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Lesnická a dřevařská fakulta Mendelova univerzita v Brně

NATURE AND LANDSCAPE MANAGEMENT STANDARDS		
ARBORIST STANDARDS SERIES A	TREE ASSESSMENT	SPPK A01 001:2018

Hodnocení stavu stromů

Baumkontrolle

This standard is intended as a definition of procedures and levels of tree assessment and design of tree treatment in non-forest environments.

References:
ČSN 01 3410 (1991): Large-scale maps. Basic and purpose-made maps
ČSN 83 9001 (1999): Orchard and landscape management – Terminology, basic professional terms and definitions
ČSN EN 1991-1-4 (2007): Wind load
ČSN ISO 4463-1 (730411) (1999): Measurement methods in construction – Delineation and measurement – Part 1: Measurement design, organisation and procedures and acceptance conditions
ČSN ISO 4463-2 (730411) (1999): Measurement methods in construction – Delineation and measurement – Part 2: Survey marks
ČSN 73 0420-1 (730420) (2002): Accuracy of construction delineation – Part 1: Basic requirements
ČSN 73 0420-2 (730420) (2002): Accuracy of construction delineation – Part 2: Delineation deviations

Act no. 114/1992 Coll. on Nature and Landscape Protection, as amended
Act no. 20/1987 Coll. on State Heritage Management, as amended
Act no. 40/2009 Coll., the Penal Code, as amended
Act no. 200/1990 Coll. on Misdemeanours, as amended
Act no. 36/1967 Coll. on Experts and Interpreters, as amended
Act no. 89/2012 Coll., the Civil Code, as amended
Act no. 326/2004 Coll. on Phytosanitary Care and on amendment of certain acts, as amended
Act no. 360/1992 Coll. on Exercise of the Profession of Authorised Architects and on Exercise of the Profession of Authorised Engineers and Technicians Active in Construction, as amended

Decree no. 37/1967 Coll. on Execution of Act on Experts and Interpreters, as amended
Decree no. 189/2013 Coll. on Tree Protection and Felling Permission, as amended
Decree no. 395/1992 Coll., executing some provisions of Czech National Council Act no. 114/1992 Coll. on Nature and Landscape Protection, as amended
Decree no. 441/2013 Coll. on Execution of Act on Property Appraisal (the Appraisal Decree), as amended

Czech Office for Surveying and Mapping Guideline no. 2600/1981-22 for drawing the Basic Large-scale Map of the ČSSR.

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1 Purpose and contents of the standard

1.1 Purpose of the standard and qualification of persons

1.1.1 The standard "Tree assessment" defines procedures, levels and contents of the different stages of assessment of non-forest trees, including their growth conditions, primarily in order to be able to design cultivation measures and provide background information for areas handled by the other standards in the series, particularly:

SPPK A01 002 Protection of woody plants during development activities,
SPPK A02 002 Pruning of trees,
SPPK A02 005 Tree felling,
SPPK A02 008 Tree stand establishment and management,
SPPK A02 010 Tree management around public transport infrastructure,
SPPK A02 011 Care of woody plants along utility lines.

1.1.2 Tree assessment is of an interdisciplinary nature and involves analysis of a wide range of factors. It is an expert activity that has to be done by qualified persons, who may be:

- judicial experts under Act no. 36/1967 Coll. with a specialisation including tree assessment or similar, or
- graduates from study programmes and specialisations of faculties of forestry, horticulture, scientific, environmental, etc., where tree assessment issues are taught, or
- holders of a national or international proof of expert knowledge in the area.[1]

1.2 Legal framework

1.2.1 **Act no. 114/1992 Coll.** on Nature and Landscape Protection, as amended (hereinafter, Act no. 114/1992 Coll.) deals with tree protection in most detail and most comprehensively. It defines both general and specific tree protection. Tree assessment is handled especially by provisions regarding owners' obligation to manage trees and provisions regarding general tree protection from damage and destruction (Section 7). In addition, the Act defines rights and obligations in connection with cutting of non-forest trees (Section 8), substitute planting (Section 9) and general and specific protection of plants and animals.

With a view to the provisions of Sections 5, Para. 1, and 48 of Act no. 114/1992 Coll., tree assessment has to take into account potential presence of species the populations of which could be endangered by interventions in the trees.

Any intervention in a tree that is a specially protected tree species under Section 48 (see Annex 12) requires an exemption from the bans for specially protected plant species under Section 56 of Act no. 114/1992 Coll. Species protection under Section 48 does not apply to cases specified in Section 49, Para. 2 of the Act no. 114/1992 Coll.

1.2.2 **Decree no. 189/2013 Coll.** on Protection of oody plants and permission of their cutting, as amended, is of importance for tree assessment particularly due to its definition of unpermitted interventions in trees (Section 2).

[1] For example, Czech Certified Arborist – Consultant, European Tree Technician, etc.

1.2.3 **Act no. 89/2012 Coll.**, the Civil Code, as amended. Tree assessment issues are related to the Civil Code notably with respect to commitments and violations and liability for indemnification. The Civil Code defines the general prevention obligation (Section 2900), liability for legal violations (e.g., of Act no. 114/1992 Coll.) (Section 2910) and liability for violation of contractual obligations (Section 2913). Moreover, the Civil Code defines liability for wilful violation of good manners (Section 2909), its Section 1013 handles pollution intake, and other similar disputes are handled, such as concerning roots, branches or other parts of trees and shrubs, if they extend to adjacent land plots harmfully.

1.2.4 **Act no. 20/1987 Coll.** on State Heritage Management, as amended, defines, among other things, the capacity of regional authorities to specify, after negotiation with applicable authorities, which properties that are not cultural monuments but are within a heritage reserve or a heritage zone, or what types of works on them, including planting and cutting of woody plants in public areas exclude the owner's obligation to apply for a prior binding position statement of the authority of the municipality with extended powers that is otherwise necessary for such works. The regional authority does so by means of protection plans, issued in the form of general measures.

1.2.5 **Decree no. 395/1992 Coll.**, implementing certain provisions of Act no. 114/1992 Coll. on Nature and Landscape Protection, as amended. Annex II to the Decree contains a list of plant species (including trees and shrubs) that are specially protected and the degrees of their endangerment. Annex III contains a list of endangered animal species, some of which, or developmental stages of which are immediately bound to trees.

2 Assessment and inspection system

2.0 In order to establish a systemic approach to tree analysis, the assessment proceeds gradually in several steps:

- assessment of basic areas (see 2.1),
- assessment of individual trees (see 2.2),
  - listing of trees (see 2.2.4),
  - dendrological survey (see 2.2.6),
  - design of cultivation measures (see 2.2.8),
- follow-up and specialised surveys (see 2.2.10).

2.1 Assessment of basic areas

2.1.1 The **basic area** is the principal unit of space. A basic area is an area of identical function, visitor mode and management intensity.

2.1.2 For the purposes of tree assessment, basic areas can be further divided into spatial sub-units.

2.1.3 Basic areas are identified with the abbreviation "ZP", followed by the unique number of the specific basic area within the assessment territory and a unique name. Spatial sub-units are identified by a number within the parent basic area after a forward slash.

2.1.4 The use of a basic area and its inclusion in the cultivation management system is characterised by the **maintenance intensity class**. Scale:

Class	Description
1	Extraordinary demands on management on particularly exposed sites in central and near-central areas of a significance forming the appearance of the municipality or cultural monument (park).
2	Average demands on management for all green areas, unless included in class 1. Typically includes residential green areas as the functional type of green areas most commonly present in settlement green systems.
3	Low demands on management, remote areas, poorly accessible parts of parks, fallow areas. Typically functional types of landscape green areas in cities.
4	Green areas that are not maintained or only maintained occasionally.

2.1.5 For the purposes of this standard, the parameters characterising the basic area are extended with:

- the overall tree stability in the area (see 2.1.6),
- the fall target value (see 2.1.7),
- in justified cases, ground slope (see 2.1.8).

These parameters are determined using the educated estimate method for the entire basic area.

2.1.6 **Overall tree stability** characterises the overall stability of trees in the basic area. It is expressed as the estimated prevailing tree condition throughout the basic area. Scale:

Degree	Description
1	Areas with trees without major statistically significant defects[2]
2	Areas with trees with defects that can be handled by ordinary cultivation interventions
3	Areas with trees with evident presence of defects that have to be handled by special stabilising interventions (such as stabilising pruning, bonds[3]).
4	Areas with trees with evident presence of failures. Limited possibility of stabilisation with cultivation interventions.
5	Areas with trees in emergency condition. Significant proportion of decaying trees beyond stabilisation.

2.1.7 **The fall target value** characterises the intensity of pedestrian and vehicular traffic within the fall distance of trees in the basic area and the value of property that may be affected in the case of tree failure. Expressed as an estimate of the prevailing parameter throughout the basic area; the highest parameter decides on area classification in the degree. Scale:

Degree	Parameter		
	Pedestrian traffic frequency[4]	**Road type (numbers of cars per day)**	**Value of property**
1	Area use between constant and 2.5 hours a day Pedestrians and cyclists 73–720/hour	Motorway, 1st class road and main streets in built-up areas 26,000-2,700 at 110 km/h 32,000-3,300 at 80 km/h 47,000-4,800 at 50 km/h	Risk of property damage in excess of CZK 5,400,000
2	Area use between 2.4 hr/day and 15 min/day Pedestrians and cyclists 8-72/hour	2nd class road and busy streets in built-up areas, parking areas 2,600-270 at 110 km/h 3,200-330 at 80 km/h 4,700-480 at 50 km/h	Risk of property damage between CZK 540,000 and 5,400,000
3	Area use between 14 and 2 min/day Pedestrians and cyclists 2-7/hour	Less busy roads or roads with worse visibility 260-27 at 110 km/h 320-33 at 80 km/h 470-48 at 50 km/h	Risk of property damage between CZK 54,000 and 540,000
4	Area use between 1 min/day and 2 min/week Pedestrians and cyclists 1/hour - 3/week	Less busy roads with good visibility 26-4 at 110 km/h 32-4 at 80 km/h 47-6 at 50 km/h	Risk of property damage between CZK 54,000 and 5,400
5	Area use between 1 min/week and 1 min/month Pedestrians and cyclists 2/week - -2/month	Roads without general access (company, private), farm tracks 3-1 at 110 km/h 3-1 at 80 km/h 5-1 at 50 km/h	Risk of property damage between CZK 540 and 5,400
6	Area use below 1 min/month Pedestrians and cyclists below 1/month	No car traffic	Risk of property damage below CZK 540

Source: Quantified Tree Risk Assessment, www.qtra.co.uk

2.1.8 **Ground slope** is one of the factors determining the financial demand of some

2 see 5.5.6
3 see SPPK A02 002 Pruning of trees, and A02 004 Crown security systems (cabling / bracing)
4 Has to take into account the nature (seasonality) of area use.

cultivation interventions. It is determined as a parameter mostly characterising the basic area.
Scale:
1. flat land – gradient up to 1 : 5,
2. gentle slope – gradient 1 : 5 to 1 : 2,
3. slope – gradient 1 : 2 to 1 : 1.5,
4. steep slope – gradient 1 : 1.5 to 1 : 1.

2.1.9 In case any of the characteristics in 2.1.4 to 2.1.8 differs significantly in any part of the basic area, it is advisable to detach the part as a spatial sub-unit with its own separate assessment.

2.2 Assessment of individual trees

2.2.1 Individual assessment is made for trees that can be located reliably and for which it is desirable to determine cultivation measures individually. In other cases, assessed trees can be grouped together.

2.2.2 Individual tree assessment is desirable at least in areas with maintenance intensity classes 1 and 2 (see 2.1.4) and in areas with a high fall target value (degrees 1-2, see 2.1.7).

2.2.3 For the purposes of a basic property overview, definition of a management and tree inspection plan, it is advisable to gradually make a complete dendrological survey of trees in all the green areas.

