Title: BS 3998 Recommendations for tree work

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BS 3998
Recommendations for tree work
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Foreword

Publishing information
This British Standard was published by BSI and came into effect on XX Month 200X. It was prepared by Technical Committee B/213, Trees and treework. A list of organizations represented on this committee can be obtained from its secretary on request.

Supersession
This British Standard supersedes BS 3998:1989, which is withdrawn.

Information about this document
This is a full revision of the standard, updated to incorporate changes in regulations and working practice, concerning the following:

- safety;
- decision-making criteria for tree work;
- wildlife and habitats;
- old, veteran and ancient trees.

Use of this document
It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people.

Presentational conventions
The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this standard. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations
This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.
1 Scope
This British Standard gives general recommendations for tree work.
It gives recommendations for deciding what to do, and where necessary, how to carry out treatments for established trees. This includes consideration of the safety of people and property, and also sustaining the tree’s longevity and its value for local amenity, landscape, biodiversity and heritage.

This standard is intended for use by competent persons. Additional information has been provided in the commentary and in the annexes so that clients employing others to do tree work can understand recommendations and agreements they enter into.

2 Normative references
The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5837, Trees in relation to construction – recommendations

3 Terms and definitions
For the purposes of this British Standard, the following terms and definitions apply.

3.1 adventitious
describing shoots which develop other than from terminal or axillary buds; also roots which form other than through primary development

3.2 arboriculturist
person who, through relevant education, training and experience, has recognized qualifications and expertise in the field of trees

3.3 arisings
any parts of a tree, including stem, roots, limbs or brushwood, bark, other woody material and foliage derived from the tree during tree work operations

3.4 bolling
pollard heads collectively, or sometimes the entire framework of a pollarded tree

3.5 branch bark ridge
anatomical feature of a branch union

NOTE See Figure 2.
3.6
branch collar
anatomical feature of a branch union

NOTE See Figure 2.

3.7
canker
area of dead cambium and overlying tissues killed by a pathogen

3.8
cavity
hole in a woody part of a tree caused by decay or damage

NOTE Cavities may hold water (wet cavity) or be dry.

3.9
client
person or organization commissioning the work

3.10
co-dominant stem
upward growing stem with a similar upper height and disposition as another stem especially arising from the same union

3.11
competent person
person who has training and experience relevant to the matter being addressed and an understanding of the requirements of the particular task being approached
[BS 5837]

NOTE 1 A competent person understands the hazards and methods to be implemented to eliminate or reduce the risks that can arise. For example, when on site a competent person is able to recognize at all times whether it is safe to proceed.

NOTE 2 A competent person is able to advise on the best means by which the recommendations of this British Standard may be implemented.

3.12
coppicing
cutting trees down to ground level (usually within 75 mm of the ground) with the intention of encouraging regrowth of multiple shoots

3.13
cortex
tissue between the phloem and the outer bark

3.14
crotch
forked region formed by the junction of a branch and the trunk, or by two branches

3.15
crown
main foliage-bearing part of a tree
3.16
crown lifting
removal of lower branches to achieve a stated vertical clearance above ground level or other surface

3.17
crown management (by pruning)
manipulation of the structure, size, shape, density or mechanical properties of tree crowns

3.18
crown reduction
operation that results in an overall reduction in the height of a tree and usually also its spread by means of a general shortening of twigs and/or branches

NOTE It retains the main framework of the crown.

3.19
crown thinning
removal of a proportion of small, live branches from throughout the crown to ensure an even density of foliage around a well-spaced and balanced branch structure

3.20
dysfunction
loss of a specific function in part of a tree, either due to a natural process, damage or abnormality

3.21
epicormic
pertaining to shoots or roots which are initiated on mature woody stems

NOTE Shoots can form in this way from dormant buds or be adventitious.

3.22
habit
growth pattern of a tree

NOTE This is important in relation to a tree’s response to cutting.

3.23
heart rot
decay in the central core of wood of a trunk, stem or branch

3.24
heartwood
the dead inner layers of wood in the trunk or branch of a tree, sharply delineated, often by colour, from sap wood

NOTE 1 In some species it is highly durable.

NOTE 2 See also Ripewood.

3.25
knuckle
swelling that forms at a pollard point especially after repeated cutting
3.26
lion tail(ing)
removal of shoots and side branches from the lower parts of a branch leaving only a bunch of twigs and foliage at the tip

3.27
owner
holder of the title to a piece of land on which a tree is growing

NOTE An owner may act through an agent.

3.28
pesticide
chemical used to control pests, pathogens or plants affecting a tree

3.29
phloem
tissue through which sugars are conducted in solution

3.30
pollard(ing)
production and maintenance of a form of tree with numerous branches arising from the same height on a main stem or principal branches (the “bolling”)

3.31
pruning
cutting branches and/or roots from a tree, whatever their size

NOTE See Clause 9 and Table 1 for management objectives.

3.32
ripenwood
dead, central core of species that do not form a true heartwood, usually not sharply delineated from sapwood

NOTE It is usually not durable since it lacks both pre-formed defensive substances and an ability to react to wounding.

3.33
sapwood
outer, living, water conducting part of the wood of a tree

3.34
stub
short section of a branch left after pruning

NOTE Also known as “snag”.

3.35
stump
the base of a trunk that remains after felling
3.36
**target**
person or object, whether mobile or fixed within falling distance (or impact radius) of a tree or its branches

3.37
**topping**
removal of most or all of the crown of a mature maiden tree or the pruning of a pollarded tree below the knuckles

3.38
**tree worker**
competent person who carries out operations on trees with specific objectives as agreed with the client

3.39
**trunk**
main above ground structural component of a tree which supports the crown

*NOTE* Often synonymous with *stem*, but a trunk can divide into a number of stems.

3.40
**veteranization**
controlled infliction of damage on a young or early-mature tree

*NOTE* Undertaken to promote or emulate the development of some of the features of an ancient tree, especially the wildlife habitats and shelters that are provided by decaying wood and cavities (A guide to veteran trees [1]).

3.41
**vigour**
overall measure of the rate of shoot production, shoot extension or diameter growth

3.42
**vitality**
overall measure of physiological and biochemical processes, in which high vitality equates with near-optimal function

3.43
**water pocket**
natural depression or crotch in a tree that holds water

3.44
**wetwood**
condition in living trees where the wood develops an abnormally high water content and water soaked appearance

3.45
**work area**
area designated for the safe execution of the specified work
3.46 work specification
detailed account of the work that is to be done and any limitations to the execution of that work

3.47 wound
injury in a tree caused by physical force, e.g. cutting or abrasion

4 Tree work

COMMENTARY ON CLAUSE 4

Trees develop in balance with their environment (available space, soil and atmosphere) but they sometimes do so in ways that conflict with the use of the land surrounding them or the safety of people and property.

Tree work can help to alleviate these problems. This standard calls for understanding of trees and caution because actions taken today can have significance for the long term growth and the need for future management of the tree.

Sites, including the trees, should be managed so as to maintain the value of the trees, and their safe and harmonious juxtaposition with all aspects of land use.

Whatever the objective of tree management, the safety of people and property should be taken properly into account and will normally be reflected in the minimum work considered necessary (see Figure 1 to aid decision making).

NOTE Other considerations might have to be balanced against the need for safety.

A competent person should identify existing and potential problems and make recommendations of remedial or preventative work.
Figure 1 – Decision flowchart

Stage 1
Provisional management objective(s)

Stage 2
Tree condition assessment (6)
Risk assessment (inc. legal obligations) (6)
Tree value assessment (inc. legal obligations) (6)

Stage 3
Review management objective(s)

Stage 4: options
Retain tree
Fall tree (14)

No work
Tree management
Retain stump (14)
Remove stump (14)

Pruning (9)
Wound treatment (10)
Bracing (12.3)
Propping (12.6.2)
Guying (12.7)
Soil amelioration (13)

Flexible (steel cable or proprietary) (12.3)
Rigid (for split stems, weak forks or cavities) (12.4)

Contaminated soil: treatment (13)
Soil removal or replacement (13)
Irrigation or drainage (13)
Nutrition (13)
Aeration or decomposition (13)

Formative pruning (9.5)
Crown thinning (9.6)
Crown lifting (9.7)
Crown reduction (9.8)
Pollarding (9.10)
Special treatments for very old trees (Annex F)

Arisings: disposal/utilization (16)
Retain in round (16)
Process on-site (16)
Remove from site (16)

Specification for work on tree(s) to be carried out by competent contractor (7.7)

Stage 5: specification

Stage 6: control of work
Legal and safety procedures during the work (5 and Annex A)

Stage 7: follow-up
Regular inspection of retained trees and stumps (6)
5 Trees and the law
Before work, including inspections, commences on trees, checks should be made to determine if there are any laws and regulations that would affect the work proposed (see Annex A).

NOTE Such checks may be made by a member of the public (e.g. the tree owner), an arboriculturist or the tree work contractor appointed to do the work.

6 Surveys and inspection of trees

6.1 General

A tree survey, depending on the objective(s), will collect a range of data which can include location, species and sizes of trees and their environmental significance/quality whether as individuals, groups or woodlands (e.g. see BS 5837:2005, 4.2).

A tree inspection, collects information as for a tree survey, as well about tree condition and location, and interprets the information in relation to the risk posed and indicates options for mitigating risk and meeting other objectives, for appropriate action.

Risks should be assessed based on site usage, proximity of targets and the nature of the tree population; those three factors will determine the level and frequency of inspection.

There should be a system for recording, onward transmission of such information and acting upon it.

Before an inspection or survey is undertaken, a brief should be prepared in consultation with the client. This will state what is required from the arboriculturist [e.g. safety report; pre-planning survey report (see BS 5837)].

Anybody undertaking a tree inspection should be aware of legal limitations restricting work to trees (see Clause 5). An inspection should, therefore, note signs that could suggest the tree is a habitat for flora and fauna that might have legal protection.

6.2 Tree inspection

A competent person should assist the client in considering the risk posed by the trees. Risks alter as trees grow and circumstances change, therefore tree management and inspections should be reviewed regularly.

The inspection of trees with the express purpose of identifying specific problems (e.g. hazards or subsidence) is a specialized subject and should be carried out only by an arboriculturist. In addition, all employees and contractors (particularly tree work contractors and grounds maintenance contractors) should be encouraged to take responsibility for making
opportunistic observations of trees during their other work and to report changes that can occur.

Tree inspections should be conducted so as to record the condition of the tree(s) and previous treatments including installations, and to consider the implications for future management.

Data collected from a tree inspection should be assessed and related to the risk, environmental and conservation considerations to form recommendations for management to meet the agreed brief (see 6.3); if the recommendations are accepted in full or in part they will form the basis for the specification of work.

NOTE 1  Previous history of tree problems on the site and adjacent land might be of relevance to the inspection in hand.

NOTE 2  Most assessments will be based on a visual inspection from ground level supplemented by simple sounding and probing of suspect areas of the tree. Where a visual assessment records features indicating ill health or the presence of potentially weak structures, a more detailed inspection might be needed, involving some invasive investigation(s) of the tree or climbing the tree.

Anyone using specialist equipment during a tree inspection should be competent to do so and to interpret the results obtained.

The owner, in consultation with the arboriculturist, should decide the need for future inspections and management.

6.3 Reporting

A written report should be supplied to the client in order to complete a tree inspection. This will normally review the risk(s) posed, and the findings of tree condition made during the inspection. Significant defects detected during a detailed inspection should be recorded and reported to the client.

The report should conclude by identifying options to meet the brief, which may include not doing anything to the tree at that time or the relocation of targets.

NOTE 1  The report may include an indication of the maximum period to elapse between inspections.

NOTE 2  It is important that inspection regimes are implemented and reviewed and records maintained.

6.4 Specification

Following review of the recommendations and the client’s objectives, a work specification should be prepared (see Figure 1).

7 Tree work safety and planning

7.1 General

There should be liaison between all parties concerned (e.g. clients, arboriculturists, local authorities etc.) when planning tree work.

7.2 Instructions prior to carrying out tree work

Tree work has inherent risks which should be recognized, assessed and appropriate working procedures adopted. The risks should be managed by trained and supervised operatives.

People employed in tree work should have been appropriately trained and be competent in the particular activity involved.
The contractor should prepare a risk assessment and method statement (including quality of work), and ensure there is a clear written specification of the work.

A tree work contractor should have current public and product liability insurance, and employers’ liability insurance if applicable.

### 7.3 Safety of tree work operations

Before work commences the hazards should be identified, a risk assessment undertaken and a system of working developed that addresses the hazards and risks. This system of working should be understood and adopted by those people doing the scheduled work and any subsequently agreed work which might require amendment of the risk assessment.

*NOTE* These activities are covered by the Health and Safety at Work Act, 1974 [2] and associated regulations, and the appropriate guides and codes of safe working practice.

### 7.4 Safety of tree workers

Before work commences, all workers should understand their roles in the safe system of work. Tools and equipment needed for all aspects of the work should be checked for safety, should be serviceable, appropriate for the work and used only by competent operatives.

### 7.5 Safety of other people

A work area should be designated and demarcated to exclude any person not directly involved in the work.

Where the area that could be affected during tree work operations extends beyond the client’s control, owners/occupiers should be advised of the risk and where appropriate barriers erected.

In locations adjacent to the public highway, signing, as detailed in the *Safety at Street Works and Road Works Code of Practice* [3], should be displayed and appropriate traffic and pedestrian control maintained.

In other areas where people have access, warning signs should be displayed and appropriate barriers erected.

Appropriately trained members of the tree work team should be detailed specifically to police boundaries of the designated work area and control traffic, including pedestrians.

Members of the tree work team should be alert, at all times, for the potential entry of people into the work area. An effective system of communication should be implemented within the workforce, and if entry into the work area occurs, work should be stopped until the risk is controlled.

The work should not create hazards or obstructions (e.g. protruding twig or branch ends, particularly at head height) to the safe movement of passers-by.

### 7.6 Protection of property

The method of working should ensure that damage to property, surfaces (including compaction), structures, plants and trees not involved in the work, is avoided.

Underground and overhead installations should be identified and protected from damage throughout the designated works.
7.7 Work specifications

The work schedule should specify the work to be done, and should include an unambiguous identification of the trees on a site plan, which should cross reference to the schedule.

**NOTE 1** It may also be necessary to mark or tag trees on site.

**NOTE 2** It is important that the client understands what will be done and the implications for meeting objectives and future management.

Those assessing the trees to give a quotation, and those doing the work, should understand the client’s wishes as modified in discussion (the brief).

Access to the site, disposal or utilization of arisings (see Clause 16) and any limitations upon working should be clearly detailed.

Where, after discussion, amendments to the schedule of work (see Clause 6) are agreed, including statutory agreement (see Clause 5) these changes should be documented and communicated to those undertaking the work.

7.8 Unforeseen factors that could influence the scheduled work

Any significant defect (e.g. split branches or hidden pockets of decay) or limitation to working in a tree (e.g. bats roosting and nesting birds, see Annex A), found during the course of scheduled work, should be reported to the owner and, if necessary, to the relevant statutory body. Any consequent modifications should have the appropriate consents.

7.9 Avoiding transmission of pests and pathogens on tools and equipment

**NOTE 1** Trees are vulnerable to pests and pathogens that are not currently found in the UK.

Extreme caution should be exercised to prevent the introduction of pests and pathogens into the UK on tools and equipment that have been previously used abroad.

Measures should be taken to avoid transmission of pests and pathogens from site to site.

**NOTE 2** Legal controls may apply (see Annex A).

**NOTE 3** Within the UK, the bacterium Erwina amylovora, causing fireblight, the bacterium Erwinia salicis, causing watermark disease of Willows, and Phytophthora species causing various diseases are the organisms most likely to be transmitted on tools, equipment and vehicles. See the Defra Plant Health service website at www.defra.gov.uk/planth/ph.htm for up-to-date information.

Hand tools should be used, where practicable, when working on trees infected with any of these pathogens, so that disinfection can be effectively carried out in accordance with Annex B.

7.10 Damage caused to trees

**NOTE 1** Carelessly undertaken tree work might damage the tree and might even shorten its life.

Tree work should be conducted and completed so as to cause no hazards.

**NOTE 2** Poor and inappropriate tree work and site management [e.g. temporary parking, movement of heavy equipment and machinery, and fire (see Clause 13)] might impair the health and mechanical integrity of the tree (See Clause 13, Table 2 and Annex G).

Steps should be taken to minimize harm from falling branches.

Where a tree, or part of a tree, is used as an anchor or to redirect a load, precautions should be taken to avoid damaging it (see Annex J).
7.11 Site management

There should be effective organization and conduct of tree work so as to minimize any adverse environmental effects on the site and surroundings.

Access and egress arrangements for the site and work area, as previously agreed, should be monitored and complied with.

