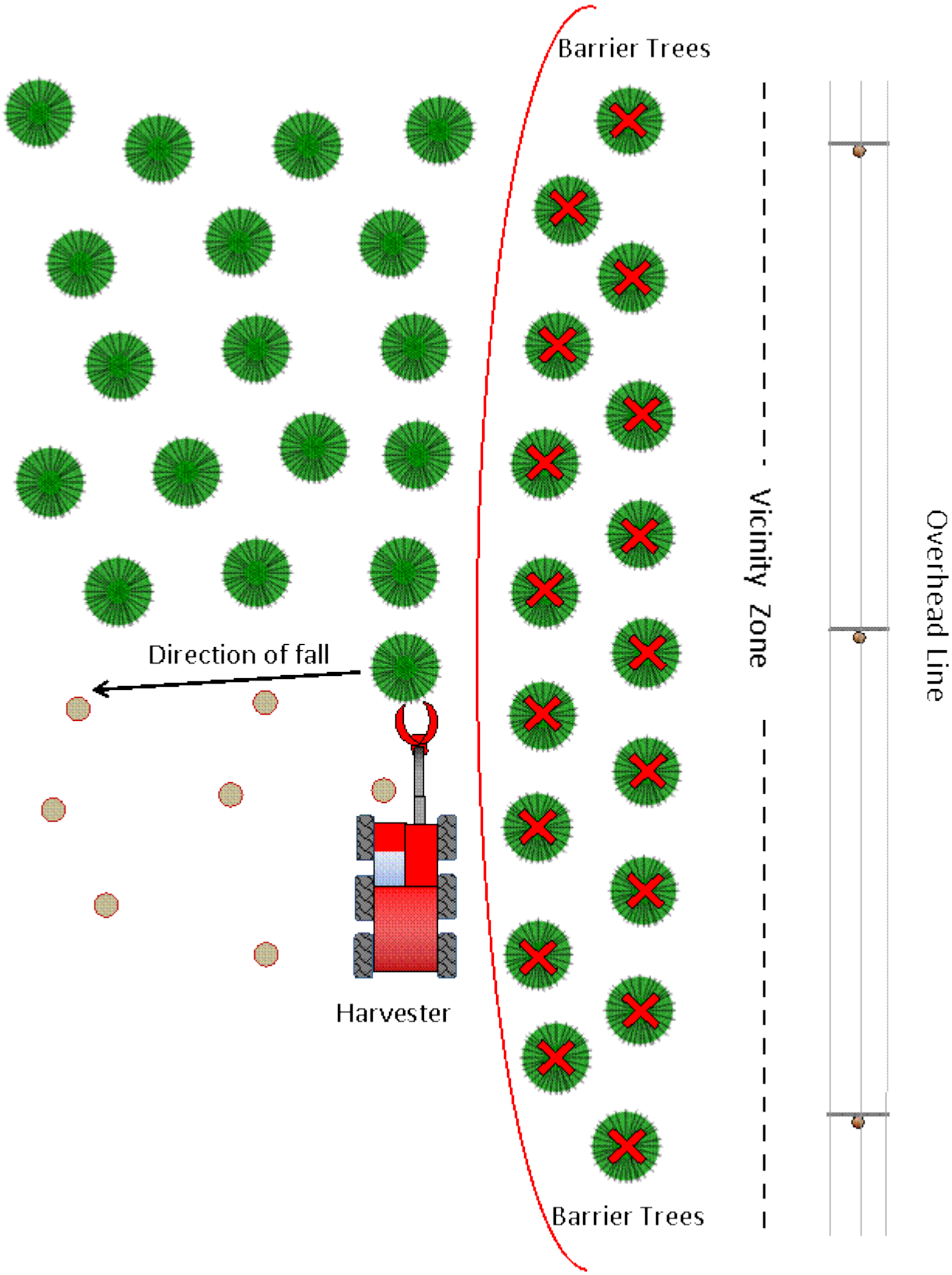



**Figure 7 – Barrier Felling Diagram**

This method of tree removal can only be used where there are sufficient control measures in place which can be maintained to avoid an electrical incident.

Prior to any **Red Zone** harvesting, an assessment will be made of the standing crop to determine if there is potential to use the outer edge trees as a barrier and, if so, to determine the extent of this barrier. Factors to consider include:

- No part of any Barrier Zone tree can be within the **Vicinity Zone**, some pruning may be necessary to ensure this in advance.
- Stability of the crop.
- Presence of any gaps in the upper canopy of edge trees as a result of windblow, dead trees, wide spacing or poor growth.
- Species and health of trees in terms of branch and stem strength.
- Previous thinning or pruning regimes.

In addition to examining the edge trees the crop should be inspected further back for clear areas of windblow or suppressed trees. This would present a potential hazard for any distant trees that fall in the wrong direction and are allowed to gather momentum.

If a satisfactory barrier can be established then this must be clearly defined by marking the trees to be left for manual removal. This barrier must consist of a number of rows and in a non uniform crop will be a line of variable width.

The type of harvester and head to be used must also be suitable, taking the importance of control and the size of the crop into account. Individual trees which are identified as being unsuitable for the head and base unit should not be felled using this method and must be clearly marked or removed by other methods in advance.

With works in progress it must be ensured that:

- The trees furthest from the line are taken first to avoid opening up holes adjacent to the barrier zone.
- The harvester and head should be orientated to give maximum leverage away from the line.
- Trees must be felled away from the line.
- Trees must not be felled into other standing trees in order to avoid a ‘domino effect’ towards the line.