2.2.4 **Listing of trees** includes:
- location of trees (see 3.1),
- basic taxonomic findings and dendrometric data for individual trees (see 4.1 to 4.5).

In justified cases, the taxonomic and dendrometric data can be determined in only a limited extent by agreement with the client.

2.2.5 In cases required by the client, the listing of trees can include a listing of tree stumps, including their diameters.

2.2.6 **Dendrological survey** includes:
- listing of trees (see 2.2.4),
- physiological age (see 5.1),
- vitality (see 5.3),
- health condition (see 5.4),
- stability (see 5.5),
- outlook (see 5.7),
- date of assessment.

The outcome includes an analysis of the determined values and some framework conclusions relevant to the purpose of the dendrological survey.

2.2.7 The dendrological survey assignment has to include a description of relationships with further provisions of Act no. 114/1992 Coll., particularly whether the tree is a part of a notable landscape feature, territorial system of ecological stability, memorable tree, specially protected area, the tree effect on landscape character, and whether the tree is populated by SPS. These facts then have to be specified and reflected in the dendrological survey.

2.2.8 **Design of cultivation measures** is based on the findings under 2.2.6 – 2.2.7 and is usually a part of the dendrological survey (unless specified otherwise). It includes:

- intervention technique (see 6.1),
- intervention urgency (see 6.2),
- proposed repetition of interventions (see 6.3.2 with exceptions).

2.2.9 If there is a finding of any facts that necessitate a specialised survey (such as on suspicion of presence of specially protected species), this background information has to be a part of the dendrological survey.

2.2.10 **Follow-up and specialised surveys** are detailed assessment types carried out in cases of special necessity as an extension or expansion of the dendrological survey. They may include acquisition of additional specific information about trees, for example focusing on the following:

- orchardist value (see 8.1),
- survey and recording of accompanying organisms (see 8.2),
- survey of the rootable area (see 8.3),
- biomechanical and safety analysis of trees (see 8.4),
- importance of trees for structural composition (see 8.5),
- tree appraisal (see 8.6),
- phytopathological survey and so on.

Further steps can be modified based on information from the specialised surveys.

2.2.11 By agreement with the client, simplified assessment types can be carried out in justified cases; the only include selected characteristics or are of limited accuracy and extent of dendrometric parameters surveyed. The client has to be informed about the limited further usability of such data.

2.3 Assessment of groups of trees

2.3.1 Assessment of groups (stands) of trees follows SPPK A02 008 Woody plant stand establishment and management.

2.4 Assessment period

2.4.1 Listing of trees can proceed at any time of the year.

2.4.2 Dendrological survey should not be made in periods when trees and soil surface are covered with snow.

2.4.3 Vitality of trees (see 5.3) is ideally assessed during the growing season. On deciduous trees, it can also be determined outside the growing season to a limited extent; this has to be specified in the documentation. It can be assessed year-round on evergreen trees.

2.4.4 Presence of fruiting bodies of annual wood fungi (see 5.4 and 5.5) can be determined only in their growing season (typically late summer – autumn).

2.4.5 The period of the dendrological survey may influence the check for potential presence of specially protected species (see 8.2).

2.4.6 The period of the dendrological survey may influence the accuracy of the taxon determination of the assessed trees.

2.4.7 The date of the listing of trees or dendrological survey or last update (check) shall be included in the database record for each basic area and/or each tree.

3 Location of trees

3.1 Location of individual trees

3.1.1 Each tree is identified with a number that is unique at least within the basic area.

3.1.2 Location of an individual tree is done using a point with defined coordinates, optionally accompanied with a symbol or depiction of the tree crown projection.

3.1.3 The basic type of location is the determination of the coordinates of the centre of the tree trunk within one of the standard coordinate system types.

3.1.4 The following coordinate system types are considered standard:

- S-JTSK (Minus S-JTSK),
- WGS 84.

In case another coordinate system is used, the coordinates have to be recalculated for a standard system.

3.1.5 The coordinates may be determined using multiple methods (see Annex 1); the choice of the specific method is up to the client and the survey contractor.

3.1.6 **Accuracy of coordinate determination** is a function of the method used (see Annex 1), background information and technical equipment.

3.1.7 Visual plotting on a cadastral map or orthophoto is done with a permissible deviation of 3 m in cases where the layout situation is not excessively complex. In cases of location of the trees in stands, on slopes and under similar conditions that make estimates difficult, the error may be greater.

3.1.8 Plotting on a technical map is done with a permissible deviation of 0.5 m, corresponding to class 5 under ČSN 01 3410.

3.1.9 For special purposes, where geodetic surveying of tree positions is required, the surveying shall correspond to accuracy class 3 under Czech Office for Surveying and Mapping Guideline no. 2600/1981-22.

3.1.10 Depending on the assessment purpose, the assessed tree shall be depicted in the graphic (drawing) section based on the selected attribute.

3.2 Marking of trees in the field

3.2.1 Location of trees in the field can be made easier by using installed identification tags or chips. These are secondary identification instruments with a unique numerical series within the assessment area.

3.2.2 Tags are installed using a single nail or screw, which only penetrates the sapwood section of the wood cylinder. The system has to enable loosening or another method reflecting the thickness increments of the tree.

3.2.3 Identification chips are embedded or drilled in the sapwood section of the tree trunk.

3.2.4 By agreement with the client, it is possible to use temporary tags only, installed in tree bark, tied to planting poles or numbers sprayed on the trunk with paint.

4 Taxonomic and dendrometric data

4.1 Determination of tree taxa

4.1.1 The report shall specify the genus, species and intraspecific unit, if any, of the assessed tree using its scientific name. Citing the author of the scientific name is not necessary if the bibliography source is quoted in the assessment methodology.

4.1.2 The formal appearance of the taxon names shall follow the International Code of Botanical Nomenclature (see Annex 2).

4.1.3 In justified cases of simplified assessments, or in tree assessments outside the growing season, it is possible, by agreement with the client, to use simplified taxon determination, which only specifies the tree genus.

4.1.4 Incomplete taxon determination or wrong classification into species for genera with difficult determination cannot be regarded as a fundamental assessment error.

4.2 Trunk dimensions

4.2.1 The trunk dimensions can be given as trunk diameter (thickness) or circumference. Mutual conversion between the parameters is possible[5]. The result is rounded to entire centimetres.

4.2.2 The trunk dimensions are measured at breast height 1.3 m above ground, perpendicular to the trunk axis.

4.2.3 The trunk dimensions are determined using adequate instruments, such as a diameter gauge or a circumference tape (see Annex 3). The parameter has to be determined by measurement, not estimate.

4.2.4 In case the trunk is uneven at breast height (bumps, wounds, etc.), the dimension is read above or below the uneven spot so as to measure a representative value of the required parameter without any effect of root taper or branching.

4.2.5 In case the tree grows on a slope, the breast height is measured from the top edge of the trunk-ground contact.

4.2.6 If the tree branches below the breast height, the trunk dimensions are measured below the branching where it is not significantly affected by root taper or branch taper. If not possible, the procedure is that for measurement of multiple-trunk trees.

4.2.7 In multiple-trunk trees, dimensions of at least 4 thickest trunks are measured. Depending on requirements on further processing, the client may require measurement of all trunks. It is recommended to specify the number of trunks in the remark.

4.2.8 For the purposes of cumulative expression of the trunk dimension in a tree with multiple trunks, the calculation of substitute trunk diameter may use conversion from all the trunks using the following formula:

$$d=\sqrt{\mathrm{d}^2\,max+d^2\,ostatní}$$

[5] The conversion **of trunk diameter to circumference** is made following the formula:

$O = d \,.\, \pi$, where **O** is the trunk circumference, **d** is the trunk diameter and **π** is Archimedes' constant given as 3.1416.

The conversion **of trunk circumference to diameter** follows the reverse procedure:

$d = O / \pi$, where **O** is the trunk circumference, **d** is the trunk diameter and **π** is Archimedes' constant given as 3.1416.

where d_{max} is the diameter of the thickest trunk and d_{others} is the arithmetic mean of diameters of the other trunks.

4.2.9 When determining the trunk dimension from a tree stump, the conversion coefficient is determined by a reference measurement of trees of similar age and taxon on the site. If no reference sample is available, the trunk diameter at breast height is determined using the function:

$$d_{1,3} = \frac{d_{pařez}}{1,37}$$

where $d_{1.3}$ is the trunk diameter at breast height and d_{stump} is the trunk diameter at the stump.

4.2.10 The maximum permissible deviation when determining the trunk dimension is 5%.

4.3 Tree height

4.3.1 Tree height is determined by the distance between the trunk base and the crown top. It is given as rounded to 1 m.

4.3.2 Tree height can be determined by direct measurement of each individual or estimate. Even when estimating, however, a direct measurement of the height of one representative tree in each area is made, as well as at least every 50th individual to make the estimate more accurate.

4.3.3 The maximum deviation[6] when determining tree height can be:

- 20% for trees up to 20 m tall,
- 25% for trees 21 to 30 m tall,
- 30% for trees above 31 m tall.

4.4 Crown bottom height/crown height

4.4.1 The parameter used for characterising the crown volume or strain area of individually assessed trees is the crown bottom height or crown height, as the case may be (difference between the tree height and the crown bottom height). It is given as rounded to 0.5 m.

4.4.2 The crown bottom height is given as the distance between the trunk base and the place where the main volume of branches and assimilation organs starts. It is determined considering the fact that its purpose is subsequent representative calculation of crown volume or strain area (Annex 17, Fig. 7, 8).

4.4.3 The maximum deviation[6] when determining the crown bottom edge should not be more than 30%.

4.5. Crown width

4.5.1 Crown width characterises the representative diameter of the crown projection onto a plane perpendicular to the tree height. It is determined as the arithmetic mean of two mutually perpendicular directions (or the sum of two mutually perpendicular radii). In the case of a significantly asymmetric crown, one measurement is made along the longest axis and one in the perpendicular direction (Annex 17, Fig. 9 and 10).

4.5.2 It is given as rounded to 1 m. The maximum deviation[7] should not be more than 30%.

[6] The reference measurement shall be made using adequate instrumentation (height gauge).

[7] The reference measurement is made using a length gauge/tape according to the methodological instruction given in 4.5.1.

5 Qualitative and related attributes of trees

5.1 Physiological age

5.1.1 Physiological age characterises the tree in terms of its developmental ontogenetic stage.

5.1.2 Scale (see Annex 4):
1. young tree in the root-taking stage,
2. acclimatised young tree,
3 adolescent tree,
4. adult tree,
5. senescent tree.

5.2 Age

5.2.1 Determination of tree age or age groups based on visually evident criteria is loaded with serious error in most cases. A more accurate determination of age is only possible using laboratory method (dendrochronological analysis) or available records on individual planting.

5.2.2 In trees growing under normal conditions, it is possible to apply the annual average wood increments for each age group of the taxon.

5.2.3 The age determination is specified only in justified cases (such as 8.6.5) or made on special request by the client.

5.3 Vitality (life functions)

5.3.1 The vitality of a tree (life functions, physiological vitality, viability) characterises an individual in terms of the dynamics of its physiological functions. Vitality is assessed based on an aggregate assessment of primarily the following manifestations of the tree and their concurrence:
- extent of defoliation (or estimate of number of needle seasons present),
- changes in size and colour of assimilation organs,
- significant infestation of assimilation organs by diseases or pests,
- dynamics of secondary shoot development,
- changes in branch forms in the crown apex,
- drying at crown periphery,
- dynamics of height increment in physiological age groups 1–3.

5.3.2 Vitality indicators may be highly variable between growing seasons. The assessment may be negatively affected by pest defoliation, extreme climate effects and major interventions in the tree habitat conditions.