Where cranes and hydraulic platforms are used, they should be sited and operated so as to avoid damaging trees or property.

Sites for storage and maintenance of equipment and materials, particularly chemicals and fuel, should be designated.

Care should be taken to avoid contamination or disruption of the ground or water courses (e.g. oil or chemicals).

Work operations that cause excessive noise (e.g. woodchippers) should be controlled.

NOTE This is covered by statutory noise regulations and site-specific constraints.

Whenever the site is left unattended, at the end of each day’s work and at completion of the work, it should be left in a safe condition.

If fires are permitted on sites, they should be located so that they will not damage any part of the site (see Clause 16 for alternative methods for disposing of arisings).

8 Timing of tree works

8.1 General

When scheduling tree works that involve cutting [i.e. pruning (see Clause 9) and felling (see Clause 14)], the following factors should be considered.

a) legal constraints (see Clause 5 and Annex A);

b) risk management priorities;

c) client priorities;

d) season;

e) weather;

f) species characteristics; and

g) habitat and wildlife.

8.2 Risk management

If the purpose of the tree work is to manage risks to people or property, priority should be determined by the risk assessment.

Decisions about priority should take account of any relevant factors that vary with the time of year, such as site usage, windiness, occurrence of drought or the potential for snowfall, that are likely to influence the degree of risk to people, including operators and property.

8.3 Tree welfare – season and weather

Both seasonal factors and weather conditions should be considered before pruning trees (see 9.3). Ideally as a general principle for maintenance of vitality trees should not be pruned
during periods of water stress or during spring growth (when sugar and starch reserves are depleted) until new leaves have fully expanded (when starch reserves are replenished) (see Annex E).

**NOTE 1** In most species, pruning causes least harm/stress to the tree if done during late winter or early spring, but see Annex E regarding possible harm caused by the depletion of dissolved sugars in species which tend to “bleed” sap copiously from wounds at this time (see Annex D).

For tree species whose defences against various wound-related diseases depend partly on the production of gum or resin (e.g. *Prunus* spp. and many conifers), pruning should preferably be done when these processes are at their most active (e.g. June to August for *Prunus* spp.).

As a general rule, pruning should be timed so as to avoid the exposure of tissues to severe conditions, e.g. due to season or weather, taking into account the tolerance of the species concerned to such conditions (see 9.3).

**NOTE 2** Previously shaded bark can be damaged by direct sunlight, particularly thin barked trees [e.g. Rowan (*Sorbus aucuparia*), beech (*Fagus sylvatica*) and maples (*Acer* species)] while fresh wounds might be damaged by frosts.

The timing of hedge cutting should avoid bird nesting season (see Annex A).

If trees to be retained are growing on clay soils, tree works, whether direct or ancillary, should be timed so as to avoid the passage of machinery or repeated trampling on soft landscape areas during wet conditions. Where such activities cannot be avoided within a distance equal to 12 times the trunk diameter of the tree, when measured at 1.5 m from the ground special ground protection should be provided.

Consideration should be given to the effect of tree works and ancillary activities on the site as a whole when clay soils are wet.

### 8.4 Operator welfare

Tree workers should take account of seasonal characteristics of the species that might, for health and safety reasons, dictate when or how operations are undertaken (e.g. the wood of beech can be brittle in winter weather; farina on young shoots of London plane).

### 8.5 Habitat and wildlife

Prior to work commencing, the tree/hedge and its surroundings should be assessed for the presence of protected species, some of which might be subject to season specific legislation (see Clause 5).

**NOTE** Nesting birds, roosting bats, badgers and other mammals have specific protection (see Annex A).

The timing of any works should be co-ordinated so as to limit the adverse impact the work could potentially cause.

If wildlife conservation is an important consideration, timing should take account of the seasonal cycles of the species of fauna and flora concerned (including the nesting habits of birds and the egg-laying habits of insects).

### 8.6 Phased work

**NOTE** Within a tree population, there may be justification for managing a percentage of trees in any one year. Such an approach may be appropriate for habitat management, visual impact and provision of shade (e.g. coppice, avenues, groups of pollards, risk management).
8.7 Site management/usage

**NOTE 1** There may be site specific characteristics and the way the site is used that influence when operations take place (e.g. seasonal access, the use for special events)

**NOTE 2** Where the objective is removal of a tree but retention of the stump, the production of root suckers from the remaining root system (e.g. various species of Prunus, Populus and Robinia) might be a problem. (see Annex H).

8.8 Tree felling

**NOTE** If the wood of a tree is to be utilized, the needs of the end user may determine the optimum time for cutting. For example, timber for firewood would preferably be cut in early autumn for most deciduous species. This contrasts with wood cut for chipping which is preferred with a high moisture content.

9 Crown management by pruning

**COMMENTARY ON CLAUSE 9**

The need and/or desire for crown management arises mainly because of concern about the safety of people and property, access, obstruction, light and/or aesthetic values (see Table 1).

For other crown management practices (i.e. bracing) see Clause 12.

The term “pruning” is used here to describe the process of cutting so as to undertake a given type of crown management practice (e.g. crown reduction, thinning or lifting). In this context, pruning falls into two main categories: (1) formative pruning, whereby mainly young trees are encouraged to grow in a desired form, (2) remedial and restorative pruning, whereby the existing form of the crown (particularly in older trees) is modified.

The removal or cutting-back of plants climbing on or over trees is covered in 9.11 and Annex F.

9.1 General

When crown management is undertaken, any adverse effects on the tree’s structural integrity and sustained growth should be avoided as far as practicable. Work should be planned so as to take account of the processes of branch growth and wood decay after pruning, which could lead to a long-term and recurrent need for further work.

The size and number of pruning cuts should be kept to the minimum required to achieve the objective (see 9.3.4). Generally, an excessive proportion of a tree’s leaf area should not be removed and excessively large or numerous wounds should not be created (see Annex E). In particular, these precautions should be considered if more than one form of crown management (e.g. crown reduction and crown lifting) is to be undertaken, and the work should be specified by a competent person.

**NOTE 1** See Annex F regarding cases where relatively severe pruning might be appropriate.

**NOTE 2** See Clause 7 for guidance on action if previously unrecognized structural defects or other problems are found in the course of tree work.

9.2 Deciding when crown management is appropriate

**COMMENTARY ON 9.2**

Trees are very good at optimizing the development and maintenance of their crowns, especially for the efficient interception and use of solar energy and for the dissipation of wind energy. Their natural processes of growth and dieback are, however, not always compatible with safety and other requirements for people and property. Well planned and properly executed pruning can reduce the probability of structural failure and so reduce risk to people and property, while sometimes prolonging a tree’s life.
Pruning should be undertaken only with good reason and on the basis of an informed decision (see Table 1), taking all its likely consequences into account (see Annex E); other options could include moving the target (see 7.3).

NOTE See Clause 7 regarding the safety of people and property in relation to sites where tree work is being done and Clause 6 in relation to risks from potential tree failure.
### Table 1 – Pruning practices in relation to management objectives

<table>
<thead>
<tr>
<th>Management objectives</th>
<th>Pruning practices (numbers refer to clauses in the text)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>To maintain health or longevity by:</strong></td>
<td>9.6/9.8.1</td>
</tr>
<tr>
<td>Good structural integrity</td>
<td>***</td>
</tr>
<tr>
<td>Disease or pest control</td>
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</tr>
<tr>
<td><strong>To protect people or property from:</strong></td>
<td>9.6/9.8.1</td>
</tr>
<tr>
<td>Tree failure</td>
<td>***</td>
</tr>
<tr>
<td>Storm-damaged branches</td>
<td>*</td>
</tr>
<tr>
<td>Subsidence of land</td>
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</tr>
<tr>
<td>Roads, paths, railways, waterways and signage</td>
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</tr>
<tr>
<td>Aircraft flight paths</td>
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To conserve:

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<th>***</th>
<th>X</th>
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<tbody>
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<td>Overhead cables and structures</td>
<td>N/A</td>
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<td>N/A</td>
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<td>***</td>
<td>X</td>
<td>***</td>
<td>X</td>
<td>**</td>
<td>N/A</td>
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<tr>
<td>Aerials and signals</td>
<td>N/A</td>
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<td>N/A</td>
<td>***</td>
<td>***</td>
<td>X</td>
<td>**</td>
<td>**</td>
<td>***</td>
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<tr>
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<td>N/A</td>
<td>***</td>
<td>***</td>
<td>**</td>
<td>X</td>
<td>*</td>
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To provide amenity or shade:

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<th>***</th>
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</tr>
<tr>
<td>Visual amenity</td>
<td>N/A</td>
<td>***</td>
<td>N/A</td>
<td>***</td>
<td>***</td>
<td>**</td>
<td>N/A</td>
<td>**</td>
<td>*</td>
<td>*</td>
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</table>

To produce:

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<th>*</th>
<th>**</th>
<th>***</th>
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</thead>
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<td>Wood or other products</td>
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<td>*</td>
<td>*</td>
<td>N/A</td>
<td>***</td>
<td>**</td>
<td>X</td>
<td>***</td>
<td>X</td>
<td>*</td>
<td>X</td>
</tr>
</tbody>
</table>

**Key**

- *** Often appropriate
- ** Occasionally appropriate
- * Done mainly for other reasons but of indirect value
- X Inappropriate
- N/A Not applicable

**NOTE** This table concerns only objectives for management and the relevant types of pruning. Even when the objective is to maintain the health or structural integrity of the tree, pruning is potentially harmful since it involves severance of the tree’s conductive and storage systems and the removal of leaf area. Information about harmful effects and their mitigation is provided in Annex E.
9.3 Pruning: factors to consider

COMMENTARY ON 9.3

The effects of pruning are influenced by many factors, some of which are related to the tree and others to its environment. The potentially adverse effects include the stimulation of processes leading to disease, dieback, decay or future structural problems. Further information is given in Annex E.

9.3.1 General

The following factors should be taken into account as far as possible when planning and undertaking pruning as a management option:

a) the tolerance of the species or cultivar to wounding (see Annex E);

b) the tolerance of the species or cultivar to shade and sunlight;

c) growth habit and response of the species or cultivar to pruning (see Annex E);

d) individual tree condition, e.g. as influenced by age, history of damage (including previous pruning), disease and growing conditions including past and current weather (see Note 2 in 9.3.2 for a method of assessing energy levels);

e) the time of year (see Clause 8);

f) the amount of leaf-bearing area to be removed (see Annex E) in crown reduction, thinning or lifting;

g) the number and size of wounds that will be created.

9.3.2 Species and cultivars

Species with little ability to react defensively against wounding (e.g. *Betula* spp.) should be cut as sparingly as possible. Also, members of the Rosaceae and other species with high susceptibility to the silver-leaf fungus (*Chondrostereum purpureum*) should preferably be pruned only when their starch reserves are high, following good growing conditions during summer (information about the time of cutting is given in Clause 8).

When there is a need to prune species such as *Salix* spp., which tend to produce a proliferation of very dense growth of weakly attached shoots from around each wound, the resulting branches should be managed by cyclic cutting at appropriate intervals, or selectively pruned until perhaps a stronger branch structure develops (see also shoot renewal pruning; F.3).

If, due to problems which develop after pruning, crown management ceases to be a good option for managing an established tree, replacement with a species or cultivar more suited to the site should be considered.

NOTE 1 Hazards from weakly attached branches which develop after pruning are less likely to develop if pruning is started on a formative basis when the trees are very young.

NOTE 2 Where it is important to assess the energy levels of the tree, this can be done by means of a simple iodine staining test (see A new tree biology/Modern arboriculture [4,5]. This test ascertains the concentration of starch in a sample from the last three sapwood increments taken from a small core sample.
9.3.3 Individual tree condition

9.3.3.1 General
Pruning should preferably not be done when the disease- and decay-resistance of the tree is likely to be impaired by physiological stress or seasonal factors; e.g. construction damage, during or soon after a drought or when starch reserves have been depleted by spring flushing and flowering.

9.3.3.2 The age of the tree

NOTE 1 Age is used as a loose term to reflect physiological condition and stage of tree development.

If there is a need to prune a tree so as to manage the size or shape of its crown, this should be started when it is young (formative pruning), so as to reduce the need for major pruning in later life.

If an unavoidable case for pruning a mature tree arises, perhaps due to unforeseen changes in the use of the site where it is growing (e.g. for building or highway development), this should be done only if its health and mechanical integrity can be satisfactorily maintained.

NOTE 2 If pruning is not an option, consideration might be given to removal and replacement.

9.3.4 Number, size and proximity of cuts
For the reasons stated in Annex E each cut should be kept as small as possible, by not cutting large-diameter branches when avoidable and by cutting at an optimum angle (see 9.3.5). The following rule should preferably be applied when selecting a branch for removal, that is the diameter of a final pruning cut should generally not exceed one third of that of the parent stem or branch, preferably well below this limit if the tree is old or declining. Similarly, if a branch or stem is to be shortened, the cut should be made distal to a union where there is a healthy lateral branch with as large a diameter as possible (i.e. at least one third and preferably more than half that of the removed portion.

NOTE 1 The principle underlying the latter “rule” is that the retained lateral branch bears enough foliage to help adequately to sustain its parent stem or branch.

The diameter of each cut should be kept to the minimum that is consistent with the objective for crown management. Taking account of both the sizes and the number of the cuts made in a single year, their total cross-sectional area should also be minimized.

NOTE 2 Some examples, showing how cuts of various sizes cumulatively equate to an advisable maximum value, are shown in Table E.1 (see also Figure E.1 concerning reduction of the volume of the crown).

The removal of branches which are close together on a parent stem or branch should be avoided, unless the tree is young (see 9.5) or the cuts are so small as to be capable of being fully occluded within a few years. If such work cannot be avoided, the branches selected for removal should not be closely aligned within the tree’s vascular system (e.g. in a vertical line). If this precaution is not compatible with long-term management objectives, the work could be phased over several seasons with a view to lessening its damaging effects.

NOTE 3 If adjacent branches are removed, the resulting zones of dysfunction (and of any associated decay) often merge into an extensive column. This is especially likely to occur in species that often
become extensively and rapidly decayed (e.g. species of Aesculus, Salix, Populus and some Acer spp.). In addition the excessive removal of lower branches causes end-loading or “lion tailing”, which might lead to increased swaying [see also crown thinning (9.6) and crown lifting (9.7)].

For most forms of crown management, pruning cuts should normally be made at branch or stem unions so as to avoid the retention of stubs/snags, which can die back so as to inhibit wound occlusion.

NOTE 4 If stubs/snags survive, they might produce an unsuitably dense growth of new shoots. The formation of shoots is, however, usually an advantage in the “retrenchment pruning” of old trees, lapsed ancient pollards and damaged trees with conservation value. For these and certain other categories of tree special procedures, often involving the retention of stubs (see F.2, Note 5), are appropriate.

### 9.3.5 The position and angle of cutting for branch removal (“target pruning”)

When a branch is removed at its point of attachment, injury of the wood and bark of the parent stem or branch above the cut should be avoided (see Figure 2). If a branch collar is visible, the final cut should be just outside it (Figure 2, 1a). If there is a branch bark ridge but no visible collar, the cut should be made with its top edge just outside the ridge (Figure 2, 1b) and at right angles to the grain, unless experience indicates the need for a steeper angle (e.g. when the species or cultivar concerned tends to die back below right-angled cuts). The cut should in any case be more acutely angled where a co-dominant branch or stem is being removed, or where there is an acute union with ingrown bark.

If neither a collar nor a ridge is obvious (e.g. on a tree with very fissured bark), the top edge of the cut should be just outside the basal flare of the branch. When shortening a stem or branch, the final cut should be just beyond and parallel to the distal end of the bark ridge (if apparent) of a branch chosen for retention as indicated above (Figure 2, 1c). If the species has whorled branches (e.g. *Pinus* spp.), the final cut should be at right angles to the grain, just distal to a whorl.
WARNING. THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD. THIS DRAFT IS NOT CURRENT BEYOND 31 OCTOBER 2008.

Figure 2 – Final cuts

Key
1a Cut where branch collar and branch bark ridge are apparent
1b Cut where neither branch bark ridge nor branch collar are apparent
1c Position for end-cut in crown reduction
2a Cut too close (removing the branch collar and cutting into the bark branch ridge)
2b Cut too close (injuring parent stem in the crotch and too steeply angled)
2c/2d Cut too far out, leaving a stub (see F.2, Note 5 regarding stub retention in special cases)
2e Incorrect end cut (made beyond a branch that is too small)

Cuts on the same stem or branch should not be made near each other if their total cross sectional area would exceed half that of the parent branch (see also Table E.1).

NOTE The optimum position and angle of the end-cut cannot be exactly prescribed, as branch unions vary considerably in their conformation.