If, in the process of harvesting, it is considered that the barrier zone is not adequate then works must be suspended and the barrier zone re-assessed or works abandoned.

#### 6.4.2.2 Clearfell

This method shall only be used where it can be shown that the head and base unit are capable of providing the principle control measure of ensuring the correct direction of fall of the tree. It is particularly important to consider that, unlike barrier felling, the edge trees will be felled; these are generally more heavily branched on the outside and leaning slightly outwards, in other words they are weight biased towards the line. This in effect means that this method will only be suitable for a limited range of specialist harvesters using specific techniques or for smaller trees.

If machinery has been modified in any way to improve directional felling control, then this modification must either be approved by the manufacturer or other competent body. The **Network Operator** must ensure that sufficient trials have been carried out enabling a suitable risk assessment to be completed and that sufficient controls have been identified

and are in place to reduce any risk to an acceptable level. An example of this would be where the addition of a hook welded to the boom of an excavator base would give additional control ensuring that a tree cannot fall back where the boom is being used to apply a force to the tree (this arrangement is shown in Figures 7 and 8).

Although termed “clearfell” there may well be a number of trees that, as a result of the site survey detailed in Section 6.2, are considered to be unsuitable for mechanised felling. These will either be removed by other methods in advance, or while the harvester waits, or clearly marked to be left for removal as soon as possible afterwards.

#### 6.4.2.3 Mechanised Topping

Mechanised topping of trees presents some additional hazards, namely the increased possibility of loss of control of the head, machine roll-over and the greater range of chain-shot (where a chainsaw head is being used). In addition (unless specifically sought by an operator) it is unlikely that the head and base unit combination have been approved by manufacturers or other competent bodies to work above ground level. In particular, conventional harvester heads that are suspended from an A-frame do not offer sufficient control for topping to be carried out safely.

If this method is used it is the responsibility of the **Network Operator** to ensure that there is manufacturer’s or other competent body’s written confirmation of machine suitability for the task. The **Network Operator** must also ensure that a comprehensive risk assessment has been carried out and that they consider sufficient and suitable controls are in place to reduce risk to an acceptable level. It is recommended that this method should only be used where the **Network Operator** has a procedure incorporating the following control measures (in addition to those in Section 6.3):

- A heavy, tracked base unit with a short boom should be used
- The **Operator** must have proven experience of using the head
- Do not top trees in strong winds
- The base unit should be placed as close to possible to the tree to avoid over stretching
- Tops only to be a maximum of 75% of the full capability of the head and base
- Top to be assessed as within the capability of the head and base unit
- Topping only to be done when there is a reasonably clear stem to avoid unseen, thick branches preventing a clean cut
- Once cut the top is not to be rotated down but lifted slightly, slewed round slightly and then lowered vertically to the ground, this should avoid unbalanced forces leading to machine roll-over.
- Topping only to be done when the machine is reasonably level and on stable ground
- Exclusion zones are enhanced due to the higher risk of chain-shot travelling further distances (where applicable)

On site these control measures must be discussed and agreed by both the **Site Supervisor** and the **Operator** prior to each individual tree being topped.

### 6.4.3 Harvester Head and Base Unit

The choice of head and base unit will be governed by a wide variety of factors including terrain, ground conditions and size of the trees to be felled. As all heads and base units have limiting factors to a greater or lesser extent with respect to the control of direction of the tree, it follows that there will be situations where site factors are such that no mechanised option is suitable to remove trees with the network live. A full discussion of currently available options is included in Appendix IV.

As the main consideration in machinery choice is to select a machine that allows the risks of working adjacent to a live line to be minimised, it is important that this choice is not constrained by what is easily available or cheaper in terms of machines or contractors.

### 6.4.4 Preparatory Work

Any necessary preparatory work should be completed before **Red Zone** harvesting begins. Examples where work may be required are:

- Felling of non-**Red Zone** trees to allow access, for example where the **Amber Zone** trees have not yet been removed
- Brashing (removal of lower branches of trees). This is likely to be essential for trees with substantial lower branches and would be carried out with chainsaw or pole pruner. This ensures that the **Operator** has good visibility and the head can grip and fully cut through the stem correctly
- Debuttressing where necessary (see Section 6.4.8)
- Manual removal of trees identified as being unsuitable to be removed by the harvester with the line live. Although these can be left at the end, it may be necessary to remove them to allow access to the remaining trees
- Preparation of brash mat roads for the harvester to travel on where brash already exists

### 6.4.5 Sequence of Tree Removal

There are two aspects to this. Firstly establish the direction of progress along the length of the line, i.e. left to right or right to left, this will depend mostly on access, terrain and choice of base unit.

Secondly and more importantly it must be established if the trees furthest from the line or those closest are to be felled first. It will usually be preferable to start with the trees furthest away and work towards the line as this provides the maximum protection for the line and a clear area for line-side trees to be felled in to. This method will normally be available as it is likely that the **Amber Zone** will have been felled in advance. Where ground conditions or standing trees allow this then working from the line outwards should only be allowed where the harvester can be positioned safely and there is room to fell the trees away from the line without risk of hang-up or strain on the machine.

### 6.4.6 Direction of Felling

The direction of felling the trees should be established to minimise the possibility of contact with the **Circuit Conductors** in the event of loss of control of the tree. Ideally this would