5.3.3 Scale (see Annex 5):
1. excellent to slightly reduced,
2. visibly reduced,
3. significantly reduced,
4. remains of vitality,
5. dry tree.

5.4 Health condition (defects and damage)

5.4.1 Tree health condition (defects and damage) characterises an individual in terms of its mechanical disruption or damage. Health condition is assessed based on an aggregate assessment of primarily the following manifestations of the tree and their concurrence:

- mechanical damage,
- infestation by wood-decaying fungi and/or xylophagous insects,
- presence of dry thick branches,
- presence of cavities and exit holes,
- presence of defective and damaged branching points.

5.4.2 Health condition assesses all disruptions in the tree as a mechanical object regardless of their immediate effect on the individual's overall stability.

5.4.3 Scale (see Annex 6):

1. health condition excellent to good,
2. impaired,
3. significantly impaired,
4. severely disrupted,
5. critical/disintegrated tree.

5.5 Stability

5.5.1 Tree stability assesses the degree of tree failure by windthrow, trunk fracture or break-off of a part of the crown.

5.5.2 The purpose of tree stability assessment is to asses the extent of identified defects and their effect on the individual's stability, not to predict the moment of failure.

5.5.3 A visual tree assessment only includes an assessment of resistance to fracture. Resistance to windthrow is only assessed to the extent of symptoms that are visually evident.

5.5.4 A representative characterisation of tree resistance to windthrow is only possible using selected instrumental examination methods (see 9.2.5).

5.5.5 The risk of failure may be fundamentally increased by unpredictable external effects (so-called force majeure effects), such as:

- extreme wind speeds,
- turbulent wind flow,
- rime, heavy loading with wet snow,
- extreme soil moisture (e.g., by long-term intensive precipitation or floods).

5.5.6 Stability is assessed based on an aggregate assessment of primarily the following manifestations of the tree and their concurrence:

- presence of defective branching points (pressure forks, damaged bough forks, etc.),
- symptoms of infection of main load-bearing parts with wood-decaying fungi or xylophagous insects,
- presence of cavities and exit holes,
- habitus defects (significantly raised crown centre of gravity, asymmetric crown),
- presence of overgrown secondary shoots,
- cracks in main load-bearing parts of the tree,
- uncompensated trunk inclination,

- symptoms of infection or disrupted mechanically important root area.

5.5.7 A specific list of identified statistically significant defects is mandatorily given in the text form in the remarks (see 5.9).

5.5.8 Scale (see Annex 7):
1. excellent to good (undisrupted),
2. impaired,
3. significantly impaired,
4. severely disrupted,
5. critical.

5.6 Operating safety

5.6.1 Operating safety is determined for a specific tree.

5.6.2 Operating safety is a synthetic value expressing the degree of endangerment of the fall target, the derivation of which is the result of the author’s individual approach based on identified qualitative attributes (notably fall target value and stability).

5.7 Outlook

5.7.1 Tree outlook characterises, in a simplified way, the expected length of its existence on the site, resulting from the individual’s condition (vitality, health condition, stability) while reflecting the site limitations, etc. The worse of the parameters is critical for ranking on the scale.

5.7.2 Scale (see Annex 8):

a long-term outlook,
b short-term outlook (temporary outlook),
c no outlook.

5.8 Photo documentation

5.8.1 Basic photo documentation is made for individual trees as an optional part of the dendrological survey (except 5.8.3).

5.8.2 Basic photo documentation includes a view of the whole tree. In case the whole tree cannot be contained in the picture, the bottom part of the trunk and bough branching area are photographed.

5.8.3 In the case of major statistically significant defects, photo documentation of their extent is a necessary part of the dendrological survey.

5.8.4 Photographs taken have to be legible and named uniquely in order to connect them to the tree database record.

5.9 Others

5.9.1 Other facts not included in the above parameters shall be given in the text form in the remark for each tree.

5.9.2 The remark text shall mandatorily contain at least:
- list of all identified statistically significant defects (see 5.5.7 and Annex 7), including an estimate of their extent,
- suspicion of presence of specially protected species,
- currently evident factors that affect or may in future affect the individual’s condition (excavations in the root space, evident changes in ground elevation, infestation with pests, improvements made to individual’s habitat conditions, etc.).

5.9.3 The dendrological survey shall include recording of installed safety bonds and braces to the extent given in SPPK A02 004 Crown security systems (cabling /

bracing).

6 Design of cultivation measures

6.1 Technique

6.1.1 The proposed technique of the cultivation measure (intervention) is given in words or as an abbreviation, always pursuant to the applicable Nature and Landscape Management Standard. A list of recommended technique abbreviations is shown in Annex 9.

6.1.2 Any recommended non-standard work procedures have to be described in the assessment methodology in detail in a way that enables their pricing and subsequent performance inspection.

6.1.3 The database used has to enable design of multiple techniques for each assessed tree.

6.1.4 Detailed specifications of cultivation measures shall be included in the technique remark.

6.2 Urgency

6.2.1 All designed cultivation measure techniques are divided into urgency classes based on their importance. The primary purpose is the possibility of financial optimisation of the intervention.

6.2.2 Performing all the designed cultivation measures in a single step (regardless of urgency) is not a process error.

6.2.3 Scale (see Annex 10):

0. cultivation measure with necessity of immediate performance – delay is risky,
1. perform in first stage of works,
2. perform in second stage of works,
3. perform in third stage of works.

6.2.4 The final staging of the works to be done is set by the investor (tree owner).

6.3 Repetition

6.3.1 In justified cases, a period of repetition can be designed for each cultivation measure technique.

6.3.2 Repetition has to be defined notably for the following types of cultivation measures (see SPPK A02 002 Pruning of trees):

S-RV – Juvenile pruning,
S-RO – Perimeter crown reduction,
S-SSK – Removal of secondary crown,
S-RS – Removal pruning,
S-RTHL – Pruning to head,
S-RTPP – Pruning to pin,
S-RTZP – Pruning of hedges and tree walls,
S-VK – Safety bond inspection.

6.3.3 The actual repetition of a cultivation measure has to be specified in an update before implementation.

7 Data optimisation and update options

7.5 Exchangeable format

7.1.1 It is recommended to provide data from inventorying, dendrological surveys, specialised surveys, inspections and instrumental assessments as well in electronic form suitable for further processing. When ordering the work, the client may define the data format or database structure to enable system interconnection and interlinkage. The database structure should respect categories and dials defined in the standard.

7.2 Area inspections

7.2.1 Inspections of basic area conditions are made periodically at intervals specified by the owner as well as one-off following extreme climatic effects (windstorms, heavy snow loading, floods, etc.) or before an expected significant traffic volume increase.

7.2.2 The contents of **periodic inspections** of an area are:

- inspection that basic area parameters are up to date, notably overall stability, fall target value and significant deviations in functional uses,
- presence of facts that justify recommendation for individual tree inspection,
- facts requiring intervention in a significant part of the trees in the area (satisfactory condition; part of the trees require intervention; most of the trees require intervention).

7.2.3 The contents of a **one-off inspection** of an area are assessment of existing risky conditions that immediately reduce the operating safety of the area and design of urgent remedial measures.

7.2.4 The output from both types of area inspections is a report, containing at least:

- inspection date,
- inspection type,
- person making the inspection,
- facts identified,
- list of designed measures.

7.2.5 Area inspections exclude individual tree inspections.

7.2.6 If a tree in evident emergency condition or an individual that is dead or otherwise fundamentally disrupted is found, their presence is recorded and a solution is designed.

7.2.7 The interval of periodic inspections has to be adjusted to parameters characterising the area (see 2.1).

7.2.8 The maximum interval between periodic area inspections should not exceed 10 years.

7.2.9 Periodic area inspections can be optimised using basic area characteristics (see 2.1.4, 2.1.6 and 2.1.7).

7.3 Inspections of assessed trees

7.3.1 Tree inspections are made periodically at intervals specified by the owner. The recommended interval is at least once every 10 years.

7.3.2 The contents of periodic inspections of trees are:

- inspection and update of dendrometric data (list of trees),
- inspection and update dendrological survey contents,
- update of treatment technique design,
- concurrent inspection of trees with safety bonds installed (see 7.4).

7.3.3 The output from tree inspections is a report, containing at least:

- inspection date,
- inspection type,
- person making the inspection,
- facts identified,
- list of designed measures.

7.3.4 Periodic tree inspections can be optimised using descriptive area characteristics and data from the dendrological survey.

7.4 Inspections of trees with stabilisation systems installed

7.4.1 Trees with safety bonds and braces installed have to be inspected periodically pursuant to SPPK A02 004 Crown security systems (cabling / bracing).

8 Follow-up and specialised surveys

8.0.1 Follow-up and specialised surveys are made after a complete dendrological survey as its extension, or simultaneously in the form of more detailed or thematically broader dendrological survey. The exception is inspection for potential presence of specially protected animal and plant species (SPS), which is a legal obligation pursuant to Sections 49 and 50 of Act no. 114/1992 Coll. (see 8.2.5) and endangered Red List species [8] in the categories CR-critically endangered and EN-endangered (hereinafter, Red List species).

8.0.2 The type, extent and purpose of specialised surveys is defined by agreement with the survey client.

8.0.3 Based on analyses and additional investigation as part of specialised surveys, changes may be made to the management plans for individual trees or tree groups.

8.1 Orchardist value (assessment of dendrological potential)

8.1.1 Orchardist value is a synthetic value of a tree in terms of horticulture and landscape architecture, expressing its present and potential functionality arising from its biologically conditioned properties. It is determined in a field investigation as a comprehensive output parameter based on evaluation of identified assessment attributes. The use of orchardist value without a previous analytical assessment (dendrological survey) is a methodological error.

8.1.2 The functionality of a tree, expressed by its orchardist value, is determined notably by these biologically conditioned characteristics:

- taxon (including its suitability for the site),
- dendrometric quantities,
- architecture of the aboveground section,
- qualitative attributes (see Chapter 5).

8.1.3 A scale for orchardist value is shown in Annex 11.

8.2 Survey and recording of accompanying organisms

8.2.1 In the case of identified presence of wood-decaying fungi, parasitic and semiparasitic plants and other types of diseases, pests and other relevant accompanying organisms, it is advisable to specify the species of the organism detected and the place of its presence.

8.2.2 The records should register notably signs of presence of SPS listed in Annexes II and III to Decree no. 395/1992 Coll. as well as Red List species[9].

8.2.3 Records on accompanying organisms shall include:

- scientific name of organism (or identification of group of organisms),
- location of presence of the symptom detected,
- characteristics of presence,
- finding date.

8.2.4 Protection of SPS pursuant to Sections 49 and 50 of Act no. 114/1992 Coll. also

[8], [9] Information on Red Lists can be found at https://portal.nature.cz/publik_syst/ctihtmlpage.php?what=1264

relates to all developmental stages of the species, and its biotope is protected as well (see Annex 13).

8.2.5 When assessing potential presence of SPS and Red List species, pay increased attention to older trees and trees with elements with increased biological potential (see 8.2.6), which are preferred by these species.

8.2.6 Elements with increased biological potential are notably:

- cavities,
- split wood and cracks,
- rot,
- dry branches,
- bark damage,
- sap outflow,
- broken branches,
- minor cavities,
- perennial fungus fruiting bodies.

8.2.7 Presence of organisms bound to tree may be attested by the below circumstances, which have to be recorded in the assessment report:

- movement of birds, bats or beetles,
- presence of bird nests,
- presence of inhabited cavities (movement, presence of droppings or acoustic manifestations),
- presence of large insect galleries or exit holes,
- presence of cavities with dry rot (particularly if containing beetle larvae, bodily remains or droppings),
- acoustic manifestations of younglings and adults,
- presence of characteristic fruiting bodies.