Except in retrenchment pruning (Annex F), care should be taken to avoid tearing or compressing retained wood and bark when the cut is made. If necessary, this should be done by making preliminary cuts so as to remove weight, before a final cut is made. Also, care should be taken to prevent falling branches from harming other parts of the tree (including its roots), its surroundings, people or property. Heavy branches should be removed in sections and, when necessary, should be lowered with ropes.
NOTE 1 Special guidance often applies to the “retrenchment pruning” of ancient trees (Annex F), when stubs might need to be retained so as to encourage new growth (see A guide to veteran trees [1] and the Good Practice Guide [6]).

NOTE 2 The treatment of pruning cuts is covered in Clause 10.

9.4 Deadwood management

COMMENTARY ON 9.4

The risk posed by dead branches depends on the location (e.g. whether the deadwood overhangs a “target” that cannot be readily moved, such as a highway) and the wood properties of the species concerned, the size of the deadwood (e.g. whether > 50 mm diameter). The dieback and shedding of branches are, however, natural processes within the development and aging of trees and provide essential habitats or places of shelter (i.e. decaying wood and cavities) for many species of fauna and flora.

Dead branches should be shortened or if necessary removed if they pose an unacceptable risk to people or property and if other options (e.g. diverting a footpath) are not practicable. The unnecessary loss of deadwood habitats should be avoided when making specifications for crown management, particularly if legally protected species (e.g. bats and many birds) are using the tree. Thus, in the absence of any significant risk to people or property, deadwood should not be removed.

NOTE 1 The hardened dead branches of several species of tree e.g. pedunculate and sessile oak, sweet chestnut and yew, can often be retained without unacceptable risk to people and property; such branches do not need to be removed where any risk associated with this deadwood is judged (by a risk assessment) to be at an acceptable level.

NOTE 2 If branches have died due to disease or to a pest infestation, their removal might be justifiable for sanitation in certain circumstances. There are, however, very few harmful organisms that can survive for long on dead branches and so the sanitation pruning of such branches is generally not appropriate except on specialist advice. On the other hand, the “sanitation pruning” of living branches is an accepted means of controlling various diseases, such as Nectria canker.

If it is appropriate to cut any dead branches (see Table 1), this should be done so as to avoid injury to living bark or sapwood, which could lead to the development of further dysfunction and colonization by decay fungi or pathogens (see Annex E).

9.5 Formative pruning

COMMENTARY ON 9.5

The main aim of formative pruning is to produce a tree which in maturity will be free from any undesired major physical weaknesses and which will complement the management objectives for the site.

If there is a need to control the shape or size of a tree crown, formative pruning should ideally start as soon as possible (i.e. in the nursery) and in any case should not be delayed more than three to five years after planting. If branches need to be removed or shortened so as to deal with undesired patterns of growth, this should be done in stages so as not to remove too much leaf cover at any one time. Ideally the selected branches to be removed should not exceed 20 mm in diameter at the point of attachment to the stem. Also, at least two-thirds of the height of the tree should preferably consist of live crown at all times.

NOTE 1 The term formative pruning may also be applied to more specialized practices, e.g. pollarding (9.10), cutting hedges (9.12), pleaching, the results of which are sometimes likened to a hedge on stilts, and more formal types of pruning, e.g. cloud pruning.
Within areas of high usage or formal plantings, co-dominant stems or branches arising from potentially weak unions in young trees should be removed so that only one of them remains. Where this would create a large wound, an unwanted stem should be shortened rather than removed, thus causing it to lose dominance.

NOTE 2 In the case of co-dominant stems, the rule of thumb stated in 9.3.4 with regard to wound-diameter cannot be applied. This might not be a serious problem if the wound is small enough to become occluded rapidly.

NOTE 3 Failure to manage co-dominant leaders and compression forks might eventually necessitate premature felling so as to safeguard people and property.

If two branches are crossing each other and likely to rub together, one of them should be removed or cut back to a point proximal to the zone of contact (see Clause 12 for bracing as an alternative).

NOTE 4 If crossing branches are in contact with each other, frictional damage or altered growth patterns could eventually lead to loss of strength or possible fracture in adverse weather.

If formative pruning involves the removal of lower branches (as in crown lifting), such work should be limited so that the crown always makes up at least two-thirds of the tree’s total height. The early removal of all the lowermost branches should if possible be avoided, as it could impair the development of a sturdy taper in the stem.

9.6 Crown thinning

Crown thinning should only be used to achieve specific objectives (see Table 1).

In crown thinning, an even density of foliage should be retained around a well-spaced and balanced branch structure which could, if appropriate, provide an adequate framework for a possible future crown reduction (e.g. in old pollards). If the objective is to reduce the overall mechanical loading on a defective branch or stem, crown reduction and reshaping should be chosen in preference (see 9.8).

NOTE 1 Crown thinning is not the most suitable method of reducing the overall loading on a defective branch or stem, since it does not reduce the lever arm and sometimes increases the probability of branch failure.

The percentage of the leaf-bearing area to be removed in crown thinning should be stated in any specification and should preferably not exceed 30%. The work should be done throughout the crown and should not be limited to the inner crown. In particular, the cutting of branches back to the main stem should be avoided if practicable.

NOTE 2 Uneven thinning or over-thinning creates gaps in the crown and/or “lion tailing” which increases the probability of branch failure.

Structurally weak or hazardous branches should be removed in the course of thinning.

NOTE 3 When one of a pair of crossing branches is cut and the remaining branch would thereby become likely to break, it might also need to be cut.

In most circumstances, crown thinning should preferably be avoided on species which tend to produce abundant epicormic shoots, so that the crown frequently becomes dense again.

NOTE 4 New branches that form in response to pruning sometimes have structurally weak or decaying attachments. This potential cause of mechanical failure is more likely to occur as a result of crown reduction than of crown thinning (see 9.8).

9.7 Crown lifting

COMMENTARY ON 9.7
Crown lifting involves pruning to achieve a desired vertical clearance above ground level or other surface (see Figure 3). This is sometimes necessary to allow site usage.

9.7.1 General

Crown lifting should if possible be phased over a number of years, with a view to providing some opportunity for physiological and mechanical adaptation to the resulting wounding and branch removal.

Crown lifting should be avoided or minimized in mature or old trees if possible, since it can increase the probability of stem failure. If it cannot be avoided, it should preferably involve the removal of secondary branches or branch shortening rather than branch removal, provided that the desired clearance can thereby be achieved. The choice of these options should take account of factors including the size, growth-potential, branching habit and shade tolerance of the tree.

NOTE 1 If crown lifting involves the removal of branches which form a substantial proportion of the lower crown of a mature or old tree, the resulting wounds on the main stem are likely to become the seat of extensive decay, which could eventually lead to mechanical failure. Failure could also become likely in the short term, since branch removal can cause an immediate impairment of mechanical properties.

Crown lifting that involves the cutting back of branches to the main stem should preferably not result in the removal of more than 15% of the live crown height and, unless the objectives change, should not be followed by further crown lifting (except in the case of a young tree undergoing formative pruning, see 9.5), which would increase the effect of wounding on the main stem and the impairment of mechanical properties.

NOTE 2 For example, if the stem of a 20 m high tree is branch-free to a height of 5 m, it could be crown lifted to a height of 7.25 m.

9.7.2 Specification for crown lifting

When specifying crown lifting, the points between which the clearance will be measured should be stated; for example, this may be from ground level or roof to the point of origin of the lowest remaining branch or the lowest remaining foliage.
9.8 Crown reduction and re-shaping

COMMENTARY ON 9.8

Crown reduction usually involves a reduction of the spread of the crown, as well as its height. It alleviates mechanical stress by reducing both the lever-arm and the sail area of the tree. Unlike topping, it retains the main framework of the crown and therefore a high proportion of the foliage-bearing structure, which is important for the maintenance of vitality.

9.8.1 General

Crown reduction should be considered in order to achieve an overall reduction in the height of a tree. Specification for such work should involve a general but not necessarily uniform shortening of twigs and/or branches. See Figure 4 for a general example.
The suitability of a tree for crown reduction should be assessed according to the prospects of preserving a satisfactory shape, its age and condition (vitality), the soil type and local climatic factors (rain, wind, etc.).

The extent of crown reduction should be determined on the basis of the objective and on an assessment of the ability of the tree to withstand the treatment (see Annex E).

The general principle is that, following reduction, there should still be a strong framework of healthy small-diameter branches and twigs, capable of producing dense leaf cover during the following growing season. In order to apply this principle, each tree should first be assessed so as to decide how much and where to cut.

Consideration should be given to:

a) the health and decay-status of a tree following crown reduction;

b) the tree’s safety immediately and in the long term;

c) management of new branch growth;

d) the safety of other trees, which could become more exposed to the wind as a result of the work;

e) the visual appearance of the tree.
Due to its potentially negative effects, crown reduction should not usually be done in combination with other crown pruning operations, which would add to the amount of wounding and leaf loss.

NOTE 1 Crown reduction often entails some degree of crown thinning, due to the selective removal of branches at their points of origin. This is especially the case with so-called “drop-crotch” crown reductions, which result in the thinning of branch tips.

NOTE 2 Within the context of crown reduction as opposed to “topping”, the diameter of cuts would not normally exceed 100 mm. Guidance on situations where a more severe crown reduction might be considered is given in Annex F.

9.8.2 Hazard management

In the context of hazard management, crown reduction should be considered as the principal means of reducing the wind loading on weak or defective parts of the tree (e.g. an extensively decayed stem or damaged roots).

NOTE Because of their form, structure or condition, not all trees are appropriate candidates for reduction.

9.8.3 Directional pruning

A crown should normally be reduced in proportion to its original shape but its shape may be altered if there is a specific objective to do this. If such work results in a substantial removal of weight or “sail area” from one side of a tree, the probable need for pruning on the other side of the tree for mechanical balance should be considered.

NOTE 1 Annotated photographs could be helpful in describing the desired result.

NOTE 2 Crown reduction to achieve a desired shape is known as crown re-shaping. Its purpose may be to create a desired appearance or to make the tree more suited to its surroundings. This technique has a place, for example, in managing previously pollarded, mature urban trees.

NOTE 3 Specific objectives may include the removal or shortening of branches near roads, railways, street lamps, utility lines (see 9.9), etc. on one side of the crown.

Directional pruning should be considered as an option, as it reduces or removes branches growing towards fixed apparatus or structures, but will retain other branches and help to direct new growth in a desired direction.

If specific branches need to be shortened or removed so as to increase horizontal or vertical clearance from other features e.g. streetlight, cable, or building façade, the specification should state the feature and the clearance to be achieved.

9.8.4 Specifications for crown reduction

The specification for crown reduction should be accurate and clear, so that the desired result is achieved. To avoid ambiguity, the specified end-result should be stated either as the tree-height and branch-spread which are to remain, or the average equivalent in branch length (in metres). End-results should be specified for individual branches if the growth habit of the tree creates a need for this.

NOTE 1 Specifications for a “percentage reduction” are imprecise and unsatisfactory without reference to volume, length, height, spread etc. A 30% reduction in crown volume can be considered to be approximately equivalent to a 12% reduction in overall branch length (i.e. radial distance). (See Figure E.1)

NOTE 2 Specifications for crown reduction which state what will remain are normally used to enable verification, but, to assist implementation, may be translated into what is to be removed (e.g. length of branch).
9.8.5 Follow-up work

Following crown reduction or re-shaping, subsequent branch growth should generally be managed so as to retain the desired results of the initial work. The time when the new branches are first cut should be determined according to the species, vigour and situation.

NOTE  Management of the new branches is likely to be necessary, so as to prevent them from breaking away from weak attachment points. This generally involves cyclic pruning (pruning cycles are likely to vary within a general range of three to seven years). A procedure known as “shoot renewal pruning” is an alternative to cyclic branch shortening or removal (see Annex F).

9.9 Pruning for infrastructure

9.9.1 Utility pruning

COMMENTARY ON 9.9.1

In areas where overhead electric conductors are present, crown reduction and/or reshaping (“utility pruning”) might be necessary so as to remove branches that could interfere with the electrical apparatus, or that could provide unauthorized people with easy access to electrical hazards (see Clause 7 and Annex C).

Utility pruning should be done in accordance with the general guidance for pruning, including directional pruning (see 9.8.3), especially so as not to leave branch stubs from which newly developing shoots could soon interfere with power lines.

NOTE 1 Conflict with fixed utility apparatus may, if strictly necessary, be avoided by means of directional pruning.

NOTE 2 Creating multiple wounds close together can lead to serious decay and reduce the safe life expectancy of the tree (see E.1.3).

NOTE 3 If utility pruning would make the shape of a tree very unbalanced, felling may be a preferable option (see 8.5 and Clause 14). Felling is also often preferable (instead of repeated crown reduction to achieve the required clearance) for trees directly underneath a power line. If, however, it is important to retain a tree and if the power line cannot easily be diverted, an unbalanced shape might have to be accepted, provided that the tree’s mechanical balance would not thereby be seriously compromised.

Accepted safety procedures should be followed at all times if pruning is carried out when lines are live/energized (see Annex C).

9.9.2 Transport, routes and watercourses

Pruning on highways, railways and watercourses should follow the recommendations in 9.1 to 9.9.

9.10 Pollarding

9.10.1 General

COMMENTARY ON 9.10.1

Pollarding is the production and maintenance of a form of tree with numerous branches arising from the same height on a main stem. It is also a system for managing trees in formal situations, either so as to control their size or for cultural reasons.

If pollarding is to be done, it should preferably start soon after the tree has become established and is between 25 mm to 50 mm in diameter at the selected height of pollarding (often 2 to 3 m). The height of the initial pollarding cut should reflect site usage.
NOTE 1 There is some benefit for the tree in having some foliage initially retained below this point, so as to reduce the probability of serious, perhaps total, dieback.

If the main stem divides into a number of branches below a height of 3 m, these should be individually cut so as to initiate a “candelabra” framework.

If the tree has attained a stem diameter of more than 50 mm, but less than about 200 mm at 2-3 m height, pollarding may still be started. The tree should be cut at or near the same height as a younger tree, but extra care should be taken to retain some existing branches. Larger trees should not normally be treated in this way (see Annex F for severe cutting for special purposes).

NOTE 2 As pollarding is initiated only on young trees, it is not synonymous with “topping”. Topping has many meanings but for present purposes it is defined as the removal of most or all of the crown of a mature maiden tree or the pruning of a pollarded tree below the “knuckles” (see Annex F).

Once initiated, a pollard should be maintained by cutting the new branches on a cyclical basis. Consideration may be given to selective cutting, whereby some of the pollard branches are retained within each cycle.

NOTE 3 The period between the cuts and the type of cutting will depend upon site management objectives, species, age, condition and/or any product that might be required. Selective cutting might help to prevent dieback and decay in the main stem.

Branches that grow after pollarding should normally be cut at their bases. If, however, the pollard cycle has been allowed to lapse over many years, the tree should normally be managed by retrenchment pruning (see Annex F).

NOTE 4 Removal of the knuckle equates to topping (see Annex F) and could lead to the extensive development of decay in the main stem.

9.10.2 Management of ancient lapsed pollards

NOTE 1 In order to help prevent an ancient lapsed pollard from falling apart, a planned and phased process of “retrenchment pruning” (see Annex F) may be undertaken. If this would be insufficient to safeguard those branches that are most likely to fail, they may be removed in one operation (a “pole thin”), while the remaining leaders are shortened so as to retain enough of the foliated structure to sustain the tree.

Except in cases where experience suggests otherwise, the leaders to be removed should be cut so as to retain stubs, (in accordance with Annex F), rather than cut immediately above the previous pollard points or “knuckles”.

NOTE 2 Retention of live stubs on lapsed pollards will often help to reduce the risk of serious dysfunction and hence decay and weakness developing below the knuckles.

Cuts should be made below the knuckles only in exceptional circumstances, e.g. to prevent catastrophic failure.

9.11 Climbing plants

The control of plants climbing on or over trees (see Annex F) is a practice that is appropriate in certain circumstances but should not be a routine aspect of crown maintenance except in certain circumstances; e.g. when there is a need to avoid the crown of the tree from being smothered (e.g. by clematis or Russian vine).

Any form of control of climbing plants should be undertaken with care so as to avoid undue damage to the tree (e.g. sunscorch) and/or the wildlife that might use the habitat (see 8.5 and Annex A). Removal or control of climbing plants should be considered if:
a) a risk assessment indicates a definite need to remove a climbing plant which could be hiding decaying or weak structures on a tree which requires close inspection due to high site usage;

b) the plant is growing high into the crown of a tree, so as to increase resistance to the wind;

c) the plant is significantly weighing down a branch or a leaning tree;

d) the tree is otherwise likely to be smothered (e.g. by clematis or Russian vine), especially if it is old and therefore unlikely to outgrow the climbing plant;

e) in a formal, high amenity area, the retention of the plants would be incompatible with objectives for maintaining the retention of the plants would be incompatible with objectives for maintaining the form and general appearance of trees.

If a climbing plant is to be controlled, this should be done by removing it if necessary or otherwise by periodically cutting selected stems, so as to cause them to die back. Where it is desirable to prevent regrowth, chemical treatment may be appropriate (see Annex H).

NOTE 1 Retaining some of the foliage will help to reduce the impact on wildlife habitats.

NOTE 2 The dead stems of a climbing plant might, in some circumstances, be regarded as unsightly and, when its stems become loosened from the tree, they can present a hazard.

NOTE 3 Ivy, the commonest climbing plant found on mature trees in Britain, is a native species that benefits wildlife as a foodplant and as shelter. It has previously been regarded as not generally causing significant damage to the support tree unless the tree is already in declining health. It is, however, increasingly observed to extend higher into the crowns of trees. This can sometimes compromise the health or mechanical stability of the tree. Also, ivy weighs down non-vertical structures such as branches and strongly leaning stems. See APN10 [7] for general guidance and The Good Practice Guide for the management of veteran trees for guidance on the impact of ivy on habitats [6].

9.12 Cutting hedges

COMMENTARY ON 9.12

Excessive pruning can be detrimental to certain species of hedging plants, especially conifers (see 9.3). An alternative to an excessive management regime or severe pruning that will disfigure or debilitate the hedge is to consider removal and replanting.

Major pruning should be carried out in such a way as to minimize disfigurement of the hedge and allow the production of new foliage. Final pruning cuts should be made in accordance with 9.3.5. Also, pruning should be carried out in accordance with 8.5 and Annex A to avoid disturbance to wildlife.

NOTE BS 7370-4 deals with the routine maintenance of hedges.

9.13 Removal of inappropriate objects

Inappropriate objects attached to or within the crown of a tree (e.g. wires, clamps or boards or old cable ties) should be removed in the course of crown management, when this can be done without inflicting undue damage on the tree concerned.

10 Wounds and other injuries to trees

COMMENTARY ON CLAUSE 10

This clause covers wounds and other injuries caused by mechanical force, extremes of temperature and other agents such as pathogens.
The guidance is concerned only with the woody parts of a tree. Wounds that affect these parts fall into two main categories:

a) “bark wounds”, in which the underlying sapwood is exposed but not directly damaged (see 10.3);

b) cross-sectional wounds in which both bark and wood (sapwood, or sapwood and heartwood) have been cut, or where wood has been broken, splintered or otherwise damaged (see 10.4).

A bark wound usually allows the affected area to dry out, so that the cambium and the outermost part (at least) of the sapwood become physiologically dysfunctional. The inner, living tissues of the bark around the wound also become dysfunctional. Fungi, bacteria and insects can readily develop in dysfunctional tissue.

Cross-sectional wounds are potentially more harmful than bark wounds, since they sever the water-conducting cells of the sapwood. It is useful to subdivide such wounds that extend:

a) only into sapwood;

b) into durable heartwood;

c) into non-durable heartwood/ripewood.

Information about the effects of injuring the above tissues is shown in Annex E.

For advice on the treatment of decay associated with wounds, see Clause 11.

10.1 The significance of wounds

People engaged in tree work should be aware of the potentially adverse effects of wounding the tree.

In assessing the significance of wounds, a distinction should be made between durable heartwood and non-durable heartwood/ripewood.

10.2 Prevention of wounds that could lead to decay

COMMENTARY ON 10.2

As explained in Clause 9 and in Annex E, the wounding of wood can lead to the development of decay in the long term. This is a particularly important consideration if the wound exposes non-durable heartwood or ripewood.

Accidental and other unnecessary wounding of woody tissues should be avoided. In particular, trees should not be pruned without good reason (see Table 1); if pruning has to be done, the tendency for serious decay to develop can be reduced if the guidance in 9.3 is followed.

NOTE 1 Wood decay is generally less significant for young trees (if well established) than for mature specimens, since they have greater potential to lay down new decay-free wood around a decayed zone.

NOTE 2 Provided that the tree is annually producing substantial increments of new wood, it will have the capacity to occlude wounds by the growth of new wood and bark around the wound edges. If in the meantime the exposed wood has become colonized by decay organisms, any decay will tend to be arrested when occlusion occurs. Occlusion of very large wounds is, however, not usually a realistic prospect.

10.3 Treatment of bark wounds

COMMENTARY ON 10.3

Bark wounds rarely lead to serious physiological dysfunction or decay except when a very large proportion of the circumference of the stem is affected. In some cases, however, they can be colonized by fungi, bacteria or insects with the capacity to harm the tree. Also, the occluding tissues that form around bark wounds sometimes develop so as to form bark inclusions, which could eventually trigger mechanical failure.
Wounded bark, together with a rim of bark that dies back after wounding, often remains in place. If it is hard and inflexible, it might inhibit the development of occluding tissues. Very occasionally, it might assist the development of potentially harmful organisms such as canker fungi.

10.3.1 General

If bark has been recently detached it should be held in place or replaced by a moisture-retentive wrapping so as reduce moisture loss, with a view to encouraging growth of callus over at least part of the exposed surface of the sapwood or cambium.

NOTE 1 As with all wounds, the occlusion of bark wounds normally takes place only from around the edges. If, however, the exposed cambial zone remains moist, it might in some cases form patches of callus and eventually new bark and wood on its surface.

Bark wounds should be left until the position of occlusion growth is obvious, and any dead or loose bark may then be gently removed so as to alleviate any restriction on the growth of the occluding tissues and also so as to view the developing margin of these tissues. If the margin shows any abrupt indentations or corners, these should be scribed with a sharp blade so as to create a smooth outline and thus to help avoid the development of bark inclusions. The wound should not otherwise be enlarged.

NOTE 2 Cankers are often similar in appearance to wounds but they are caused by bark-killing pathogens rather than by mechanical force. Also, a pathogen might colonize the tissues around a wound, so as to cause the formation of a canker larger in size than the original wound.

If there is a high risk of a bark wound being colonized by a pathogen such as a canker fungus (e.g. *Nectria* spp.), the use of an approved wound protectant, where available, should be considered. The treatment should cover at least the edges of the wound(s).

10.3.2 Girdling bark wounds

COMMENTARY ON 10.3.2

If a wound girdles the stem or affects most of the circumference (as sometimes happens, for example, due to animal browsing, rubbing or fraying), there is little chance that the growth of callus and occluding tissues will satisfactorily re-connect the tissues above and below the wound. It might, however, be possible to bridge graft over the wound (see *The grafters handbook* [8]).

Bridge grafting should be considered as a treatment of a girdling wound, taking account of the operator’s skill, the tree species, the length of time since the wound occurred and the time of year (it is often most successful when undertaken during the dormant season). If there is little chance of restoring the tree to normal health and vigour, establishing a replacement should be considered.

10.4 Treatment of wounds that penetrate the wood

Generally, exposed wood should be left untreated. If, however, wounded sapwood is at risk of being colonized by a fresh wound pathogen, such as *Chondrostereum purpureum* (the cause of silver leaf disease in rosaceous trees), an approved wound protectant should be applied to the fresh wound as soon as possible (also see 9.3.1 and 9.3.4).

NOTE 1 As a general rule, wound treatment with chemicals or “sealants” is not of any proven benefit against decay-causing organisms, mainly because of inadequate long-term persistence, penetration or adhesion. Short-term protection is, however, of value against pathogenic fresh wound colonizers (see E.1.2).

NOTE 2 Wounds older than about one month are likely either to have been colonized already or to be no longer susceptible.
No attempt should be made to stop the loss of xylem sap from a wound, since this is not normally practicable and causes no harm other than the possible depletion of dissolved sugars (see E.1.4.3 for information on loss of sap and Clause 8 for information on the season of pruning).

If a fluid other than sap is seeping from a wound, expert advice should be sought regarding its significance and the possible treatment of the condition.

10.5 Cankers
If an active canker has developed around a wound, consideration should be given to excision of the dead tissues. The dead bark should be carefully removed together with a surrounding margin of apparently healthy bark.

NOTE This might, however, involve an excessive proportion of the circumference of the affected part if the canker is large.

If an approved canker paint is available, its use should be considered.

If during inspection, decay is found, appropriate treatment should be considered (see Clause 6 and Clause 11).

10.6 Root wounds – additional considerations

NOTE For protection of roots, see Annex K

Damaged roots or those that have to be pruned should be cut so that the final wound will be as small as possible and free from ragged torn ends.

If root damage has occurred, its extent and therefore its consequences for the condition of the tree and for the safety of people or property should be assessed (see Clause 7) and appropriate remedial action taken in accordance with Annex K.

11 Decay, cavities and water pockets

COMMENTARY ON CLAUSE 11

Any part of a tree can decay. Decay is caused by various fungi, bacteria or other organisms. In the woody tissues of a tree, this sometimes progresses until a hollow (cavity) is formed. The decay of wood can affect the mechanical integrity of the tree.

11.1 Inspection of decay and cavities

11.1.1 General

Cavities and other zones of wood decay should be inspected (see Clause 6) so as to determine their extent and significance for the mechanical integrity of the tree.

NOTE See Clause 5 and Annex A regarding legal requirements for wildlife protection.

11.1.2 External signs of decay

COMMENTARY ON 11.1.2

The most obvious signs of decay include open cavities and areas of exposed decaying wood (e.g. on old pruning wounds or where bark is missing). Less obvious signs which might indicate decay include various kinds of swelling, cracking or stretching of bark or underlying wood (see The body language of trees [9]).

Toadstools and fungal brackets are the reproductive and dispersal organs of many fungi, most of which are harmless or beneficial to trees. Fungi gain nutrients and energy they require by breaking down
organic matter – this may be the woody material of a tree, above or below ground. Fungal decay is, however, often very localized, e.g. on areas of exposed dead wood – and does not necessarily impair the mechanical integrity of the tree.

Toadstools, brackets or other types of fungal fruit bodies that are found on a tree or on the soil above tree roots should be identified if there is a need to determine whether decay is present in the tree, e.g. due to concerns about safety (see Clause 6). If advice is needed on the identification and significance of toadstools and fungal brackets growing on or in the vicinity of a tree, it should be sought from a person with appropriate knowledge of arboriculture and mycology.

11.2 Remedial action
Where a tree is found to be so mechanically weakened, by cavity formation or other decay, that it poses an unacceptable risk to people or property, remedial action should be taken.

NOTE 1 Remedial action may involve moving the “target” or tree work such as height reduction, selective branch removal or felling. Where it is not practicable to reduce the lever arm of a branch or stem affected by a cavity (see Table 1), for example if the tree is of high value and is not amenable to substantial height reduction, the walls of the cavity may be braced (see Clause 12).

NOTE 2 Filling cavities is not generally considered to improve the mechanical integrity of the surrounding wood and indeed might inhibit the development of pillar-like rolls of occluding wood, which provide natural strength at the edge of a cavity opening. See 11.3.3 regarding control of access to cavities.

11.3 Intervention to influence the decay process
COMMENTARY ON 11.3
Once decay has begun in a tree, some forms of management might help to limit the rate or the eventual extent of the decay, while others might accelerate the process.

11.3.1 Treatment of dry cavities
NOTE 1 If a cavity is dry it may be cleared of loose rubbish and rotten (soft) wood in order to assess its extent and the need for any further work.

NOTE 2 Partly decayed wood can provide a food base for the survival and further development of wood-rotting fungi. Its removal or partial removal might therefore be of some benefit to the tree.

There should be no attempt to cut into or expose sound wood since the resulting wounds are likely to breach the tree’s natural defences against wood-rotting fungi.

Decaying wood lining the cavity should not be removed if it is likely to be the habitat of any rare or endangered species, especially those protected by law (see Clause 5, Annex A and Annex F).

11.3.2 Wet cavities
NOTE See also 11.4.

Water-filled cavities should not be drained, since drilling drainage channels will breach defensive barriers, allowing decay to extend into previously sound wood. Also, the retention of continuously wet and stagnant conditions helps to deter decay.

If bolts are to be inserted so as to strengthen the walls of a wet cavity, (see 12.4 rigid bracing), this should be done above the level at which water accumulates.
11.3.3 Control of access to cavities

COMMENTARY ON 11.3.3

Open cavities are not a mechanical problem in themselves, provided that the width of the cavity opening is judged to be within current mechanical failure criteria, and they provide essential habitats for many forms of wildlife (see 8.5). In some localities, however, such cavities might attract arson, other vandalism or pose an unacceptable risk of harm to small children. If so, it may be worthwhile to install some form of barrier so as to deter human access.

The method used to restrict access into a cavity should avoid interference with the natural occlusion of the cavity-opening. It should be designed so as minimize any adverse effects on species of wildlife that might be using the cavity.

NOTE  The method of restricting access into a cavity may take a number of forms, e.g. stout wire netting, inserted so that it cannot easily be removed.

11.4 Water pockets

COMMENTARY ON 11.4

Water pockets form where water accumulates in cavities or concave areas, e.g. crotches

If a water pocket is free from decay, no action should be taken.

If decay is present, the water pocket should be treated in the same way as a wet cavity (see 11.3.2).

12 Management of weak structures

COMMENTARY ON CLAUSE 12

Trees can develop structures susceptible to mechanical failure. These might take many years to develop before they become threats to the tree or people and property (see 9.5 for preventative pruning). Weaknesses in a tree might develop because of damage or growth pattern (e.g. tight forks, included bark) but eventual failure is frequently precipitated by factors of the weather, particularly wind and snow.

Introduction of mechanical restraint into a tree might reduce the risk of structural failure and/or lessen the risk in the event of the restrained part failing. This can conserve the integrity of a tree’s structure and appearance.

12.1 General

In order to address a risk posed by a weak structure (see Clause 6 and Clause 7), the following options should be considered, singly or in combination, to achieve an acceptably safe remedial treatment:

a) moving or modifying the “at risk” target (see 6.3);

b) pruning to reduce the leverage on parts of the tree (see Clause 9);

c) installing braces or props to provide support (in accordance with Annex G);

NOTE 1 In some forms of fastigate trees, there is a tendency for individual branches to become permanently displaced from the outline of the crown. This is unsightly and the displaced branches can break out. When branches are displaced they may be repositioned and supported with netting wrapped around the tree, however, in some instances such branches may be pruned out without disfiguring the tree.

d) felling (see Clause 14).
Structural weaknesses should be identified and evaluated in relation to their potential for failure, the target, and the potential long-term effect of mechanical restraint on the tree.

The choice of any mechanical restraint and the way in which it is used should take account of future adaptive growth of the tree.

**NOTE 2** Appropriate restraint may be provided by one of the following three types of mechanical installation:

- **a)** flexible bracing – the installation of either steel cables or synthetic fibre ropes to reduce dynamic loading on potentially weak structures and thereby to restrain excessive movement. This operation is often accompanied by pruning to reduce the loading on weak structures (see Clause 9);
- **b)** rigid bracing – the installation of rods into the tree to limit movement or to help support a weak structure;
- **c)** propping – the provision of support from the ground or a solid structure to the underside of a branch or to a stem, sufficient to reduce the risk of fracture or uprooting of the tree.

The design, materials selection and installation of any form of mechanical restraint should be undertaken by an arboriculturist experienced in this aspect of tree care.

**NOTE 3** It might be necessary to seek guidance from a mechanical engineer.

### 12.2 Materials in braces

All components and materials used in a brace should be of appropriate strength and characteristics for the anticipated maximum loadings to effect the support safely and have a safe working load $4.5 \times$ (check LOLA (7x) and PPE regulations (10x)) the anticipated maximum load.

The component parts of a brace should be compatible and such that their strength properties are maintained for at least twice the stated inspection period (see Clause 6 and Annex G).

**NOTE** Introduction of artificial materials (e.g. metal bolts and cables) can alter the pattern of damage that occurs if the tree is subsequently struck by lightning.

Where lightning conductors are fitted to a tree, all metal components should be connected to the conductor(s).

### 12.3 Flexible bracing

**12.3.1 General**

**NOTE 1** Flexible braces can be bespoke (See Annex G) or a manufactured system. A brace may be attached either to an eye secured into the tree (invasive) (see 12.3.2) or a belt passing around the parts of the tree (non-invasive) (see 12.3.4).

The attachment of the flexible brace to the restrained branch or stem should be at least two thirds of the distance out from its base. The flexible brace should have a minimum angle of $45^\circ$ to the restrained part.

When constructed, a flexible brace should not displace the restrained branch or stem from its resting position, but when the restrained part of the tree is at rest, the brace should not be slack at any time of the year.