8.2.8 Indicative background information about presence of SPS and Red List species can be obtained from the NCA CR[10]. Any absence of a proof of presence of SPS or Red List species in the Nature Protection Finding Database does not mean that those species are not present there. Therefore, examination in trees that might a potential biotope for these species (8.2.5) always has to be carried out.

8.2.9 When assessing a tree that is an SPS biotope, the fact has to be pointed out. Any intervention in such a tree requires an exemption from bans for specially protected plant and animal species pursuant to Section 56 of Act no. 114/1992 Coll.

8.2.10 In suspicion of presence of SPS in a tree, cooperation with a specialist (zoologist/mycologist) is required.

[10] www.nature.cz

8.3 Rootable area survey

8.3.1 In justified cases, a description of visually evident signs of influences of habitat conditions in tree rootable area can be made. The survey includes notably the following parameters:

- characteristics of rootable area,
- symptoms of disruption to adjacent structures as a consequence of tree growth,
- signs of interventions (excavation, backfill) in the protected root area (see SPPK A01 002 Protection of woody plants during development activities),
- identification of location of any underground public technical infrastructure networks.

8.3.2 Characteristics of rootable area describe the site in terms of limitations to the rootable area and soil conditions for tree growth and development. Growth conditions are assessed visually in an area given by the crown width of an adult individual of the taxon using the following scale[11] (see Annex 14):

1. unaffected,
2. good,
3. impaired,
4. extreme.

8.3.3 If using instrumentation for analysis of habitat conditions, other specialised pedological analyses may be made pursuant to SPPK A02 007 Modification of woody plant site conditions.

8.4 Biomechanical and safety tree analysis

8.4.1 Biomechanical and safety tree analysis may use any of the published methodologies, such as:

- SIA (Statisch Integrierte Abschätzung),
- VTA (Visual Tree Assessment),
- QTRA (Quantified Tree Risk Assessment),
- TRAQ (Tree Risk Assessment Qualification) – ANSI A300, Part 9.

8.4.2 The WLA (Wind Load Analysis) method is recommended in the Czech Republic[12].

8.4.3 **The WLA method** can only be used in the following cases:

- analysing the condition of a solitary tree or a tree growing outside continuous stands,
- not a multiple-trunk tree,
- not a tree with a secondary crown,
- analysing the stability of a whole tree (i.e., not parts of the crown or branches) using the parameter of resistance to fracture or twisting (not resistance to windthrow).

8.4.4 Taxonomic and dendrometric parameters (see 4.1 – 4.5) comprising the input values for calculation of the basic stability using the WLA method have to be determined by measurement using adequate instrumentation.

8.4.5 The basic stability is determined at an accuracy to entire percent in the parameters:

[11] in the context of NCA CR methodology Appraisal of non-forest trees.

[12] See www.wla.cz

- resistance to fracture,
- resistance to twisting.

8.4.6 Using educated estimate, the calculation can be extended with the effect of selected defects on the basic stability in the area of resistance to fracture.

8.4.7 Increased resistance to fracture can be calculated in the WLA method based on a calculation of effectiveness of perimeter reduction (S-RO under SPPK A02 002 Pruning of trees).

8.4.8 Increased resistance to twisting can be calculated in the WLA method based on a calculation of change in the crown eccentricity, achieved using local reduction in order to stabilise the tree (S-RLLR under SPPK A02 002 Pruning of trees).

8.4.9 The possibility of performance of the stabilising interventions pursuant to 8.5.6 – 8.5.7 on a specific tree has to be judged by a qualified person.

8.5 importance of trees for structural composition

8.5.1 Trees fundamentally determine stability and authenticity of compositions of structures of garden and landscape architecture. Assessment of their importance for structural composition is a basic precondition for designing spatial compositions and their management.

8.5.2 Assessment of importance of trees for structural composition applies one of the assessment methods specified below. The choice of the assessment method depends on the structure type and the nature of the planned intervention. Specific procedures and combinations of assessment methods are applied notably to protected heritage structures of garden and landscape architecture.

8.5.3 **Location of trees within a composition**. Expresses the importance of a tree for the structural composite derived from its location. A precondition for the assessment is knowledge of the composition principles that form the structure.

8.5.4 **Authenticity of trees within a composition**. Authenticity of trees within a composition is determined based on an analysis of the historical development of the composition of the structure or its parts. The probability of physical existence of trees or tree groups and stands since a chosen period in the past is assessed.

8.5.5 Authenticity of trees is related to determination of the age of trees or tree groups or stands, which ranks them in age groups defined in the assessment methodology either schematically with 10-year increments (more for older specimens) or by stages of planting development within the structure.

8.5.6 **Historical appropriateness of trees.** Expresses their ability to carry on the original principle. The principle is carried on successively by one generation of trees after another. From this perspective, for example, even a newly planted tree can be authentic.

8.5.7 Preconditions for determining the historic value is both knowledge of the historic development of the composition of the structure or its parts and assessment of tree authenticity (see 8.6.4) and knowledge of period tree assortments and methods of their use.

8.6 Appraisal of trees

8.6.1 Calculation of value of trees in non-forest environments may proceed in the following basic regimes:

- appraisal from a proprietary (or penal) law perspective,
- appraisal in terms of societal value of trees or environmental harm done by

tree cutting or damage.

8.6.2 Appraisal of trees from a **proprietary perspective** is made using the methodology of Decree no. 441/2013 Coll.

8.6.3 Appraisal of the **societal value of trees** or environmental **harm done by tree cutting or damage** (as part of public administration) pursuant to Act no. 114/1992 Coll. is made using the recommended NCA CR methodology[13].

8.6.4 In appraisal under 8.6.2, in justified cases, the value of the biomass (wood) can be added to the total value.

8.6.5 **Specialised appraisals are made by experts** with adequate specialisation.

[13] Bulletin of the Ministry of the Environment of the CR no. 2014/5, www.ocenovanidrevin.nature.cz.

9 Instrumental assessment methods

9.1 General requirements

9.1.1 Instrumental methods enable more accurate assessment of vitality (life functions) of trees and more exact assessment of health condition (damage and defects) and determination of their extent and probability of tree failure.

9.1.2 Instrumental methods are used exclusively as an extension to previously performed comprehensive dendrological survey of a tree. Their use without any connection to dendrological survey is a process error.

9.1.3 A list of instrumental methods with a description of their possible applications is shown in Annex 15.

9.1.4 Application of instrumental methods is relevant if:
- visual assessment is insufficient,
- the value of the tree is very high,
- the condition of the tree is debatable.

9.1.5 Application of instrumental assessment methods:
- must not lead to damage to the tree,
- must not lead to occurrence of permanent damage of the tree woody tissues past sapwood,
- must not lead to a disruption of the tree site, e.g., by application of inappropriate substances.

9.1.6 The methods have to be repeatable and independent of the person making the measurements. The measurement results have to be clearly identified (e.g., cavity extent detection, failure probability determination) and the determination method has to be described in the report or otherwise available.

9.2 Classification of instrumental methods

9.2.1 The list of instrumental methods shown may not be exhaustive. Only approaches verified by scientific research and practical application recommended for use in the Czech Republic are shown. The principle of each instrumental method typically quantifies only a part of the parameters included in the diagnostic characteristics.

9.2.2 **Assessment of vitality**. The purpose of the method application is a more accurate assessment of parameters of the dynamics of a tree’s physiological functions or assessment of the parameter development in time. Examples of methods:
- gasometric measurement methods,
- transpiration flow measurement,
- dendroecological analysis (invasive method intervening in heartwood).

9.2.3 **Crown stability**. The purpose is a detailed analysis of the stability of thick boughs and trunks comprising the tree crown. Methods used have to enable working in the tree crown. Recommended methods:
- acoustic measurements,
- acoustic tomography.

9.2.4 **Trunk stability**. The primary purpose is to detect the extent of hidden defects in the area of the trunk (from the soil contact to bough forks). Recommended methods:

- acoustic measurements,
- acoustic tomography,
- tensile testing.

9.2.5 **Root system stability**. The purpose is to detect the extent of disruption to mechanically important root system regardless of the reason (inappropriate architecture, mechanical damage, infection with wood-decaying fungi, etc.).
Recommended methods:

- tensile testing.

9.2.6 **Architecture analysis**. These methods deal with a detail description of architecture of either the aboveground or the underground section of the tree. Purposes include more accurate calculation of the load analysis or determination of the extent of the root system (regardless of intactness or functionality of roots). Recommended methods:

- soil radar (GPR),
- LIDAR,
- acoustic delineation of root system (special sensors).

Annex 1 Method for determining tree/tree group coordinates

Precise location of trees is one of the basic preconditions for tree assessment. Correct location not only facilitates subsequent tree management, but most importantly determines property relationships, since a clear location of a tree also clearly identifies its owner in the Cadastre.
At present, location can be determined using a range of methods with varying resulting accuracy and time demands for data collection and processing. The basic location methods include:

1. Manual plotting of location on a map or orthophoto,
2. Geodetic tree location,
3. GNSS measurement,
4. Location based on aerial laser scanning data,
5. Use of unmanned aerial vehicles (UAV),
6. Combinations of methods.

1. Manual plotting on a map or orthophoto
The easiest method of locating a tree is manual plotting of the tree position on a paper-based map background (basic or topographic maps) based on only a subjective location of the tree position compared to surrounding objects (roads, buildings). This method has very low time demands, but its disadvantage is its lower accuracy. The digital data processing increases the time demand due to the need for subsequent redrawing using manual digitisation in a computer over a map background. Collected data also have to be recorded in paper form and then transferred into a digital database. Higher accuracy can be achieved by plotting positions of trees in aerial orthophotos, which are currently available in high resolution for the entire country and enable accurate location of trees. Again, digitisation in a computer and manual database editing is necessary.
Summary:

- time demand – low in the field, high in the office;
- accuracy – low (approx. 5-10 metres on map background), high (1-3 metres in orthophotos);
- demand on user – low;
- cost – very low.

2. Geodetic location
Geodetic location is based on use of geodetic measuring instruments, most commonly so-called total stations. The measurement principle is mostly based on so-called polar measurement (measurement of horizontal angle and distance) using a pre-determined network of geodetic points (stations). The method shows a high accuracy of position location, but its disadvantage is its high time demand as well as high demand on knowledge of measurement method and instrument control. The method is applicable only when locating larger areas with dense stands (such as parks and forest parks), where other methods do not provide sufficient accuracy. The method also requires double records in the tree database (on paper in the field, editing in a computer).
Summary:

- time demand – high in the field, medium in the office;
- accuracy – very high (order of cm to dm);
- demand on user – very high;
- cost – very high.

3. GNSS measurement

The method is based on use of GNSS devices (global navigation satellite systems, typically GPS and GLONASS). The method accuracy depends on the type on instrument used (code versus phase measurement, single-frequency and multi-frequency devices, etc.) and ranges from the order of centimetres to several metres. The main drawback when locating trees is the omnipresent signal shading by the tree crown. The advantage of the method is the commonly available possibility to enter attributes for measured objects, which accelerates the database recording and reduces the time demand during office processing.

Summary:

- time demand – low in the field, low in the office;
- accuracy – different depending on instrument type (from cm to several metres);
- demand on user – medium;
- price – different depending on instrument type and data processing software.

4. Location based on aerial laser scanning data

The location is based on automated identification of trees and their tops using analysis of aerial laser scanning data. The advantage of the method is accurate identification of tree tops, and it is possible to obtain highly accurate information on tree height and crown shape. The disadvantage is high demand on data processing and higher cost of the data themselves. However, it is applicable for mapping vegetation in larger urban or municipal areas.

Summary:

- time demand – very low in the field, low in the office;
- accuracy – approx. 1 metre;
- demand on user – very high;
- cost – very high (will decrease fast with data availability).