**NOTE 2** To make allowance for seasonal weight variations and growth, a flexible brace may include an appropriately specified spring or shock absorber.
Cables or ropes should not rub against each other or against fixings, or any part of the
tree.

12.3.2 Fixing anchor points using eyebolts and screw eyes
Eyebolts and screw eyes should form a straight line with the fitted cable and should
be inserted through or into the trunk or branch.
Screw eyes should not be used in decayed or damaged wood or in soft wooded trees,
e.g. *Populus* spp, *Salix* spp or *Aesculus* spp.
Eyebolts should be fitted using washers and “spacers” (see Figure 5).

Eyebolts and screw eyes should fit flush to the branch with the eye oriented along the
axis of the branch.

12.3.3 Securing flexible braces
Only one cable should be attached to each screw eye or eyebolt except where a
through system is adopted, when cables can be attached to both ends of the bolt
provided they are all in line (see Figure 6).
Multi-strand high tensile cables should be fixed to eyebolts or screw eyes by securing around thimbles using a minimum of three wire rope grips (see Figure 5).

**12.3.4 Installing anchor points for non-invasive flexible braces**

Securing belts and slings should be positioned and constructed so that they do not slip or cause abrasion or constriction of the stem or branch to which they are attached. Synthetic fibre ropes should be secured in accordance with manufacturer’s recommendations.

**12.3.5 Maintenance of flexible braces**

All components of flexible bracing systems should be inspected for wear and tear and continued suitability for purpose at regular intervals (e.g. every 3-5 years) and necessary maintenance/adjustment/replacement undertaken.

With specific reference to synthetic fibre bracing materials, particular attention should be given to material-specific factors (e.g. photodegradation of soft materials) and the manufacturer’s recommendations should be followed.

**12.4 Rigid bracing**

**COMMENTARY ON 12.4**

Rigid bracing is most commonly used to help support a split trunk or weak forks, sometimes in conjunction with flexible bracing and/or pruning, or as a reinforcing measure for decayed stems or branches. Crossing branches may also be secured by rigid bracing.

**12.4.1 General**

*NOTE* Rigid bracing involves solid rods or bolts (see Annex G for details of materials) secured into the wood across structural weaknesses in a tree.

The cause of the split in a branch or stem should be assessed. The use of rigid bracing should be considered as a means of preventing further opening of a split. If appropriate, mechanical stress on the split should be mitigated with a rigid brace and/or pruning of the crown.

When removal of one branch of a pair that rub together would disfigure or unbalance the tree, the two parts should be either held apart or bolted together.
The position of rigid braces should be decided taking account of the need to avoid breaching natural barriers within the tree and the propagation of new splits between the braces.

When bracing the walls of a cavity, the principles of rigid bracing should be observed but there may be an additional need to secure the bolts or rods both inside and outside the cavity, using nuts and washers. Such work should not be undertaken without a proper assessment both of the mechanical effects of the brace and of the probable spread of decay via the holes needed to insert the bolts.

12.4.2 Care and maintenance of rigid braces
Rigid braces should be inspected every 3-5 years to check for recent cracking associated with the bolts and for evidence of further movement in the original weak structure.

Signs of decay in the vicinity of the brace should be investigated to ascertain their extent and significance for the effectiveness of the brace.

Where new defects are identified, the management options and treatments should be re-assessed and appropriate action taken.

12.5 Other attachments to trees

COMMENTARY ON 12.5
Trees have for long been used as supports for fences and notice boards etc. Lightning conductors are being prescribed as preventative measures for valuable trees, while increasingly trees are being used as supports for CCTV cameras and lights, both security and ornamental lights.

Attachment to a tree using bands of metal or other materials around parts of trees should be avoided unless annual inspections and adjustments will be made to minimize the risk of unacceptable damage to the tree.

Fastenings into trees should allow for radial growth in the part of the tree to which attachment is made.

NOTE Inappropriate fastenings e.g. plastic cable ties, rope and wire, and their neglect will result in damage and, in extreme cases, death of the tree.

12.6 Propping

12.6.1 General
Propping should be considered where the removal of a low branch or windblown/leaning tree, because of concern over structural integrity and/or stability, would conflict with other tree management objectives or site usage.

NOTE Excessive artificial support could adversely affect adaptive growth.

12.6.2 Propping branches
The object of propping a branch should be to prevent excessive movement that could lead to failure.

Where a prop is used, it should be designed to reduce the probability of failure, not to replace the support of the branch in its entirety. The natural position of a branch to be supported should not be altered to accommodate a prop system.
NOTE 1 For example, long, heavy low branches that are liable to fail may be pruned so as to reduce their length or weight. If the result would be unacceptable because of the size and location of wounds (see Clause 9) and the visual impact of the action, propping may be an option.

NOTE 2 In appropriate circumstances, it may be acceptable to install a soil mound to support the branch or to allow low branches to bend or partially break, until they reach the ground. By this means, the branch is retained and serves as a natural prop for the tree. Branches in contact with the ground can “layer” themselves by developing adventitious roots. This can be a critical factor in extending longevity.

12.6.3 Propping windblown/leaning trees

NOTE 1 Many trees that develop a lean become stable over a period of time.

NOTE 2 It will rarely be practical to return a blown tree to its original position.

Where space permits, blown trees should be retained and allowed to regrow.

Where a recently windblown tree lacking anchorage or a leaning tree which has become unstable is to be propped, it should be positioned and a firmly founded prop inserted so that the prop is placed under compression.

12.6.4 Prop design and materials

The design of a restraint system should take account of all anticipated loads, both vertical and lateral, providing a safe working load allowance, (Acrow props safe working load margins) and should take account of the location, appearance and other relevant site factors.

A prop should be designed, founded and installed to restrict movement of itself and the propped branch or tree. Abrasion or dislodgement should be prevented by appropriate design of the prop head e.g. a cushioned “U” shape form.

Materials used should be durable, but should not constrict the supported part of the tree. The life expectancy of materials should be at least twice the stated inspection period.

NOTE Materials commonly used for propping trees or parts of trees include timber, scaffold poles and engineered devices both of which can be adjustable, and built structures e.g. soil mounds or brick structures.

12.6.5 Inspection of props

The condition of the tree and the prop should be assessed periodically and appropriate action taken to ensure that neither the tree nor its prop pose an unacceptable threat to people and property.

The inspection interval should be determined according to the type of prop, the materials used in its construction, the condition of the tree and the site usage (i.e. the presence of any targets within falling distance).

Additional inspections should be made after extreme weather events or if the site usage increases.

NOTE 1 Attention is drawn to the Construction (Design and Management) Regulations 2007 [10].

NOTE 2 See Clause 6 and Clause 7.

12.7 Guying unstable trees

COMMENTARY ON 12.7
In some instances (e.g. because of the height of the tree) it might be impractical to use a rigid prop to support an unstable tree. A system of cables may then be an option if site usage permits.

Any guying system should be designed in consultation with an engineer and should use a minimum of two anchor points with a 60°-90° angle horizontal separation. Proprietary cables and anchors should be installed to the manufacturer’s specification. The cables should not cause damage to the tree at the point of attachment (see 12.3.1).

13 Tree roots and their environment

13.1 General

A tree’s root system is made up of large diameter often brown roots which are found close to the base of the trunk. These roots divide repeatedly and rapidly to form a mass of fine thread-like roots which are important for water absorption from the soil. These roots usually develop in association with fungi (known as mycorrhizal fungi) which assist in the uptake of essential nutrients from the soil. The fine roots and associated mycorrhizal fungi, along with other soil organisms, are very easily damaged or killed particularly by changes in the physical conditions in the soil. Addition of fertilizers can suppress the beneficial activities of the mycorrhizal fungi or encourage the development of non-mycorrhizal roots.

Healthy tree roots are able to function properly in the presence of oxygen in the soil and they grow through the soil. Reduced intake of oxygen, moisture or nutrients can result in a reduction in growth. In extreme cases crown dieback or even tree death will occur.

For tree roots to survive and function effectively they need to be able to penetrate the soil and have access to oxygen and water throughout the soil they occupy. It is generally accepted that a tree’s roots can extend a radial distance often greater than the equivalent height of the tree, with the majority being located in the upper 600 mm of soil.

Adverse changes in the soil and damage to the roots should be avoided (see Annex I). In some instances an adverse change will be known to have occurred, in other cases trees could have been damaged by unrecorded events, the nature of which should be investigated before a treatment is formulated.

Investigations should include consideration of naturally occurring adverse conditions, species and age, and location of the tree.

Investigations should be carried out in such a way as to avoid adversely affecting the roots and soil, and any other adjoining trees.

NOTE 1 Following damage to the roots, a tree might take many years to show distress.

NOTE 2 For common causes of damage and options for remediation see Table 2.

Where survival of a tree is in doubt, consideration should be given to planting one or more replacement trees.
Table 2 – Root and soil problems: possible options for remediation

<table>
<thead>
<tr>
<th>Problems</th>
<th>Options for remediation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mulching (see 13.2)</td>
</tr>
<tr>
<td>1. Contamination of the soil</td>
<td></td>
</tr>
<tr>
<td>Pesticides</td>
<td>✓</td>
</tr>
<tr>
<td>Pollutants</td>
<td>✓</td>
</tr>
<tr>
<td>Excess fertilizers</td>
<td>✓</td>
</tr>
<tr>
<td>2. Soil water relations</td>
<td></td>
</tr>
<tr>
<td>Flooding</td>
<td>✓</td>
</tr>
<tr>
<td>Drought</td>
<td></td>
</tr>
<tr>
<td>3. Alteration of soil level</td>
<td></td>
</tr>
<tr>
<td>Raised soil levels</td>
<td>✓</td>
</tr>
<tr>
<td>Erosion</td>
<td>Possible</td>
</tr>
<tr>
<td>Sealing the soil</td>
<td>✓</td>
</tr>
<tr>
<td>Compaction of the soil</td>
<td>✓</td>
</tr>
<tr>
<td>Severance of roots</td>
<td>See 10.7</td>
</tr>
<tr>
<td>Fire</td>
<td>Possible</td>
</tr>
<tr>
<td>Pests and diseases</td>
<td>Possible</td>
</tr>
<tr>
<td>Nutrient deficiency</td>
<td>Possible</td>
</tr>
</tbody>
</table>

NOTE  Possible” indicates a less well proven treatment that might provide benefit. A tick indicates an established practice.

Addition of organisms to a soil should only follow rigorous investigation of the soil conditions and demonstration that other conditions in the soil are appropriate for tree root functioning.

13.2 Mulching

COMMENTARY ON 13.2

Organic matter (e.g. dead leaves) frequently accumulates on the ground under trees. This reduces evaporation of water from the soil and, as the material breaks down nutrients are recycled into the soil and become available to the plant. This process can be assisted by applying mulch.
Advantages of mulching are:

- moisture retention;
- weed suppression;
- beneficial soil flora and fauna (e.g. worms);
- relieves/prevents compaction;
- mitigates extremes of soil temperature;
- absorbs toxic materials.

Disadvantages of mulching are:

- can lead to retention of excess water, potentially leading to anaerobic conditions;
- can introduce and/or encourage root infecting pathogens;
- induces surface rooting.

A material used as mulch should:

a) be non-toxic in its applied form or as it breaks down;
b) be capable of retaining water in the soil below;
c) not harbour pests or pathogens;
d) have a life consistent with planned management or the anticipated need for the conditions under the mulch;
e) be sightly, i.e. it should not detract from the tree’s appearance (e.g. black polythene can be blended into the landscape by covering it with a thin layer of gravel or chipped woody material).

Pulverized bark and chipped woody material arising from tree work should be composted for at least a month before being applied if there is a possibility either of pests or pathogens being present, or a short-term nitrogen deficiency in the treated tree being unacceptable.

Fresh organic matter (e.g. lawn mowings, animal manure) should not be used as mulch.

Mulches should not be applied on soils that are prone to waterlogging or that are particularly susceptible to soil inhabiting pathogens (e.g. Phytophthora species).

To be effective, mulches should be applied over as much of the root system as practicable, but not against the bark of the trunk, or over major roots that are visible on the soil surface.

Where manufactured sheet materials are used as mulches (e.g. black polythene, carpets and cardboard), these should be secured to prevent them being lifted by wind, and inspected regularly to ensure they remain suitable for purpose.

Mulches should be maintained or topped up regularly as appropriate.

### 13.3 Aeration/decompaction

**NOTE.** Soil compaction can be relieved, over time, by eliminating the cause of the compaction and allowing natural processes to operate. Such natural decompaaction may be hastened by covering the area of the root system with an organic mulch (see 13.2).
Where soil compaction and physical conditions are thought to be limiting tree growth, the soil conditions in the area of the root system should be investigated by excavating small pits, or by use of a soil sampler so that problems are identified and appropriate prescriptions formulated.

Operations to improve soil physical conditions should be as extensive as possible, but within the root system of the tree the intensity of treatment should not be so great that the tree’s roots will be irreparably damaged.

Options that should be considered for improving soil physical conditions are:

a) use of a soil auger;

b) radial trenching;

c) injection of gas or water under pressure.

(See Annex I).

NOTE 2 The benefits from any treatment designed to improve soil physical conditions might require a long time (years) for a tree to show full benefit.

Any attempt to break up compaction in the soil has potential for damaging roots; disturbance of the soil should, therefore, be localized and controlled so that major roots (i.e. 25 mm and greater diameter) are retained undamaged.

After decompaction the ground should be made good by back filling with a coarse material, possibly enriched with fertilizer. The backfilling should not be compacted but allowed to settle naturally and periodically topped up.

13.4 Removal/replacement of soil

13.4.1 Soil removal

Where the soil level has been raised over the root system of a tree, consideration should be given to:

a) the age, condition and species of tree and its tolerance to soil level changes;

NOTE 1 Some species, notably Poplars, Willows, London plane and the Cypress type conifers, can tolerate some soil being placed over the roots and they might even benefit by producing adventitious roots from any buried stem tissue.

b) the length of time that the increased soil level has been in place;

NOTE 2 Removal of added material that has been present for a long time around a tree might result in water stress or bark and root death.

c) the nature of the added material and how it was placed (i.e. loose, tipped or compacted by heavy machinery).

Investigation by hand tools should determine whether a healthy root system has extended into the added material; if so, the material should be left intact.

Decompaction and aeration of the area of the root system should be considered as an alternative to the removal of added material (see 13.3).

13.4.2 Soil replacement

Where roots have been exposed by removal of soil (i.e. by lowering the ground level) the tree should be assessed for stability (see 12.7 and Clause 14 for options) and, if
appropriate, good rootable material should be placed over the area without compacting the soil.

13.5 Irrigation/drainage

NOTE 1 Established trees generally are able to fulfil their water needs by developing roots where water is available in the soil. In periods of drought they are able to adapt – some trees might shed their leaves earlier than usual, others might be able to extract water from other parts of the soil.

NOTE 2 The symptoms of too much water and too little water in the soil are generally the same. Site investigations can demonstrate the likely scenario.

NOTE 3 Excess water in the soil could occur due to unnecessary irrigation combined with natural precipitation, or from the addition of bulky organic matter to the soil as a soil improver or as a mulch. This, particularly over a protracted period, can favour pathogens (e.g. Phytophthora species) that can kill roots and even whole trees.

Irrigation should be applied to established trees only when there is a demonstrated shortage of water available in the soil around the root system.

Irrigation should be applied so that it wets the whole tree root volume as a slow trickle onto the surface of the ground over a period of several hours.

NOTE 4 Flooding water onto the soil surface leads to run-off, wasted water and the tree remaining in a water shortage situation.

Where water collects on the surface of the soil, whether from poor irrigation practices or from precipitation, steps should be taken to channel it away from the vicinity of the tree.

NOTE 5 Soil decompaction (see 13.3) can assist by encouraging water to move through the soil.

13.6 Nutrient deficiency

COMMENTARY ON 13.6

Poor growth in trees is often attributed to a deficiency of available minerals and/or nitrogen (nutrients) in the soil. Other causes, e.g. root severance, can produce similar symptoms. Annex D reviews some commonly encountered causes.

Chemical analysis of the soil can indicate which if any nutrient is lacking, or present at a level that could be limiting to growth. Only in extreme cases will chemical analysis of foliage indicate an imbalance of nutrients.

Thorough site investigations should be undertaken (in accordance with Annex M) to find possible explanations for any symptoms of poor growth or decline before any remedial work is formulated.

Where chemical analysis of the soil has confirmed a nutrient deficiency, consideration should be given to developing an appropriate fertilizer regime, with materials being applied at the manufacturer’s recommended rate(s) where available.

NOTE Applications of fertilizers are usually made into holes augered into the soil (see Annex I).