5. Use of unmanned aerial vehicles (UAV)

Unmanned aerial vehicles (UAV) are a fast-evolving segment applicable to tree location as well. The principle consists in production of detailed orthophotos and a digital model of the surface from stereophotogrammetrically taken photographs and subsequent processing in a GIS environment. The processing is then similar to aerial laser scanning – identification of trees, their height, crown shape, etc. The method accuracy depends on the UAV flight height and is in the range of decimetres.

Summary:

- time demand – very low in the field, low in the office;
- accuracy – up to 1 metre;
- demand on user – very high;
- cost – very high (will decrease fast with technological development).

6. Combinations of methods

Besides the methods listed above, their combinations can be used. In terms of accuracy and time demand, a combination of measurement using GNSS (with production of the digital database in the field – recording of attributes in the instrument) followed by more accurate location on an orthophoto background still appears to be the most efficient method. This combination enables both fast location in the field and an equally fast conversion into the computer and sufficient resulting accuracy after manual location correction over an orthophoto. At the same time, the method is not very demanding on the user, instrumentation (ordinary tourist GNSS device or smartphone is sufficient) and office software.

Summary:

- time demand – low in the field, low in the office;
- accuracy – up to 1-3 metres;
- demand on user – low;
- cost – low.

Annex 2 Taxonomic nomenclature under the International Code of Botanical Nomenclature

Genus name (genus)
Scientific (Latin) name spelled with the first letter capitalised.
National (Czech) name spelled with all lower case letters.

Species name (species)
Scientific (Latin) name spelled with all lower case letters.
National (Czech) name spelled with all lower case letters, except cases where the plant is named after a person;in such cases, it is capitalised.

Cultivar (form, subspecies, variety)
Binomial species names can be extended with an epithet for subspecies, variety or form if any of such taxa are discerned and validly described for the species (e.g., *Tilia platyphyllos* subsp. *cordifolia*).
Nomenclature for cultivated plants is standardised by the International Code of Nomenclature for Cultivated Plants.
The basic rules for spelling of cultivar epithets (cultivar names) include their non-Latin form and the necessity of appending them to the accepted scientific botanical name, i.e., Latin name. In practice, cultivar epithets are appended most commonly to species names, but they can be appended to the genus name directly (if detailed classification is unknown or the cultivar is the result of selection from multiple species) or to the name of intraspecies taxon (subspecies or variety), but that is often left out in practice.
Another important rule strictly requires use of capital first letters of each word in the epithet (except conjunctions and prepositions).
Cultivar denomination is currently permitted only using apostrophes immediately before and after the epithet, either straight ('.....') or in the form of single upper quotation marks (‘.....’), whereas marking with double quotation marks (".....") or ”.....”) or the abbreviation “cv.” or “var.” should not be used.

Identification of hybrids
Taxa of plants considered to be hybrids or taxa of hybrid origin are identified most commonly with the mathematical sign of multiplication “×” located depending on the taxonomic level and form of identification (another, less common method is to append the Greek prefix “*notho*-” before the taxon level identification, e.g., *nothospecies* for hybrids between two species. The nomenclature rules accept two forms of identification of hybrids: the first is the hybrid formula, which is formed by simply inserting the symbol “×” between the names of the assumed parents of the hybrid [e.g., *Populus alba* L. × *P. tremula* L. or *Pyrus communis* L. × *Sorbus aria* (L.) Crantz], the other is a binary hybrid name [for the same cases, see *Populus* × *canescens* (Aiton) J. E. Smith, and ×*Sorbopyrus auricularis* (Knoop) C. K. Schneider], the formation of which follows the same rules as those for scientific names of non-hybrid taxa. Since 2006, the symbol “×” or the letter “x” shall always be separated by a space from the first letter of the following name or epithet.

Abbreviation for the name author

The abbreviations are used for older known authors, and their form is currently required in scientific papers in accordance with "Brummitt & Powell: Authors of plant names, Kew, 1992". Scientific names of plants do not have to be always quoted with the authors – it is only required in taxonomic or nomenclature papers and where leaving out the author might lead to confusion.

Others

It is customary in printed text to type scientific names of plants – unlike cultivar names – in italics (except taxon level identification).

Annex 3 Procedures for determination of dendrometric data

Trunk diameter measurement

Trunk diameter measurement is made using adequate instrumentation, typically using a diameter gauge or circumference tape.

The circumference tape has to be in contact with the trunk around its entire circumference. It has to be applied perpendicular to the trunk axis (Annex 17, Fig. 1).

Trunk diameter measurement using a diameter gauge is made in two mutually perpendicular directions. The first measurement is made along the longest axis. The resulting value is the arithmetic mean of the two measurements. The diameter gauge always has to be applied perpendicular to the trunk axis so that it touches the trunk in 3 points (Annex 17, Fig. 2).

Tree height measurement

Height measurement is made using adequate instrumentation, typically height gauge and distance gauge. The main systemic errors have to be eliminated, such as:

- insufficient clear distance (the minimum clear distance is approximately equal to the tree height),
- wrong measurement of clear distance from trees with deflected crown top (has to be measured from the vertical projection of the highest point of the crown) (Annex 14, Fig. 6),
- lack of knowledge of use of the height gauge (e.g., necessary addition or subtraction of two measurements in relation to the horizontal line in some instruments) (Annex 17, Fig. 3, 4).

Annex 4 Physiological age – description of stages

1 young tree in the root-taking stage
An individual with a height up to 1 m growing up from competing grasses and shrubs or a newly planted tree in the root-taking stage.

2 acclimatised young tree
A young rooted individual in the stage of crown architecture formation.

3 adolescent tree
An adolescent individual with formation of characteristic attributes and continuing preference of height increment.

4 adult tree
An adult tree with mostly completed height increment stage. Height increment still continues, but does not contribute to a dynamic change in the individual’s height; instead, it increases the crown volume.

5 senescent tree
A tree showing signs of senescence, most commonly indicated by the following parameters:

- perimeter drying of the crown, substitution of secondary sprouting lower in the crown for the assimilation organs,
- evident signs of population of other organisms,
- share of dried and decaying wood in the crown,
- frequent presence of elements with increased biological potential (see 8.3.4).

The detailed definition of senescent trees is based on SPPK A02 009 Special tree treatment.

Annex 5 Vitality (life functions) – description of stages

1 excellent to slightly reduced

- Densely foliaged compact crown,
- no signs of drying at the periphery (possible exceptions if growing in partly shaded areas),
- apex section shows long-term development of macroblasts from both the terminal and axillary buds (without exception for individuals of physiological ages 1-3),
- no spontaneous development of secondary shoots (possible exceptions under significantly changed lighting conditions – crown reduction, loosened stand position, etc.),
- number of needle seasons corresponding to the taxon for evergreen conifers).

2 visibly reduced

Growth stagnation, crown drying in peripheral areas.

- Evident crown defoliation with possible fragmentation at the periphery,
- lateral crown sections drying not due to shading, a tendency towards continued drying (mostly not in the apical section),
- frequent development of brachyblasts from axillary buds in the apical crown section,
- possible spontaneous development of secondary shoots in the crown, on the trunk or near the trunk base without change in site conditions,
- reduced number of needle seasons on evergreen conifers.

3 significantly reduced

Incipient crown reduction.

- Significant crown defoliation (down to approx. 50%),
- crown significantly fragmented,
- dynamic drying not due to shading with a tendency towards further decline; frequently dry apical crown section,
- brachyblasts develop from both axillary and terminal buds,
- only 1-2 needle seasons on evergreen conifers.

4 remains of vitality

Larger part of the crown dry,

- crown defoliation significantly above 50%,
- only some parts of the crown show living assimilation organs, most of the crown dry.

5 dry (dead) tree

- Completely necrotic individual.

Annex 6 Health condition (defects and damage) – description of stages

1 excellent to good

- No evident mechanical damage to the trunk and thicker boughs (possible presence of wounds after properly done pruning),
- no presence of dry thick branches in the crown (above 50 mm),
- no symptoms of infection by wood-decaying fungi (exceptional possible presence of saprophytes on dead wood),
- possible defective branching (including primary boughs) only in a developing stage.

2 impaired

Mechanical disruption of a significant nature.

- Possible presence of damage on the trunk and larger damage to branches,
- evident symptoms of infection by wood-decaying fungi in early development stages,
- possible presence of dry thick branches, thicker branches broken off or fractured,
- possible presence of isolated exit holes in the crown,
- developing defective branching (pressure forks) in primary boughs,
- possible presence of cracks in the trunk and primary boughs,
- possible presence of “cancer” formations,
- imbalanced increment of rootstock and graft or evident inconsistency in the joint area.

3 significantly impaired

Presence of damage usually reducing life expectancy of the assessed individual.

- Mechanical damage to the trunk with symptoms of active infection with wood-decaying fungi,
- more extensive cavities, more significant presence of exit holes at multiple levels,
- more extensive symptoms of infection along primary boughs,
- part of the crown broken off,
- developed pressure forks in primary boughs or thick branches,
- suspicion of intervention in the mechanically important root area.

Individual major defects not functionally connected, not present in combination. If more than 2 of the above defects are concurrent, the health condition changes to 4.

4 severely disrupted

Concurrent defects or presence of damage significantly reducing life expectancy of the assessed individual.

- Extensive cavities in the trunk,
- symptoms of infection or significant disruption to mechanically important root area,
- developed pressure forks with cracks or symptoms of infection by wood-decaying fungi,
- major part of the crown broken off,
- trees with fundamentally impaired outlook as a consequence of mechanical damage.

Generally there is concurrence of several major defects.

5 critical/disintegrated tree

- Generally disintegrating or disintegrated tree (torso).

Annex 7 Stability – description of stages

Assessment concerns exclusively structurally significant defects, the most important of which are described in 5.5.6.

1 excellent to good (undisrupted)

- No identified presence of structurally significant defects.

2 impaired

- Presence of structurally significant defects in the developing stage, so far no expected risk of failure,
- extent of defects can mostly be resolved with normal cultivation interventions (such as S-RZ and S-RV) without the need for special stabilising interventions.

3 significantly impaired

- Identified presence of one well-developed defects with expected effect on the probability of tree failure,
- possible presence of multiple structurally significant defects in the developing stage,
- frequent need for implementation of special stabilising interventions (stabilising pruning, safety bonds, etc.).

4 severely disrupted

- Identified concurrence of several well-developed structurally significant defects,
- necessary implementation of a special stabilising intervention, the alternative being tree felling,
- stabilising interventions frequently need to be made to such an extent that they may have secondary negative impact on the individual’s outlook.

5 critical

- Trees with an imminent risk of falling or breaking up,
- stabilisation cannot be achieved by a non-destructive cultivation intervention.

Annex 8 Tree outlook – description of stages

a long-term outlook
Tree suitable to its site and sustainable for decades.

b short-term outlook (temporary outlook)
Tree temporarily sustainable on its site or in a condition where long-term outlook cannot be expected.

c no outlook
Tree unsuitable for its site or with a very short expected time of retention.

Annex 9 Tree cultivation measure techniques

The design of cultivation measures has to be based on the latest wording of the applicable Nature and Landscape Management Standards (SPPK)[14].

Tree pruning (A02 002 Tree pruning)

Code	Technique name	Remark
S-RZK	Crown cultivation pruning	
S-RK	Comparative pruning	
S-RV	Juvenile pruning	
S-RZ	Medical pruning	
S-RB	Safety pruning	
S-RLSP	Local reduction towards obstacle	Specification of pruning intention mandatory
S-RLLR	Local reduction for stabilisation	Specification of pruning intention mandatory
S-RLPV	Adjustment to underpass clearance profile	
S-OV	Removal of leader shoots	
S-RO	Perimeter reduction	Specification of extent of proposed reduction mandatory
S-SSK	Secondary crown stabilisation	Specification of extent of proposed reduction mandatory
S-RS	Removal pruning	Specification of extent of proposed removal mandatory
S-RTHL	Pruning to head	
S-RTPP	Pruning to pin	
S-RTZP	Pruning of hedges and tree walls	Specification of hedge/tree wall height and width mandatory

Pruning of fruit trees (C02 005 Management of functional plantings of fruit woody plants)

Code	Technique name	Remark
O-RK	Pruning of fruit trees to crown	
O-RV	Juvenile pruning of fruit trees	
O-RP	Clearance pruning of fruit trees - thinning	
O-RO	Corrective pruning of fruit trees	
O-RA	Medical pruning of fruit trees - renewal	
O-OV	Removal of suckers and rootstock shoots of fruit trees	
O-RZM	Gentle revitalisation pruning of fruit trees	
O-RZS	Medium revitalisation pruning of fruit trees	
O-RZH	Deep revitalisation pruning of fruit trees	

[14] The table is informative only and may not reflect latest updates and changes to specified standards.