13.7 Other treatments

13.7.1 Soil organisms

NOTE There are commercially available soil additives that contain preparations of mycorrhizal fungi. If such products contain fungal species that are suited for local conditions and compatible with the tree species concerned, they might help the establishment of trees in soils that are deficient in mycorrhizal fungi. They will not, however, be of benefit if soil conditions are hostile to root development. Also, it has not been scientifically proven whether they benefit established trees.
Addition of organisms to a soil should only follow rigorous investigation of the soil conditions and demonstration that other conditions in the soil are appropriate for tree root functioning.

13.7.2 Contamination of the soil

*NOTE* The range of potentially damaging materials that can contaminate soil is infinite. Some are toxic (e.g. weedkillers) while others alter the soil properties (e.g. oils), the duration and significance of which can vary. It is not possible to prescribe treatments for all of these. Testing and chemical analysis may be needed to determine the nature of a contaminant.

Where a soil has been contaminated, advice should be sought from a person experienced in treating such problems.

14 Tree felling and stump management

14.1 General

The effects of removal of trees on soil and local climate should be recognized and factored into decisions about future use and management of the site occupied by them. Consideration should also be given to the impact of exposing retained trees. Where a tree is removed, its replacement should be considered.

The potential for indirect damage occurring as a result of tree removal should be recognized (see BS 5837) and communicated to the owner.

*NOTE 1* Indirect damage to structures as a result of either retaining (subsidence) or removing (heave) trees on shrinkable soils is difficult to predict.

Every option, from retaining as much of the tree as possible to complete removal, has advantages and disadvantages and these might have further management implications which should be considered in coming to a decision (see Table 3).

*NOTE 2* Attention is drawn to statutory restrictions e.g. TPOs, conservation areas and protected species (see Clause 5 and Annex A).

The client’s wishes and the future use of the site should be determined so that the most appropriate method of felling and stump retention or removal can be adopted. The specification should include height of retained stumps and their subsequent management.

See 14.4, 16.10.5, and 16.11 regarding windblown trees.
### Table 3 – Stump management options

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
<th>Possible management implications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stump retained – long term -alive or dead</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All stumps – general</td>
<td>No costs in removing stump</td>
<td>Pre and post-felling treatments to prevent regrowth</td>
</tr>
<tr>
<td></td>
<td>Wildlife habitat</td>
<td>Specification of height of retained stump</td>
</tr>
<tr>
<td></td>
<td>Mineral and nutrient recycling</td>
<td>Safety survey</td>
</tr>
<tr>
<td></td>
<td>Natural biological control of pathogens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No disturbance of underground structures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No mechanical damage to roots of nearby plants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No ground disturbance/compaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuing need for hazard management (e.g. trip hazard) (see</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potential host for pathogens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limits the choices for future use of the area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potential for regrowth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Natural regeneration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Greater range of wildlife and greater longevity of habitat</td>
<td></td>
</tr>
<tr>
<td>Coppice stump</td>
<td>Replacement tree</td>
<td>Cyclical cutting</td>
</tr>
<tr>
<td></td>
<td>Greater range of wildlife and greater longevity of habitat</td>
<td>Singling stems</td>
</tr>
<tr>
<td>High stump</td>
<td>Plant support</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sculpture potential</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Larger area at risk for a longer period</td>
<td>Safety survey over longer period</td>
</tr>
<tr>
<td>Stump to be removed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All stumps</td>
<td>No future management</td>
<td>Ground investigations e.g. underground structures</td>
</tr>
<tr>
<td></td>
<td>No/reduced regrowth</td>
<td>Specification of height of stump prior to removal</td>
</tr>
<tr>
<td></td>
<td>Space for other land use</td>
<td>Pre/post-felling treatment to prevent regrowth</td>
</tr>
<tr>
<td></td>
<td>Reduced source for pests and/or pathogens</td>
<td>Method of removal</td>
</tr>
<tr>
<td></td>
<td>No safety hazard</td>
<td>Hole treatment and reinstatement</td>
</tr>
</tbody>
</table>

- **Pros**
  - No costs in removing stump
  - Wildlife habitat
  - Mineral and nutrient recycling
  - Natural biological control of pathogens
  - No disturbance of underground structures
  - No mechanical damage to roots of nearby plants
  - No ground disturbance/compaction

- **Cons**
  - Continuing need for hazard management (e.g. trip hazard)
  - Potential host for pathogens
  - Limits the choices for future use of the area
  - Appearance
  - Potential for regrowth

- **Possible management implications**
  - Pre and post-felling treatments to prevent regrowth
  - Specification of height of retained stump
  - Safety survey

  - Natural regeneration
  - Greater range of wildlife and greater longevity of habitat
  - Replacement tree

  - Cyclical cutting
  - Singling stems

  - Plant support
  - Sculpture potential

  - Larger area at risk for a longer period

  - Safety survey over longer period

  - No future management
  - No/reduced regrowth
  - Space for other land use
  - Reduced source for pests and/or pathogens
  - No safety hazard

  - Costs of removal and hole treatment
  - Loss of wildlife habitat
  - Loss of minerals and nutrients
  - Root suckers

  - Ground investigations e.g. underground structures
  - Specification of height of stump prior to removal
  - Pre/post-felling treatment to prevent regrowth
  - Method of removal
  - Hole treatment and reinstatement
By assessing the pros and cons shown in Table 3, one of the following three end-results should be selected:

a) live stump retained;

b) dead stump retained;

c) dead stump removed.

NOTE In order to arrive at one of these end results, refer to the flow chart below (e.g. Figure 1).

14.2 Tree felling

NOTE The stump and root system of a large tree will have taken many years to develop. It is unlikely, therefore, that anything will be known about the hazards (e.g. services, land drains and structures) that could be buried in the vicinity of the stump.

Underground structures (e.g. pipes, ducts, cables and foundations) which could be damaged directly during felling should be identified, located and protected from damage.

Tree felling is a skilled and potentially hazardous operation that should be undertaken only by a competent person.

A tree should be felled in one piece only when there is no significant risk of damage to people or property. There should be a safe working distance between the tree being felled and people or property.

Where restrictions, e.g. lack of space, buildings, other features, land ownership or use, or other trees or shrubs which are to be retained, cannot be overcome, trees should be dismantled in sections (sectional felling).

Large pieces of wood should generally not be allowed to fall freely. A more controlled system of working should be adopted (see safety section).

Nothing that is removed from the tree should be roped directly to trunks or branches of any part of a tree that is to be retained (see also Annex J). Rigging systems or cranes should be used when appropriate.

14.3 Stumps for retention

14.3.1 General

Stumps for permanent retention should be cut at a specified height, free from snags and left in a condition appropriate for subsequent use.

Where there is a delay between felling and stump removal, the stumps should be left in a condition that keeps the site safe (i.e. not left as a trip hazard).

NOTE Most broadleaved tree species and a few coniferous species (e.g. yews) will produce new shoots when stumps are retained after felling. This could be coppice shoots (i.e. from the cut stump) or root suckers. Such regrowth might be acceptable, or even desirable in some situations, but if left unchecked the shoots will develop into mature trees similar in proportion to, or even larger than the original tree.

Regrowth should be expected on such stumps and management implications acknowledged.

14.3.2 Stump to be killed and retained

Where it is desirable to kill the stump, one of the following options should be used:
• apply translocated chemicals directly to the stump surface (including the bark) as soon as possible after felling, and apply translocated chemicals to any new shoots that might develop (in accordance with the further guidance given in Annex H);

• remove any new growth from the stump (e.g. cut or break off) as soon as it appears. This should be continued (if necessary over several years) until shoots are no longer produced.

NOTE 1 Attention is drawn to the Control of Pesticides Regulations (COPR [11]). The list of currently approved pesticides for this field of use can be checked against the latest Pesticides Safety Directorate (PSD) list (see www.pesticides.gov.uk).

NOTE 2 Where trees are close together in groups or avenues or where trees are in shrubberies there might be contacts between the roots of plants. Chemicals used for killing stumps could damage or kill other plants with which their roots are in contact.

NOTE 3 Some chemicals entering the soil will migrate and could be absorbed by plants including trees and shrubs to be retained, as a result they could be killed. Plants receiving a sub-lethal dose could produce abnormal growth and progressively recover over two or more years.

NOTE 4 Those chemicals capable of killing plants or trees could also be toxic to humans, animals or desirable organisms.

NOTE 5 A retained tree stump may be kept (e.g. as a habitat or a carved or sculpted feature), but such an object will have a limited life because decay-causing organisms will gain entry through the roots even if the above ground parts of the stump are treated with preservatives.

14.3.3 Inspection cycle for retained stumps
Tree stumps and major roots decay over time; this can result in hazards such as voids in the ground or a tall stump becoming unstable, therefore a cycle of safety inspections should be initiated and appropriate work carried out.

Supports for previously fallen trees and upturned root plates should be inspected and assessed for their continued effectiveness (see Clause 6 and Clause 16).

14.4 Tree stump to be removed/destroyed

14.4.1 General
Where there is a risk of a stump being a trip hazard or a source of a pathogenic form of Honey fungus that could affect retained trees and shrubs, stump removal/destruction should be considered as an option

Underground structures (e.g. pipes, ducts, cables, foundations) and archaeological features which could be damaged directly during stump removal should be identified, located and protected from damage.

NOTE 1 Attention is drawn to wildlife protection legislation (e.g. Wildlife and Countryside Act) (see Annex A).

NOTE 2 It is not normally practicable to remove the whole root system or even the major roots. The methods detailed in 14.4.2 to 14.4.4 may be appropriate in different situations. Dead roots rot slowly and as cavities left usually become filled with fine soil particles, the risk of soil collapse occurring is extremely small.

14.4.2 Digging out stumps
NOTE Whether done by hand or machine, digging out can cause severe disturbance of the site.

Stump removal by digging out should include disposal/utilization of the often substantial piece of woody material (see Clause 16).

If winches are used to assist in the operation of stump removal, they should not be anchored to trees to be retained (see Annex J).
14.4.3 Stump chipping

NOTE  Mechanical destruction of a stump by stump chipping (stump grinding) is less disruptive to the site than digging out.

The reason for chipping the stump should be ascertained and the appropriate depth of operation agreed. Stump chipping should normally extend through the base of the stump leaving the major roots unconnected if the intention is to reduce the potential for the spread of Honey fungus.

The wood chips should be treated as arisings (see Clause 16) and their use or disposal specified.

Destruction of the stump by burning or the use of explosives is not recommended.

14.4.4 After stump removal

The hole left by stump removal, whether by digging out or chipping, should be filled with soil or other material appropriate for the future site usage, and for any surface treatment that is to be installed.

Where future plant growth is desired, the backfill material should be firmed in 150 mm layers but avoiding excessive compaction.

Any disturbance to the site, whether for access or during working, should be made good.

15 Fallen trees

COMMENTARY ON CLAUSE 15

Trees are sometimes uprooted, e.g. in strong winds. Such trees can come to rest propped on other trees or structures, or on the ground, and often continue to grow (phoenix). They may be partially or totally reinstated in association with crown management and artificial support (see Clause 12).

Management of such trees can be particularly hazardous because of the unpredictability of movement of the tree and the root plate as the weight distribution is changed.

When considering options for management of fallen trees, the following should be considered (see also 9.3):

a) available space, access to the site and land use (particularly if space is needed to accommodate guys or props);
b) species, age and condition of the tree;
c) size of the tree (there may be a need to reduce or remove the crown, so as to improve stability and lessen water needs, see Clause 9);
d) soil conditions;
e) client’s wishes and expectations;
f) amenity or other value of the tree;
g) safety of people or property during the work and thereafter.

NOTE  The following options for management progress from minimal intervention to removal of the tree.

a) Retention of the tree with root plate left in the upturned position.

As fallen trees are usually alive, it may be acceptable to retain them and allow them to regrow from the trunk and main branches. In the long term, such trees might develop adventitious roots in a natural process of layering (phoenix regeneration). Such rooting may be encouraged by mounding soil around branches and the trunk. If the whole tree cannot be retained in its entirety, the root plate can still be stabilized in the upturned
position by retaining a long stump. Root plates left exposed are of benefit to local habitat (see The Good Practice Guide [6]) even if the tree dies.

b) Restoring a tree towards its original position.

In attempting to re-erect a tree, it is likely that excavation will be required to accommodate roots. Smaller trees can be levered back into position. Where this is not practicable, as with some larger trees, the crown may be reduced or removed in such a way as to allow the root plate to fall back into its hole. Where it is not possible to completely reposition a tree, propping may be necessary to prevent or restrict movement, and support the tree at an angle (see 12.6). If these works are not practicable, then the tree may need to be felled so as to leave a stump (see 14.3).

16 Completion of work

16.1 Disposal/utilization of arisings

COMMENTARY ON 16.1

Retaining arisings on or local to the site delivers conservation benefits and allows the gradual recycling of the mineral nutrients and carbon that they contain.

Before any work on a tree commences it should be agreed exactly what is to happen to the arisings (e.g. retained or removed from site). During the works, arisings should be left in a safe condition (see Annex C) and in sizes and locations agreed with the client.

The following should to be taken into consideration when deciding what to do with arisings:

a) access, site usage and safety;

b) wildlife and habitat (see Annex A);

c) amenity;

d) scope for utilization;

e) pest and disease management/encouragement of beneficial organisms;

f) potential for damage to the site and adjacent property.

Small-diameter arisings should be either retained intact or utilized (e.g. by chipping) and stored for composting and/or mulching.

Large diameter material should be left as habitat or converted into a useable product, preferably on site

NOTE 1 When working with ancient trees refer to Annex F and The Good Practice Guide [6].

NOTE 2 Firewood stacks are attractive to deadwood inhabiting insects, some of which are endangered. To minimize the risk of their destruction when the wood is burnt, the stack may be covered. Material retained for firewood stored undercover could benefit from quicker drying.

16.2 Conservation benefits

Where ancient trees are present, special consideration should be given to the potential value of arisings, e.g. because of their value as habitat for endangered species.


16.3 Burning

Arisings should not be disposed of by burning on site unless:
a) other options are completely impracticable, or

b) the material is affected or likely to become affected by a disease or pest for which sanitation is a necessary form of control.

NOTE 1 Where any material has to be burned, see Annex C on safety.

NOTE 2 Attention is drawn to laws governing the transport/prevention of the spread of plant and soil pests, for example: Statutory Instruments issued under the Plant Health Act 1967 [14], the Weeds Act 1959 [15] and the Wildlife and Countryside Act 1981 [12].

16.4 Completion of work

The site, including any retained arisings, should be left in a condition appropriate for its intended usage as specified and agreed with the client, and with proper attention being paid to safety (see Annex C).

16.5 Follow-up work

If follow-up work e.g. the inspection of trees and stumps, identified defects or installations (e.g. bracing or propping) is appropriate it should be specified and recorded for the client’s information.
Annex A (informative)
Trees and the law

A.1 General

Trees in any location might be protected by legislation for various reasons including amenity, biodiversity or to avoid unnecessary tree loss. Work to or near trees might also be affected by legislation (e.g. to avoid disturbance to bats or birds) or codes of practice (e.g. to avoid damage to trees during installation of underground or overhead services).

Substantial penalties can be incurred for contravention of any of these forms of legal protection.

Attention is also drawn to legal rights and liabilities under common law which need to be considered when proposing tree work or developing management plans.

Where tree work is associated with proposed development, see BS 5837.

A.2 Statutory legislation

A.2.1 Trees

The Town and Country Planning Act 1990 [16], as amended by the Town and Country Planning Regulations 1999 [17], empowers local planning authorities to make tree preservation orders to protect trees in the interests of amenity. In Scotland, this is covered by the Town and Country Planning (Scotland) Act 1997 [18] and the Town and Country Planning (Tree Preservation Order and Trees in Conservation areas) (Scotland) Regulations (amended) 1984 [19].

In conservation areas, trees over a certain size are protected. Except in certain circumstances six weeks notice of intent is to be given to the local planning authority before work is carried out.

Tree preservation orders allow for trees to be protected, from individual trees through to woodlands. The orders have the effect of preventing the cutting down, topping, lopping, uprooting, wilful damage or wilful destruction of trees, except in certain circumstances, other than with consent of the local planning authority.

Even when no specific legal protection exists, it might be necessary to obtain a felling licence. These are required (except in certain circumstances) if the volume of timber to be felled exceeds specified amounts. The Forestry Commission England 1), the Forestry Commission Scotland 1) and the Forestry Commission Wales 1), under the Forestry Act 1967 [20] (as amended), administers felling licences.

A.2.2 Wildlife and habitat


1) www.forestry.gov.uk
The protection afforded to bats makes it illegal to injure, kill or disturb a bat; damage, disturb or obstruct access to a roost; or damage or obstruct access to any structure or place that bats use for shelter or protection. Where bats are thought to be present, the Statutory Nature Conservation Organization, i.e. Natural England 2), Countryside Council for Wales 3), Scottish Natural Heritage 4) or Northern Ireland Environment and Heritage Service 5) need to be consulted before starting any work.

Similar protection is afforded to birds in that it is an offence to take, kill or injure any wild bird or to take, damage or destroy any eggs or nest that is either in use or being built. Similarly it is an offence to intentionally or recklessly disturb a bird listed in Schedule 1 of the Wildlife and Countryside Act 1981 while it is building a nest, is on or near a nest containing eggs or young, or disturb the dependent young birds. There are a number of exceptions to the offences including the provisions for licences to be issued under Section 16 of the Act. Tree works cannot take place if there is a risk of the works, or its effects, being harmful to resident wild birds. Under certain circumstances where such a risk is present a licence can be obtained from the Department for Environment, Food and Rural Affairs (Defra) 6) or the Scottish Government 7).

A.2.3 Development and planning conditions

Where full planning permission has been granted, the consent of the local planning authority is not needed to carry out work on protected trees required to enable a person to implement that permission.

Planning conditions might be imposed to retain and protect trees during construction. Such conditions might require the approval of the local planning authority for any proposed tree work.

Felling or pruning of protected trees cannot be said to be required when planning permission has been given on an outline application only, nor when development is exempt from planning control.

A.2.4 Hedges

Disputes can arise where the height of a neighbouring hedge adversely affects the reasonable enjoyment of a domestic property. If such a dispute cannot be resolved between the parties a complaint could be made to the local authority who will then determine the matter under Part 8 of the Anti-Social Behaviour Act 2003 [26] (this does not apply in Scotland).

The government has published guidance (Hedge height and light loss [27]) which will help to assess an appropriate height for evergreen hedges to avoid undue restriction of light in a domestic situation.

A.3 Common law claims and litigation concerning trees

A.3.1 General

Problems caused by trees can result in disputes giving rise to common law claims and litigation. Such problems are particularly likely where trees grow across boundaries between

2) www.naturalengland.org.uk
3) www.ccw.gov.uk
4) www.snh.org.uk
5) www.ehsni.gov.uk
6) www.defra.gov.uk
7) www.scotland.gov.uk
properties. These can include root activity (see Clause 6), branches touching buildings and structural weaknesses that fail, and could result in damage to property or injury to people. Foliage can restrict sunlight and/or natural light, be overbearing or branches can interfere with the use and enjoyment of neighbouring land.

There are established legal remedies to deal with branches growing over neighbouring land. These might still require consent through other protection regimes. Legal advice needs to be sought when trees could or have become a problem.

Planned tree inspection and management can minimize the possibility of litigation in the short term, but as trees grow, mature and decline their condition can change making a need for periodic inspections and implementation of preventative/remedial works (see Clause 6).

**A.3.2 Trees on boundaries**

Careful consideration of new planting to anticipate both the likely encroachment of roots or overhang of branches of the fully grown tree relative to the site boundary can prevent potential future conflict, while the possibility of direct mechanical damage to boundary fences and walls can be avoided by allowing room for growth and movement.
Annex B (normative)
Sterilization of equipment

B.1 Sterilization procedure
The following sterilization procedure is recommended:

a) brush off, or blow off using an airline, all loose debris;
b) if oil or grease are present, clean with a suitable solvent (e.g. paraffin);
c) where resin and/or gum is present, clean with a suitable solvent (e.g. paraffin);
d) wash or swab with detergent and water;
e) if possible, immerse the tools in sterilizing fluid (see B.2) and leave them to soak for a few minutes; alternatively, swab liberally several times with the fluid;
f) rinse and dry to prevent corrosion.

Synthetic fibres included in PPE and climbing/rigging equipment should be maintained in accordance with the manufacturer’s guidance.

B.2 Sterilant
An effective, cheap and readily obtainable sterilant is diluted household bleach (sodium hypochlorite). As diluted bleach soon loses its sterilizing properties, especially if organic matter is present, freshly mixed solution should be used each day.

*NOTE* It has been found that a solution of one part bleach to 100 parts water is adequate.

All disinfectants should be used in accordance with the manufacturer’s instructions.
Annex C (normative)
Safety
To be drafted.
Annex D (informative)
Information concerning tree nutrition, techniques for improving soil physical conditions, and sources of nutrients

*NOTE* See Clause 13.

Some problems that give rise to symptoms in a tree resembling those caused by nutritional disorders:

a) pathogen activity killing roots;
b) poor soil physical conditions;
c) mechanical damage to roots particularly during construction works;
d) toxic chemicals in the soil;
e) tree species unsuitable for the site.
Annex E (informative)
Background information about pruning and wounding

E.1 Adverse consequences of pruning

E.1.1 General
Pruning is a form of damage, which removes foliage and locally disrupts columns of liquid and the network of living cells, so that zones of sapwood become physiologically dysfunctional. The immediate effects of the damage include the following:

a) reduction of leaf area and hence the tree’s capacity to produce photosynthetic products, which are needed for containment of disease and decay;

b) exposure of sapwood to potential colonization by fresh wound parasites and opportunistic decay fungi (colonization is favoured also by aeration via injuries);

c) exposure of wood susceptible to heart-rot in the centres of old branches of tree species that lack a durable heartwood;

d) injury of phloem and cortex, which can die back from the wound-edge and/or become infected by canker-causing organisms.

E.1.2 Colonization of pruning wounds by pathogens and decay fungi
Various fungi and bacteria, mostly harmless, colonize tree wounds. Three main groups of harmful organisms are:

a) “fresh wound parasites” that can rapidly and extensively colonize sapwood certain wood-decaying organisms;

b) canker-causing pathogens, that kill areas of phloem and cortex around wounds;

c) decay fungi, some of which can cause extensive heart-rot;

d) certain insects and other animals that bore into wood, thus exposing it to microbial colonization.

NOTE 1 The risk of a fresh wound parasite causing damage may depend on the prevalence of particular fresh wound parasites in the locality concerned. For example, rosaceous genera are more susceptible than most other kinds of tree.

NOTE 2 Decay is a normal process in wood that is already dead within trees, especially in dead branches or in the central wood of old trees. Wounding can, however, accelerate this process, by increasing the avenues for fungal colonization and aeration of the wood.
Figure E.1 – Crown reduction in relation to the current leaf-bearing area (shown as stippled dark)

a) Intact tree.
b) 30% crown volume reduction.
c) 30% shortening of branch length.
d) 30% tree height reduction with proportional crown width reduction.

E.1.3 Severity of pruning

The more severe the wounding, the higher the probability of the above effects occurring. Heart-rot is, however, unlikely to be a consequence of removing young branches that contain
only sapwood. Pruning can be regarded as severe if the total cross-sectional area of all the cuts is more than one-third of the cross-sectional area of the trunk. As shown in Table E.1, forty-eight cuts of 50 mm-diameter have the same area as a single 346 mm cut (see also Figure E.1 concerning reduction of the volume of the crown).
Table E.1 – Total cross-sectional area of branch cuts on a tree of 600 mmdbh

<table>
<thead>
<tr>
<th>Diameter of each cut (mm)</th>
<th>No. of cuts whose total cross-sectional area is roughly equal to one-third of that of the main trunk</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>100</td>
<td>12</td>
</tr>
<tr>
<td>200</td>
<td>3</td>
</tr>
<tr>
<td>346</td>
<td>1</td>
</tr>
</tbody>
</table>

Full occlusion of wounds helps to arrest decay but is unlikely to ensue if the wounds are very large and if the tree is very old (see 9.3.5).

E.1.4 Factors affecting the tolerance of trees to pruning

E.1.4.1 The inherent tolerance of different species, cultivars and individuals

The ability of a tree to tolerate pruning depends partly on certain inherent characteristics of the species, cultivar or individual concerned. These include the following:

a) ability of sapwood to react defensively against wounding (e.g. this is low in Betula);

b) decay-resistance of older central wood (heartwood or ripewood);

c) ability of foliage to function if the pruned parts of the tree are in shade (e.g. Fagus sylvatica is more shade-tolerant than Carpinus betulus);

d) resistance of bark to sun-scorch, following removal of parts of the tree that were previously shading it (thin-barked species are generally less resistant);

e) the habit of the tree in relation to its growth response;

f) the capacity to retain viable shoots or dormant buds and/or to produce adventitious buds, which can develop into new branches after pruning.

E.1.4.2 Tolerance of individual trees

Age affects the following characteristics of a tree:

a) ability to grow after pruning;

b) the proportion of its wood that is readily available to colonization by decay fungi;

c) resistance to certain pathogens, due to reduced vigour in older trees;

d) size and complexity (a young tree, although vigorous, could be more easily girdled by a canker disease);

Tree-related or site-related factors which affect vitality and vigour and hence the availability of moisture and of starch reserves, for the maintenance of tissues surrounding wounds and for new growth; include:

a) the tree’s history of disease and damage (including previous pruning);

b) site-related growing conditions.
E.1.4.3 Tolerance in relation to weather and season

COMMENTARY ON E.1.4.3

Xylem sap sometimes exudes from fresh wounds, especially when trees of certain genera (e.g. Acer, Betula, Carpinus and Larix) are pruned shortly before spring flushing. This loss of fluid, often described erroneously as “bleeding”, normally ceases after flushing (see Clause 8 for information on season of pruning).

In some cases, a fluid other than xylem sap can exude or flow from a wound. This could happen because the wound has exposed a zone of wetwood or a water-filled cavity or crack. Wetwood takes various forms, most of which are not harmful to the health of the tree. Seepage from wetwood might, however, kill bark with which it comes into contact (see bark wounds; 10.3).

Exudation from bark, perhaps in the absence of any wound, can be indicative of a condition with implications for the health and longevity of the tree or adjacent trees (e.g. bacterial canker).

Weather-related factors include:

a) drought stress or waterlogging, which make trees particularly susceptible to dieback and decay after pruning;

b) frost, which can lead to dieback of wounded bark.

Seasonal factors include “bleeding” from recently made wounds, mainly in the period before leaf expansion in the spring (see 10.4). In some types of tree, (e.g. Acer spp.), it can lead to significant loss of dissolved sugar, with potentially detrimental effects on health (see Clause 8 regarding guidance on season of pruning);

NOTE Seepage of liquid or slime (usually dark-coloured) from unwounded bark can be due to a canker disease or to wetwood.

E.1.4.4 Position of pruning wounds within the tree

Removal of large branches from the main stem (see crown lifting, 9.7) or topping often leads to decay that can weaken the tree, so that future work might be needed to prevent mechanical failure. This rarely happens if cuts are made only in the outer parts of the crown.

E.2 Injuries other than pruning cuts

Certain kinds of injury are not made intentionally in tree work, but they are potentially important in relation to avoidance of accidental damage and the inspection of trees (Clause 6). Such injuries include the following:

a) removal or dislodging of bark, caused by glancing blows or by gnawing mammals (e.g. squirrels); this occasionally allows entry by pathogens but rarely leads to deep-seated decay;

b) crushing, in which not only bark but also the underlying wood is affected (e.g. from vehicle impacts); if severe, this can lead to extensive decay;

c) heat injury which, like mechanical wounding, causes dysfunction in the affected part of the tree; causes include bonfires too close to trees (see Clause 16) and sunscorch (especially on thin bark), following removal of shade;

d) lightning strikes, which have very variable effects with regard to the potential for decay;

e) cracks in the bark and/or the underlying wood; these have a very wide range of mainly mechanical causes and consequences, including potential hazards.

E.3 Formation of shoots after shortening of stems or branches

Shortening of stems or branches can have implications for the future management of a tree, since weakly attached new branches tend to develop near the cuts. (See Annex F regarding
“shoot renewal pruning” as a method for managing them; also see 9.5, regarding formative pruning as a means of avoiding such a situation.)

NOTE The formation of new branches is usually an advantage in the “restoration pruning” of old trees, lapsed ancient pollards and damaged trees with conservation value (Annex F).
Annex F (normative)
Crown management by cutting – specialized practices

F.1 Reduction of crown size and subsequent management

If, due to decay or structural weakness, there is a need to prevent failure in an ancient tree or lapsed pollard, some kind of crown reduction (see 9.8) should usually be considered as the main solution. Conventional reduction should be considered if the tree shows good vitality and an abundance of branches or potential branches in its lower crown but poor vitality in its upper crown, combined with a sparse branch structure that could lead to major break-up or dieback rather than natural retrenchment.

F.2 Retrenchment pruning of ancient trees and lapsed pollards

COMMENTARY ON F.2

If the desired amount of reduction would entail excessive wounding and loss of leaf area (see Annex E), or would not retain a well developed lower crown, the appropriate action is usually to adopt a special kind of crown reduction known as retrenchment pruning, whereby no more of the crown volume is removed at any one time than can be physiologically tolerated by the tree.

Retrenchment pruning is intended to emulate the natural process whereby the crown of an ancient tree retains its overall mechanical integrity by becoming smaller through the progressive shedding of small branches and the development of the lower crown (“retrenchment”). The loss of branches of poor vitality improves the ratio between dynamic (biologically active) and static (inactive) mass. This natural process is not, however, always sufficient to prevent trees from falling apart or from posing unacceptable risks to immovable targets.

Retrenchment pruning should be chosen as the main option for managing lapsed pollards that would otherwise tend to break up.

NOTE 1 Pollarding is the production and maintenance of a form of tree with numerous branches arising from the same height on a main stem. It is a traditional form of sustainable tree management that originally provided a product (fodder, timber pole or firewood) as part of a silvopastoral system of land management (typified by wood-pasture). It is also a system for managing trees in formal situations, either so as to control their size or for cultural reasons.

The tolerance of the tree to loss of leaf area and wounding should be assessed before retrenchment pruning is started. It should be done by shortening heavy, long or weakened branches throughout the crown, while retaining as much leaf area as possible and encouraging the development of new secondary branches from epicormic shoots or from dormant or adventitious buds.

NOTE 2 Although the above objective can sometimes be achieved in a single operation (as in conventional crown reduction), a phased programme of pruning over many years is often appropriate.

NOTE 3 Even species such as willows, which have an exceptional capacity to produce new growth after injury, can succumb to problems such as cambial drying when subjected to massive wounding and to the loss of shade formerly provided by their foliage.

NOTE 4 An appropriate risk assessment needs to be undertaken so as to ensure that the proposed work is compatible with health and safety requirements.

If a phased programme of pruning is adopted, each phase should take place only when newly developed branches suitable for retention have become strongly established. After the final stage of progressive pruning, a cyclic pruning of new growth should continue, so as to avoid the excessive loading of extensively decayed branches.

NOTE 5 Even the above approach is unlikely to give good results if the tree is not of such a species and condition that it will respond by producing new branches.
If there is a need to encourage the development of a dense lower crown, the development of shoots from dormant and/or epicormic buds should be stimulated by retaining stubs when branches are pruned. The length of the stubs should be about three to five times their basal diameter. In order to enhance the formation of adventitious buds, the stubs should be cut so as to include a large surface area of wounded tissue on jagged ends. This can be created by the technique known as corona cutting (Veteran Trees [1], Good Practice Guide [6]), or by controlled breakage after partial cutting.

**NOTE 6** Also, the bark may be scored so as to stimulate new growth.

**NOTE 7** A long stub is likely to bear a number of dormant buds or (in some species) potential sites for adventitious bud formation. This is a natural survival mechanism after storm damage.

So as to plan the details and timing of retrenchment pruning, an Individual Tree Management Plan (ITMP) should if necessary be drawn up and later modified as necessary over the duration of the Plan. If possible, the details of the work and of the condition of the tree should be recorded throughout the duration of the Plan, so as to improve knowledge for future application. The Plan should be based on the following decisions:

a) The objectives of restoration pruning for the tree concerned (with respect to its structural integrity, desired crown shape and size, vitality etc.).

b) The suitability of pruning as a means of improving or safeguarding the mechanical integrity of the tree, taking account of its predicted tolerance to pruning, by virtue of its species, age and the current vitality and vigour.

c) Whether to try to achieve the desired size and shape of crown in a single operation (in consideration of the previous decision).

d) The number of phases of work, the predicted details of each phase and the timescale (duration).

f) Pragmatic options to be implemented in tandem with prudent financial planning.

**F.3 Shoot renewal pruning**

**NOTE** This is an alternative to the cyclic cutting of the branches that grow after crown reduction or re-shaping (9.8).

Shoot renewal pruning should be done by retaining these branches, while carrying out a follow-up cycle of thinning and branch tip reduction. The interval between the first crown reduction and the thinning of the new branches should be determined according to the species and situation.

**F.4 Encouragement of layering and of ground-support for branches**

Low branches should be allowed to rest on the ground if site usage allows, so as to provide them with support and thus prevent breakage. Layering (the production of roots and of new shoots where soil contact is established) may be encouraged by restraining movement and by protecting the low branches from browsing by livestock (Veteran Trees [1], The Good Practice Guide [6]).