Tree felling (A02 005 Tree felling)

Code	Technique name	Remark
S-KV	Open-space tree felling	Specification of possible use of heavy machinery mandatory.
S-KSP	Tree felling with pulling	Specification of possible use of heavy machinery mandatory.
S-KPV	Gradual felling with open impact area	Specification of possible use of heavy machinery mandatory.
S-KPP	Gradual felling with obstacles in impact area	Specification of possible use of heavy machinery mandatory.
S-US	Stump treatment by cutting	
S-OR	Manual stump removal (stumping)	
S-OK	Stump removal using heavy machinery	
S-OF	Stump removal by milling	

Other intervention types A02 004 Crown security systems (cabling / bracing), A02 006 Protection of trees against lightning strike, A02 007 Modification of woody plant site conditions, A02 009 Special tree treatment).

Code	Technique name	Remark
S-HRI	Lightning conductor installation	Mandatory annex to project documentation
S-HRK	Inspection of lightning conductor installed	
S-OKT	Removal/repair of anchor in a young tree	
S-OUV	Removal/repair of bond in a young tree	
S-TP	Instrumental tree test	Mandatory specification of test focus or instrumental method under Chapter 9
S-TVV	Specialised detailed tree survey from the ground	Specification of survey focus mandatory
S-TVL	Specialised detailed tree survey using climbing equipment	Specification of survey focus mandatory
S-VDD	Installation of dynamic bond at lower level	Specification of number of cables and system sizing mandatory
S-VDH	Installation of dynamic bond at upper level	Specification of number of cables and system sizing mandatory
S-VSV	Installation of drilled static bond	Specification of number of cables and system sizing mandatory
S-VSP	Installation of sole plate static bond	Specification of number of cables and system sizing mandatory
S-VO	Cabling installation	Cabling specification mandatory
S-VP	Installation of bracing for crown of primary boughs	Specification of number of braces mandatory
S-VK	Detailed inspection of installed bond using climbing equipment	
PB-RO	Controlled circumference reduction (retrenchment)	

Code	Technique name	Remark
	to increase stability of a senescent tree	
PB-RR	Controlled circumference reduction to revitalise a senescent tree	
PB-RB	Safety pruning of senescent trees	
PB-RLLR	Local reduction of senescent trees to improve their stability	
PB-SSK	Removal of secondary crown of senescent trees	
PB-RT	Recultivation of crown of a cut-down tree (torso)	
PB-ST	Crown reduction to a torso	
PB-OU	Management of surrounding woody plant stand to release the target senescent tree	Mandatory specification of form and extent of management of surrounding stand.
PB-OS	Modification to tree site conditions	
PB-KO	Preservation treatment of fresh or historic wounds on tree trunk	
PB-KZ	Preservation treatment of cavities consisting in roofing them or making them inaccessible	
PB-ZZ	Installation of protection to adult (senescent) trees from animal damage	
PB-PS	Tree replanting from its permanent site	
PB-CH	Installation of root protection sleeve	Necessary specification of distance from the tree, depth and length of installation
PB-MH	Mechanical protection from insect pests	
PB-CP	Tree protection from insect pests or fungal diseases by spray application	Necessary specification of spray type and application time.
PB-CI	Tree protection from insect pests or fungal diseases by micro or macroinjection application	Necessary specification of type of applied chemical.
PB-JO	Removal of semiparasitic or parasitic shrubs from crowns of massively infested trees.	
PB-LO	Removal of lianas growing up the crowns of host trees, including pulling them off the trunk and primary boughs.	
PB-LR	Reduction (undercutting) of lianas growing up the crowns of host trees.	

Annex 10 Intervention urgency – description of stages

0 cultivation measure with necessity of immediate performance – delay is risky

Interventions resolving mostly site operating safety. Typically, proposals to fell trees whose condition evidently and immediately threatens their surroundings. They may include proposals for immediate implementation of safety or stabilising pruning (see SPPK A02 002 Pruning of trees).

1 perform in first stage of works

Interventions of a high priority, implemented both to ensure site operating safety and to maintain continuity of cultivation management.

2 perform in second stage of works

Interventions that are necessary but not of essential priority. Mostly cultivation measures suitable to implement but not with a priority sign.

3 perform in third stage of works

Interventions designed for a longer time horizon. They are made only after implementation of all the previous urgency classes. Frequently cases where a cultivation intervention has been made recently.

Annex 11 Orchardist value – description of degrees

1 very valuable individual

Typical or required habitus (not affected by canopy or otherwise), grown, absolutely healthy and undamaged, fully vital individuals with a long-term outlook.

2 individual of above-average value

Have certain shortcomings compared to the previous category, which do not significantly reduce their value. Grown to at least half the dimensions achievable on the site (start of full functionality). Long-term outlook.

3 individual of average value

Habitus may deviate from the normal even significantly (as a consequence of canopy, etc.) or the presence of damage or diseases or pests does not significantly affect the vitality. Medium to long-term outlook. This category also includes young, fully vital trees with a typical or required habitus that have not yet attained approximately half the dimensions achievable on the site or the start of full functionality.

4 individual of below-average value

Old age, diseases and pests or damage have significantly reduced the vitality, only short-term existence in an acceptable condition is probable.

5 individual of very low value

Old age, diseases and pests or damage have reduced the vitality so much that there is no expectation of even short-term existence. This category also includes individuals that have to be removed immediately for safety and phytopathological reasons (dangerous diseases).

Developed based on: Pejchal, M., Šimek, P. Metodika hodnocení dřevin pro potřeby památkové péče. Mendelova univerzita v Brně: Lednice, 2015.

Annex 12 List of specially protected woody plant species, excerpt from Annex II to Decree no. 395/1992 Coll.

1. critically endangered species:

Sudeten mountain ash	*Sorbus sudetica*
Bohemian mountain ash	*Sorbus bohemica*
Dark-leaved willow	*Salix myrsinifolia*

2. severely endangered species:

Common yew	*Taxus baccata*

3. endangered species:

Cornelian cherry	*Cornus mas*
Downy oak	*Quercus pubescens*

Annex 13 Groups of specially protected animal and fungus species (SPS) who developmental stages are bound to non-forest trees

Period of presence. Animals make use of trees throughout the year, but their numbers differ in different periods. Most are present in the growing season (from April to September), when nesting birds, mammals and insects are to be spotted. Detection of the widest range of species is easy from May to July, when even adult individuals of insect SPSP are present and active. Conversely, detection is difficult in winter (from October to March), when bats are inactive and hidden in cavities and adults of most insect SPS are missing.

Birds make use of trees for nesting and foraging. Presence of nesting birds is signalled by their increased movements around the tree, acoustic manifestations of adults or younglings or increased amounts of droppings or remnants of eggs under the tree. Freshly chiselled cavities, peeled bark, etc., indicate the presence of Piciformes. Presence of birds is not bound to specific damage such as cavities. However, cavities increase the probability of finding a wider range of species. Birds use trees of every age and size category.
Only a part of the species are SPS, but the protection of other species is at a level similar to SPS, which is why all birds should be considered SPS for the purposes of the present standard.

Bats use trees with cavities for shelter, reproduction and wintering. Their presence is signalled by exits from cavities or acoustic manifestations in cavities. The chance to find them is highest in the evening of warm nights, when they are active and exit from cavities. In winter (October to March) the chance to discover their presence is low, even if they use the tree (it is possible to use a camera for looking into a cavity). Bats use cavities of various sizes from minor to large, some species use fissures under loose bark, etc. Only a minor part of the species range use trees, but all belong to SPS. Besides bats, trees are used by other mammal species: dormice and squirrels.

Insects use trees for their development: insect larvae develop in them. Attention has to be paid particularly to old broadleaved trees, mainly oaks, lindens and elms. Most SPS are bound to cavities with dry rot, but many species also inhabit other microhabitats. Presence of cavity-dwelling species is signalled by larger cylindrical droppings (hermit beetles, rose chafers) or remnants of beetle bodies (hermit beetles, rose chafers, click beetles). Both droppings and body remnants can be found in accessible cavities and at the foot of the tree, where they drop out of cavities (including those inaccessible). Presence of capricorn beetles (great, longhorn) is signalled by large exist holes and characteristic galleries). However, it is relatively difficult to confirm presence of some species. The majority of insect SPS bound to standing trees live in the warmest areas of the country (South Moravia, Elbeland, Central Bohemia); the probability of their presence elsewhere is low.

Fungi use trees mostly as a source of organic matter or a mycorrhizal partner or they parasite them. Saprotrophic fungal species decompose dead organic matter, mostly wood (lignicolous fungi); these fungal species are dependent on the presence of substrate of their nutrient woody plant, which may be a branch, root or stump in various stages of decomposition. Mycorrhizal fungi live in a symbiosis with trees or shrubs and their presence is dependent on the presence of their host plant. If the tree or shrub is felled, the mycorrhizal fungus disappears as well.

Annex 14 Rootable area survey – description of degrees

1. **Unaffected** – tree growing in a built-up environment or open country, where the growth and development of both its aboveground and underground sections is unrestricted and where soil conditions are not affected or only to a minimum extent.
2. **Good** – tree growing in areas where the development of both its aboveground and underground sections is partly (unilaterally) affected and where there may be some minor negative effects on the soil environment (such as soil compaction due to pedestrian traffic, maintenance of roads near the tree, etc.).
3. **Impaired** – trees growing in grass strips and enclaves in built-up areas, in areas with spatial restrictions on two sides for the development of both its aboveground and underground sections, such as by adjacent development or paved surfaces near the trunk base. Soil conditions are significantly impaired, the soil is visibly compacted or demonstrably contaminated.
4. **Extreme** – tree growing in areas where development of its root system, or even its aboveground sections, is restricted on more than two sides and where activities directly or indirectly inhibiting its growth recur (effects of chemicals, road salt, soil compaction, etc.). The soil conditions are extremely impaired, impermeable surfaces approach the immediate vicinity of the trunk base, soil compaction or contamination attain demonstrably high levels.

Annex 15 Annotations of instrumental methods of tree assessment

Method	Method description	List of instruments	Area of assessment
Gasometric measurement of photosynthesis, respiration and transpiration	The method is based on analysis of absorption of infrared light with differing wavelength for gases composed of atoms of multiple different elements (CO_2, H_2O, NH_3, CO, N_2O, NO, SO_2, HCN). Each gas absorbs radiation at a specific wavelength. Molecules composed of two identical atoms (e.g., O_2, N_2) do not absorb the radiation, thus are not an obstacle when determining concentration of heteroatomic molecules.	LI-6400 (LI-COR)	Photosynthesis, vitality assessment
Transpiration flow measurement	There are several principles of transpiration flow measurement. Measured values make it possible to determine the radial profiles of transpiration flow, water consumption, flow dynamics, risks of drought or waterlogging, and proportion of water pumping from surface and deep soil layers. The methods are generally based on measurement of heat diffusion or transfer: the heat pulse method (HPV), the thermal balance method (SHB, THB), the heat diffusion method (HD), the heat field deformation method (HFD), and the heat ration method (HR). The disadvantage of these methods is their time demand (measurement typically takes 24 hours) and limitation to periods with measurable transpiration flow. The methods are in the authentication stage and mostly used for scientific purposes.		Vitality, transpiration
Root absorption area measurement	It is based on measurement of impedance in the tree and the soil. It is measured between the trunk and a sliding probe, which is progressively located at various distance from the trunk. The practical application is limited by a relatively high destructiveness (installation – nailing probes in the trunk) and necessity of free soil surface for pushing in the sliding electrode.		Vitality, physiological damage to the root system
Dendrochronological/dendroecological analysis	Dendrochronological analysis is another option for evaluation of collected drillings. Its basic purpose is accurate determination of age of annual growth rings, thus the age of the tree. A detailed quantitative and qualitative analysis provides additional information about activity in each year, development of reaction wood, effects of the environment and the tree's reaction to them. The advantage is the ability to interpret and date effects of various factors on tree vitality. The method is authenticated, but the measurement destructiveness means it is not recommended in the Czech Republic for testing living trees with internal defects.	TimeTable Series, LINTAB, WinDENDRO, Core-Microtome	Vitality trend assessment

Acoustic measurements	The method is based on measurement of speed of passage of acoustic signal through a material, assuming that the signal trajectory is significantly increased in a hollow cross-section, thus reducing the velocity. Changes in material properties caused by decay will also lead to a signal deceleration. Its velocity is in direct proportion to the material rigidity and inversely related to its density. The methods measure velocity along a straight line between two points and their information value is limited. This shortcoming is eliminated by acoustic tomography.	Arborsonic Decay Detector, Pundit, Fakopp 2DTimer	Detection of branch and trunk cavities and damage
Acoustic tomography	Based on a series of acoustic velocity measurements in the tree wood, this method draws a 2D image of the measured cross-section, enabling easier interpretation of measurement readings. Measured values can also be compiled into a pseudo-3D picture. This is not a 3D measurement. The method is suitable for detecting cavities in the trunk and larger boughs. Its accuracy depends on the number of sensors and the trunk circumference and shape. The denser the measurement grid, the more accurate the detection. Rugged cross-sections are difficult to measure. The method has difficulty interpreting cavities of a significantly linear nature (closed pressure branch), layers of dry wood in the tree (it has high density and rigidity, increasing the velocity in those areas), and free water contained in disrupted wood may be a problem as it may mask the defect. Modification of the method using special sensors enables measurement of the root system distribution (architecture). In this case, root integrity is not analysed; only the spatial distribution of roots is detected. The method is widely used and authenticated.	Arbotom, Fakopp and Picus	Detection of branch and trunk cavities and damage
Electric impedance tomography	The method principle is measurement of resistance and voltage in various cross-section areas. Distribution of conductivity or resistance in the cross-section is calculated based on the measurement. It is bound to humidity and content of free ions. The interpretation requires knowledge of conductivity distribution along the cross-section of a healthy individual, because tree species differ and it is not possible to draw a single generally valid rule for interpretation. The method is largely conceived auxiliary to acoustic tomography or another method, and its separate use is only possible on selected taxa.	Picus Treetronic	Detection of branch and trunk cavities and damage

Penetrometric measurements	The method principle is measurement of input power required for a thin drill bit to penetrate the wood. The higher the wood density, the greater input power is necessary for maintaining a constant penetration speed. The method can map changes in density in the measurement area. Trees with distinct annual growth rings enable growth ring analysis of the measurement data. Detection of any rot is easy and fast. The instrument can be of compact dimensions. The disadvantage is the limited information value (measurement proceeds along a line and cannot be generalised for the whole cross-section). A thin drill bit will easily slip on knots and summer wood layers if it enters them at an inappropriate angle, so the measurement is then not linear but proceeds along a curve that is difficult to specify. The method is authenticated, but the measurement destructiveness means it is not recommended in the Czech Republic for testing living trees.	Resistograph, Sibbert, MicroProbe	Detection of cavities and damage
Evaluation of drillings	A certain modification to the previous method is interpretation of the condition of drillings collected using an incremental gimlet. It is easy to detect cavities and rot as well as determine material constants of the wood (e.g., using the Fractometer or a versatile testing machine). The drill bit trajectory is not deformed, but the resulting hole is much larger (1 cm). The measurement destructiveness means it is not recommended in the Czech Republic for testing living trees.	Fractometer	Detection of cavities and damage
Tensile testing	Comprises three steps: strain analysis, measurement and data interpretation. The strain analysis determines the potential strain acting on the tree at a chosen wind speed. The measurement consists in artificial straining of the tree with a tensile force while simultaneously measuring the force exerted, the trunk deformation and the trunk inclination at the base. These data are extrapolated to obtain the potential strain and the tree resistance to fracture and windthrow is determined based on a comparison of the potential deformation against the limit deformation and the potential inclination against the general windthrow curve. The advantage is direct determination of the probability of failure or resistance to failure due to windthrow or fracture. The method does not enable detail location of cavities and detection of their extent, or detection of root distribution.	Picus TreeQinetic	Assessment of resistance to fracture and windthrow

Method	Method description	List of instruments	Area of assessment
Radar – GPR	Based on penetration of a radio signal, this method detects both defects in the trunk and distribution of the root system. Depending on the required measurement depth, the instruments are able to detect roots starting from approx. 1 cm in diameter. The disadvantage of the method for root detection is its inability to identify the difference between roots and other objects and to measure qualitative condition of the roots. Therefore, measurement errors may occur easily in skeleton-rich soils and urban soils. In spite of that, the method can be regarded as suitable for root system extent measurement.		Root system geometry
Imaging tree structure with laser beams (LIDAR)	A method for remote distance measurement based on calculation of velocity of a laser beam pulse reflected from the studied object. The result is a cloud of points that can be interpolated, after processing, into the form of a digital surface model or a 3D model of buildings and other objects. It can be used for determining the biomass volume and trunk and branch geometry. In aerial application, it can be used for detecting heights in vast stands and other dendrometric parameters (crown volume).		Tree geometry, biometric data

Annex 16 Examples of proposed outcomes from dendrological survey

Basic area number:		Name:	
	Maintenance intensity class:		
	Overall stability:		
	Fall target value:		
	Ground slope:		
Basic area description:			

Basic area name:																								
tree number	tag number	taxon	trunk diameter				trunk circumference				tree height	crown bottom height	crown width	physiological age	vitality	health condition	stability	operating safety	outlook	remark	cultivation measure technique	urgency	repetition	remark on cultivation measure
			1	2	3	4	1	2	3	4														

The depiction of dendrological survey results in the graphic section follows the survey purpose and the client's requirements.

Annex 17 Illustrations

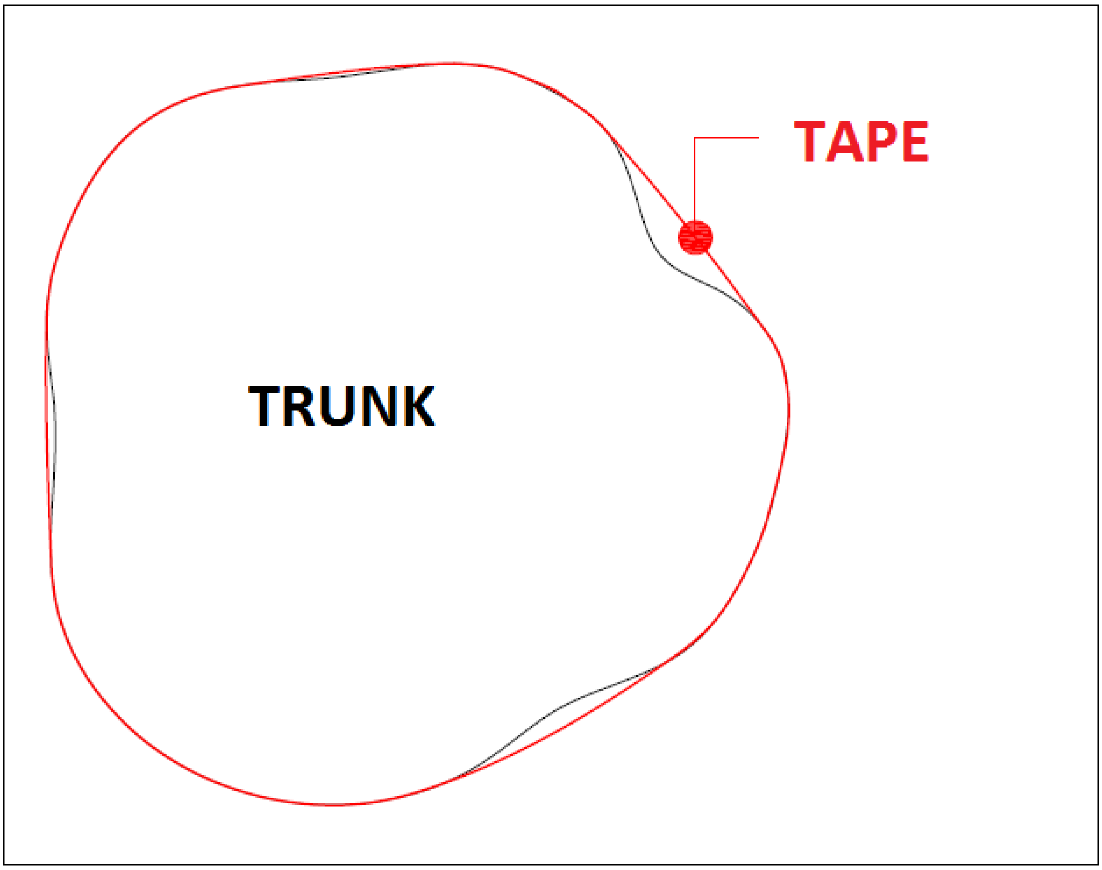

Fig. 1 Trunk diameter measurement using a circumference tape (4.2.4)

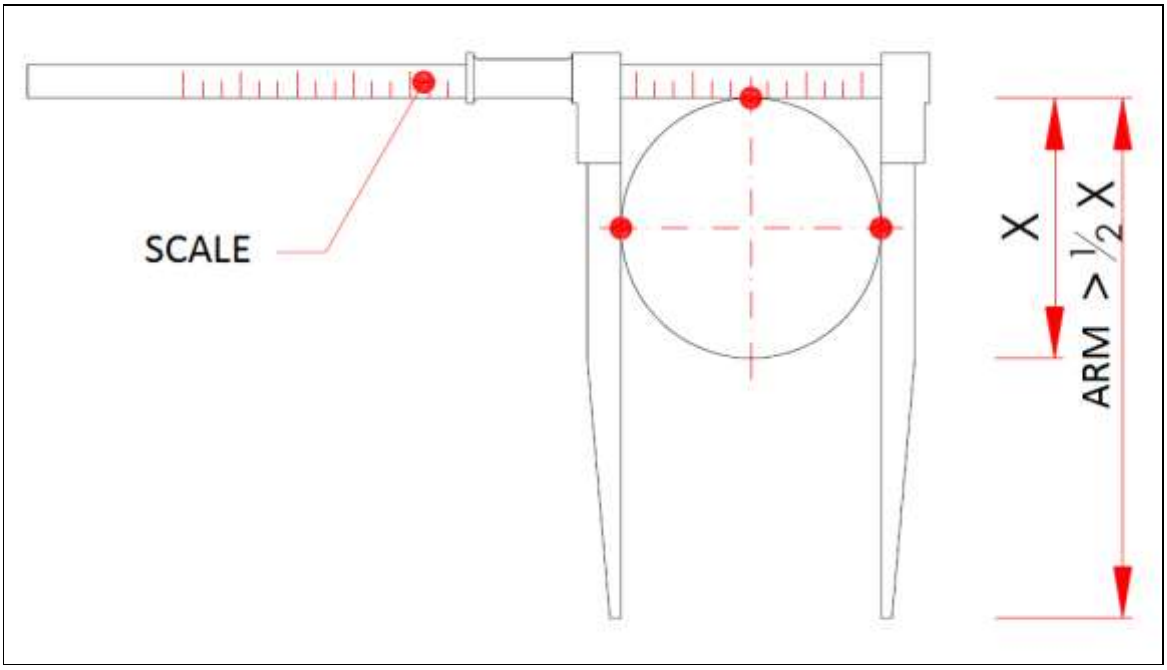

Fig. 2 Trunk diameter measurement using a diameter gauge (4.2.5) in two mutually perpendicular directions