**F.5 Severe cutting for special purposes**

**F.5.1 Extreme crown reduction and topping**

**COMMENTARY ON F.5.1**
Severe cutting is anything done in excess of the guidance in Clause 9.

Although it is generally undesirable to wound trees so severely that major dieback or excessive decay are likely to ensue, such treatment may be considered appropriate in certain circumstances.

Depending on the crown structure, general condition and species of tree, and also taking into account the need for risk management, the desired reduction can sometimes be achieved over a number of years without undue loss of leaf area by means of phased retrenchment pruning (see F.2).

Severe crown reduction, which at its most extreme equates to topping, may be considered if it is the last resort for retaining a valuable tree which would otherwise pose an unacceptable risk to people or property.

F.5.2 Veteranization

COMMENTARY ON F.5.2

Trees may be severely wounded in order to encourage the development of decay and other features characteristic of ancient and veteran trees when there is an important need to maintain continuity of the wildlife habitats and shelters that are provided by such trees, especially in decaying wood and cavities (Veteran Trees [1]).

A major age gap in the tree population prevents the natural replacement of the desired habitats and shelter currently provided by the older trees.

Veteranization may be initiated, for example, by the removal of large branches (perhaps the creation of stem wounds, which may take the form of V-shaped notches or auger holes. The wounding should be only just severe enough to life of the tree so much as to achieve the objective of perpetuating desired deadwood features.

If some trees are to be veteranized, others (normally a majority) within the population should be left intact and indeed protected so as to maximize their longevity. Also, veteranization should be done only where site usage is compatible with the existence of trees with extensive decay.

NOTE 1 Veteranization requires specialist guidance regarding its suitability and the techniques available (Good Practice Guide).

NOTE 2 Some attempts have been made to introduce desired species of decay fungi (e.g. Laetiporus sulphureus) into "veteranization wounds". The decay produced by such fungi provides good habitats and tends not to shorten the life of the tree by extending into functional sapwood. Further research is, however, needed.

F.6 Other considerations for habitat conservation

F.6.1 General

Conventional management often needs to be modified so as to conserve deadwood habitats, since these are often removed or not allowed to develop if the objectives of management are purely formal or economic. Habitats provided by living foliage and bark (including those of climbing plants) also deserve consideration, but they can more often co-exist with conventional management.

F.6.2 Climbing plants in relation to habitat conservation

In most woodlands and areas designated for wildlife conservation, climbing plants can be left to contribute to the habitat, subject to any conservation objectives and safety requirements for people and property.
 Annex G (normative)
Support for weak structures

G.1 General
One of two types of rod should be used when providing support bracing within a tree:

a) **Threaded rod**: a metal bar threaded along its length with a wood screw thread should be screwed into a lead hole 1 mm to 2 mm smaller in diameter than the rod and extending into sound wood either side of the structural weakness for at least half the diameter of the second stem/branch. This form of rod should be used only where the wood is free from decay. After screwing the rod into the lead hole excess metal should be cut off flush with the bark;

b) **Bolt, nuts and washers**: a long, unthreaded metal shank should be placed through a pre-drilled hole 1 mm to 2 mm larger than its diameter. The ends of the rod should be threaded with a metal screw so that they can be secured as appropriate with washers and nuts. The washers should be counter-sunk to the cambium and the nuts should be secured to hold the parts of the tree together. This treatment should be used for soft wooded species, e.g. *Populus* spp, *Salix* spp and *Aesculus* spp. Washers should be at least 2½ times the diameter of the bolt.

*NOTE* See Clause 12.

G.2 Flexible braces
Flexible, bespoke cable bracing should use high tensile, multi-strand steel cables with right hand ordinary lay and taped or sealed cut ends attached to either:

a) screw eyes formed on the end of a tapered wood screw threaded bolts should be screwed into drilled guide holes slightly deeper than the length of their shank; or

b) eyebolts formed from a length of steel rod with an eye at one end secured with washers and nuts, the washers being countersunk to the cambium. Guidance on cable sizes is given in Table G.1.

**Table G.1 – Galvanized high tensile steel wire ropes**

<table>
<thead>
<tr>
<th>Construction</th>
<th>Nominal diameter mm</th>
<th>Breaking load kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 strands, each having 19 filaments, with fibre main core</td>
<td>4.0</td>
<td>885</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>2990</td>
</tr>
<tr>
<td></td>
<td>9.0</td>
<td>4480</td>
</tr>
<tr>
<td></td>
<td>13.0</td>
<td>9350</td>
</tr>
</tbody>
</table>

Wire rope grips and thimbles should be the right size for the respective cable and be either galvanized or plated.

The number of wire rope grips should not be less than three for each end of the cable.

*NOTE* A guide to materials is given in Table G.2.
Table G.2 – Compatible cables, eyebolts and screw eyes

<table>
<thead>
<tr>
<th>Nominal cable diameter (mm)</th>
<th>Screw eye/eyebolt diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>10 to 13 screw eye</td>
</tr>
<tr>
<td>6.0</td>
<td>13 eyebolt/screw eye</td>
</tr>
<tr>
<td>9.0</td>
<td>13 to 16 eyebolt/screw eye</td>
</tr>
<tr>
<td>13.0</td>
<td>16 to 19 eyebolt/screw eye</td>
</tr>
</tbody>
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Washers should be made from minimum 6 mm thick metal plate and should be oval in shape. The short axis should be at least 2.5 times the diameter of the bolt.

G.3 Rigid braces

Rigid braces should be formed from bright drawn steel rod: available sizes are 13 mm, 16 mm, 19 mm, 22 mm and 25 mm diameter.

Washers should be made from minimum 6 mm thick metal plate and should be oval in shape. The short axis should be at least 2.5 times the diameter of the bolt.

Branches to be separated should be held apart and a guide hole for the rod or bolt should be drilled through the two branches. The branches should then be held apart by a spacer, e.g. a steel pipe, which should sheath the bolt, which in turn should be secured on the outside by nuts tightened over countersunk washers.

NOTE An alternative would be to use nuts and washers within the split as well as on the outside.
Annex H (normative)
Treatment of tree stumps to prevent regrowth

H.1 General

COMMENTARY ON H.1

After felling most broadleaved tree species can produce new shoots. This might be coppice shoots or root suckers. Such regrowth might be acceptable, or even desirable in some situations, but if left unchecked the shoots will develop into mature trees similar in proportion to, or even larger than the original tree.

When regrowth is not wanted, stumps and major roots that cannot be removed should be killed with chemicals.

NOTE Most coniferous tree species do not produce either coppice shoots or root suckers. In these cases there is no call for chemicals to kill them. Conifers that do produce coppice shoots e.g. yew, Coast redwood and juniper, from a stump may warrant chemical treatment.

When there is a possibility of root grafts with other trees or plant material, chemicals should be used with extreme caution.

All chemicals should be used strictly in accordance with manufacturers’ recommendations.

H.2 Before felling – treatment of stumps and roots

COMMENTARY ON H.2

Standing trees can be treated before felling and this technique can be particularly useful to prevent root sucker development.

After treatment the tree should be left long enough for the chemical to reach all parts of the root system; however, if dead trees are allowed to remain too long they might shed branches or fall over.

Treatment methods are as follows:

a) stems less than 70 mm in diameter - the lower 1 m of stem should be sprayed with a water or oil carried herbicide until it runs off;
b) stems more than 70 mm in diameter – downward cuts should be made into the bark and wood (“frill girdling”), into which liquid preparations of chemical can then be poured or crystals or granules of dry chemical applied.

Those parts of the tree that have been treated should be covered in order to reduce both the risk of the chemical being diluted by rain and the risk of environmental contamination with the chemical; this is particularly important with treated frill girdles.

H.3 After felling

Chemicals should be applied to stumps as soon after felling as possible. Solutions or crystals of the chemical should be applied particularly to the outer part of the cut stump surface, and the bark.

NOTE There is a range of chemicals suitable for killing tree stumps. Chemicals currently used for poisoning stumps and roots include:

a) triclopyr; [2006]
b) ammonium sulphamate;[2006]
c) glyphosate;
d) 2,4,5-T.

After treatment, cut stumps should be covered to prevent dilution and dispersion of the chemical by precipitation.
Annex I (informative)

Soil management

The root system of a tree is an extensive and complex mesh of woody (brown) roots and thread-like (usually whitish) roots. The fine roots are primarily responsible for absorbing water and minerals from the soil but all roots provide transport routes to the trunk and onwards to other parts of the tree.

The effectiveness of roots in absorbing material from the soil can be increased where there is a symbiosis with beneficial fungi. These symbiotic (mycorrhizal) fungi increase the surface area of the root and differentially absorb minerals which become available to the tree.

The root system is typically concentrated within the uppermost 600 mm of the soil, although it can be deeper within the dense mass of roots and soil close to the base of the tree. Within a short distance of the stem the roots are highly branched, so as to form a network of small-diameter woody roots, which typically extend radially for a distance much greater than the height of the tree or extent of the crown. All parts of this system bear a mass of fine, non-woody absorptive roots.

The root system does not generally show the symmetry seen in the branch system. The development of all roots is influenced by the availability of water, nutrients, oxygen and soil penetrability. As far as these conditions allow, the root system tends to develop sufficient volume and area to provide physical stability.

The uptake of water and mineral nutrients by the root system takes place via the fine roots, typically less than 0.5 mm diameter. Their survival and functioning, which are essential for the health of the tree as a whole, depend on the maintenance of favourable soil conditions. The fine roots are short-lived, with the majority dying each winter and with fresh ones developing in response to the needs of the tree.

All parts of the root system, but especially the fine roots, are vulnerable to damage. Once roots are damaged, water and nutrient uptake is restricted until new ones have grown. Mature and over-mature trees respond slowly, if at all, to damage of their woody roots.

Soil auger - puncturing the soil with a large[-]diameter (minimum 37 mm) auger to make holes 300 mm to 600 mm deep at 450 mm centres throughout the root system has been commonly practised.

Trenches – carefully formed to avoid damaging roots >25 mm diameter, cut radial to the trunk of the tree and extending to the edge of the crown will ease [the effects of] soil compaction. The trenches can be backfilled with the indigenous soil, provided it has not become anaerobic and does not contain toxic material. Imported granular fill may be used, but mechanical compaction avoided.

Injection of a gas or water - equipment is available [for explosively injecting] a compressed gas (e.g. nitrogen) into the soil and so [alleviating] soil compaction. The efficacy of this technique has not been fully demonstrated.

High pressure water and air lances are available and may have a place in soil decompaction but their efficacy has not been fully demonstrated.

Species of tree are better adapted to survive periods of waterlogging, while most species have a greater tolerance to excess water in the soil during the dormant season than in the growing season.

NOTE 1 Manufacturers offer products which absorb and retain water. These have been suggested for use as additives to soils as a method of reducing water stress in plants. Such products are not suitable for tree
management because of the very large volume of soil that would have to be treated and the fact that herbaceous plants would probably benefit more than the tree.

NOTE 2 Any fertilizer applied to a site with herbaceous plants growing on it, particularly grass, is likely to benefit those plants in preference to the tree. Chemical removal of a sward may be appropriate as a short-term cultural operation to allow fertilizers to be available to the tree.

NOTE 3 Care needs to be taken when using inorganic fertilizers to ensure that roots are not killed by localized high concentrations of nutrients, particularly potassium.

NOTE 4 Applications of fertilizers, even if made direct to the foliage, will have no lasting benefit if the conditions in the soil prevent root activity, for example because the soil is waterlogged, compacted, has become anaerobic or contains toxic material.

Non-bulky organic fertilizers may be useful in providing a more sustained supply of nutrients in a non-toxic form.
Annex J (informative)
Principles for protecting a tree to be used as an anchor

J.1 General
Using a tree as an anchor point applies pressure that can cause damage to the cambium. There are three applications where a tree may be required as an anchor point:

a) to assist with felling a tree in chosen direction;
b) pulling a tree (or stump) out by its roots;
c) when using rigging systems.

Where possible, it would be preferable to use a ground or other anchor rather than a tree to be retained.

J.2 Felling
When using a hand winch to apply tension to assist with directional felling, a webbing strop with a minimum width of 80 mm is placed around the trunk, without encircling it, approximately 0.5 m above ground level. The two ends are secured by a shackle, which is secured to the winch. Padding made of a compressible material such as reinforced rubber matting is inserted between the strop and the trunk.

It might not be possible to use a tree as an anchor if the trunk tapers rapidly from the base, as the webbing strop can slide upwards when pressure is applied. If there is a low branch or protrusion, such as an old occluded wound, the webbing needs to be placed just below it.

There needs to be a safe working distance between the tree being felled and people or property. Care needs to be taken so that the winch cable does not cause damage or abrasion with any major branches or limbs on the anchor tree.

J.3 Grubbing out
The tree to be grubbed out will have been reduced to a stump. The same principles as in G.2 apply.
Annex K (normative)
Protective work relating to roots

NOTE 1 As roots increase in diameter they apply a direct pressure to structures, including paving (see Arboricultural Research and Information Note 134 [28]).

Cutting of tree roots inside the root protection area, as defined in BS 5837, should be avoided.

Lightweight structures (e.g. paving, boundary walls), which have been damaged by direct root activity should be modified if practicable (e.g. by replacing an area of paving with more appropriate materials or using bridging foundations).

NOTE 2 Sometimes there is a substantial depth of soil or other loose material between roots and paving which they are displacing. In such cases, some of this material can be removed and the paving then re-laid as a medium-term measure.

If the tree is not considered to be of sufficient value to justify such work, its removal and replacement should be considered.

NOTE 3 A root that is girdling another (major) root or the base of the trunk may be removed, subject to expert advice being obtained on the possible effects of this work on the stability of the tree and on the potential for decay to develop from the wound.
Annex L (informative)
Tree inspections/surveys

Where trees exist in close proximity to people or property there might be conflict between the needs of the trees and the expectations of man. Environmental changes around a tree, including intensification of site usage, might increase any risk posed to or by the tree.

It is important that structural weaknesses in a tree and changes in a tree’s health are recognized and reasonable steps taken to reduce to an acceptable level the risk, if any, posed by the tree to people and property.

Trees generally grow in balance with their environment, but they sometimes develop fracture-prone growth patterns, or become damaged by mechanical injury, disease, or decay. All of these can contribute to the potential for failure which could place people and property at unacceptable risk.

Diseases rarely result in a hazardous situation unless they lead to the death of a major part of the tree.
Annex M (normative)
Tree health

COMMENTARY ON ANNEX M

Leaf colour and leaf size are indicators of the “organic” condition of a tree, but poor colour and reduced size of leaves can be caused by several factors (e.g. root system malfunction; impeded movement of liquids through the tree; the action of chemicals). It is very rare to find that an established tree has a nutrient imbalance.

A thorough investigation of the tree and its surroundings should be undertaken to establish the likely cause(s) of the symptoms observed before pursuing possible nutrient deficiencies.

When, after elimination of all other possible causes, nutrient deficiency is suspected, foliar analysis should be carried out. This should be accompanied by soil analysis to establish which, if any, nutrients (macro and micro) are lacking or present in abundance.

NOTE 1 Some nutrients (e.g. magnesium) might be adequately available in the soil but deficient in the soil. In such circumstances addition of a fertilizer will not correct the problem. It is important, therefore, to understand the mechanisms of nutrient supply before making what could be both environmentally and culturally damaging applications of nutrients. It may be possible to correct the deficiency with a suitable regime of fertilizer application, provided that the growing conditions are otherwise satisfactory.

If analysis does not demonstrate a significant imbalance in the nutrient status of a tree, other causes (e.g. soil compaction; root severance; chemicals; soil level changes; pests and/or diseases in the tree) should be suspected.

NOTE 2 Information concerning likely causes of symptoms which could indicate nutrient deficiency and techniques for applying nutrients and for improving soil physical conditions, are given in Annex E.
### Annex N (informative)
Organizations from whom additional advice can be obtained

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<th><strong>Ancient Tree Forum</strong></th>
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<tr>
<td>c/o Woodland Trust</td>
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<td>Autumn Park</td>
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<td>NG32 6LL</td>
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<td>01476 581135</td>
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<td><a href="mailto:ancient-tree-forum@woodland-trust.org.uk">ancient-tree-forum@woodland-trust.org.uk</a></td>
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<td>Wrecclesham</td>
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<td>GU10 4LH</td>
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<tr>
<td>Tree Helpline: 09065 161147 (Premium rate)</td>
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<td>Email: <a href="mailto:admin@treehelp.info">admin@treehelp.info</a></td>
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<td>British Association of Landscape Industries (BALI)</td>
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<td>Landscape House</td>
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<td>Stoneleigh Park</td>
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Bibliography


Further reading