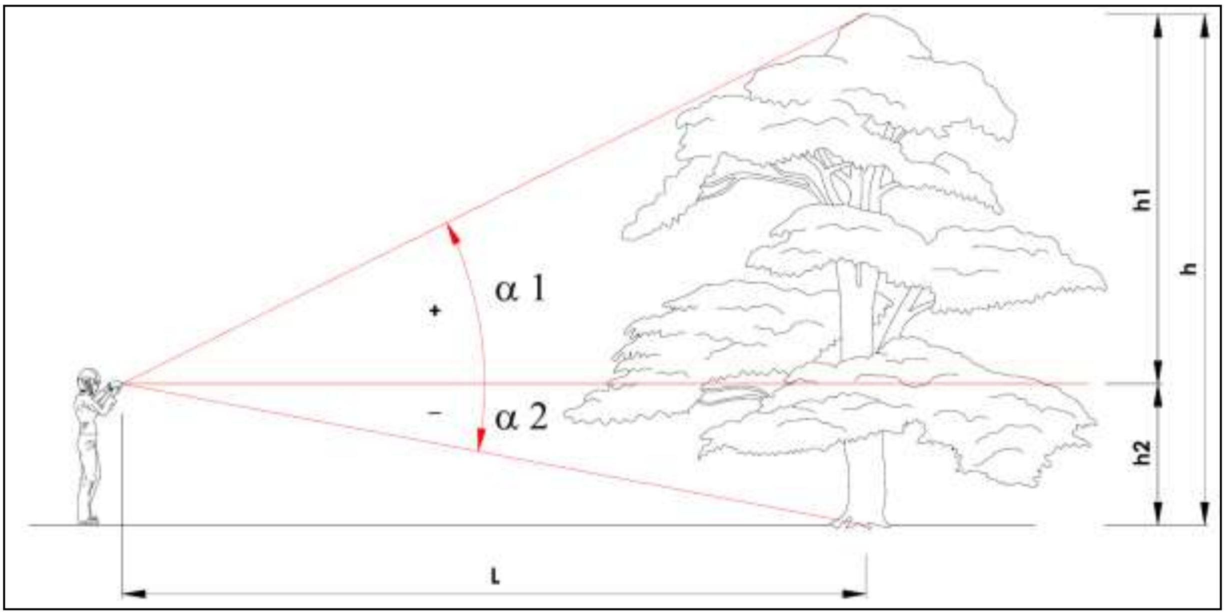

Fig. 3 Tree height measurement on flat surface using a height gauge, employing the triangle similarity principle. Measured dimensions are added up (4.3.3).

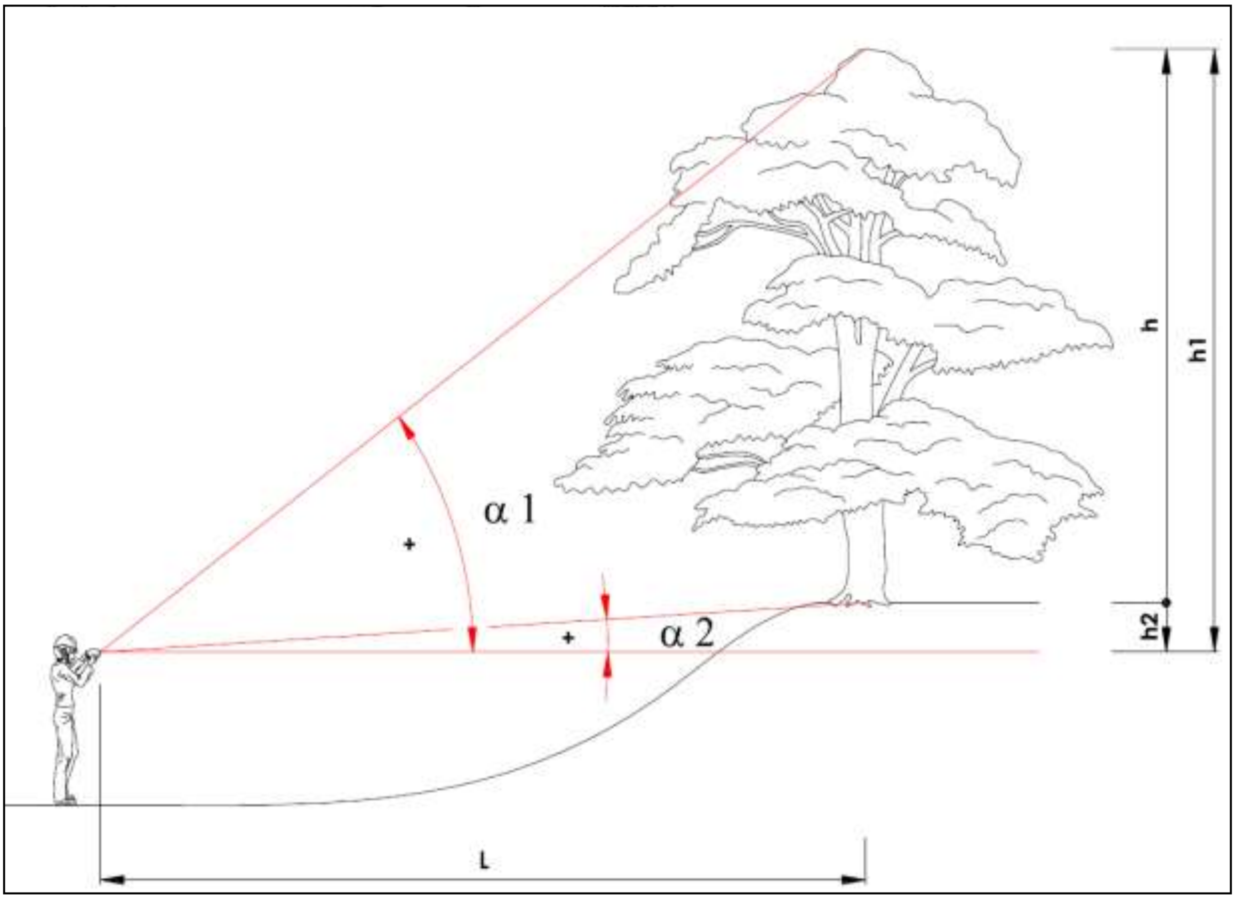

Fig. 4 Tree height measurement on a slope using a height gauge, employing the triangle similarity principle. Measured dimensions are subtracted (4.3.3).

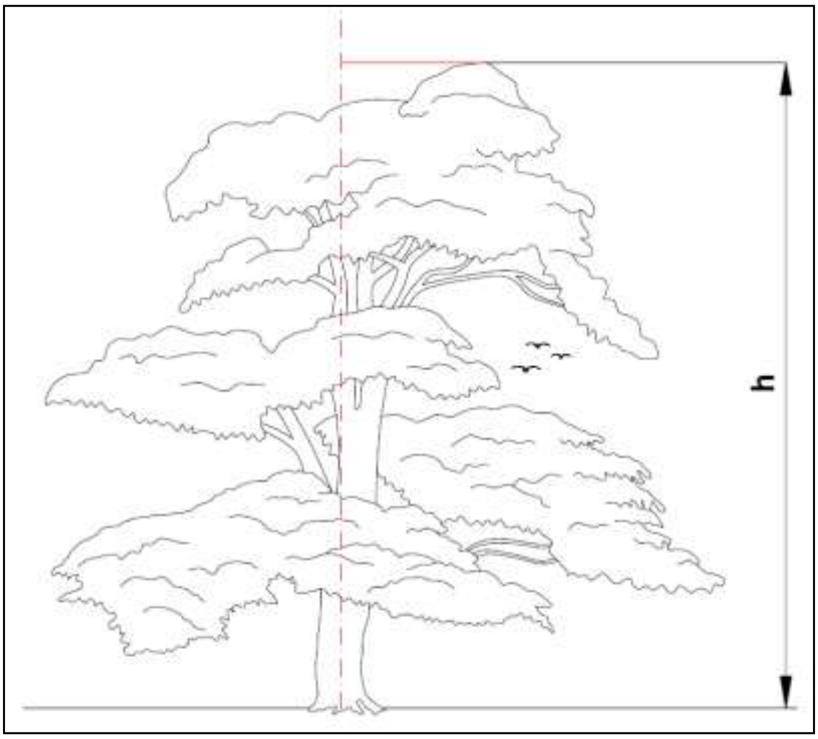

Fig. 5 Tree height measurement in the case of an unevenly distributed crown. Measure the perpendicular distance between the trunk foot level and the highest point in the crown (4.3).

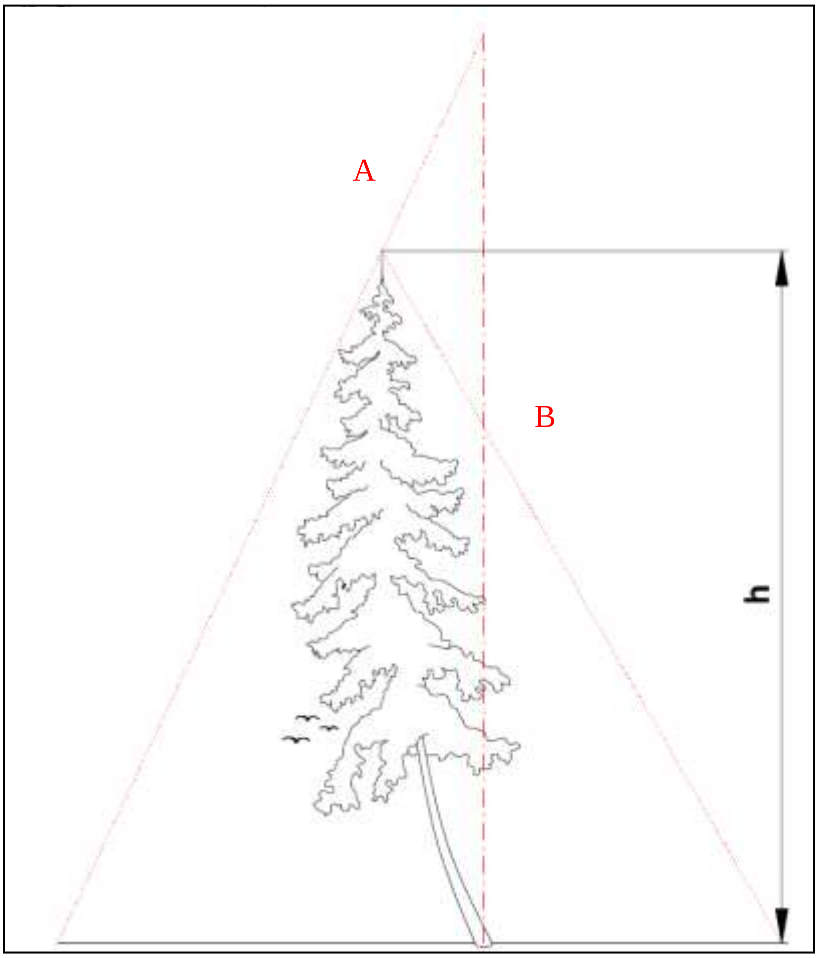

Fig. 6 Height measurement of an inclined tree. Measurement along the deflection axis distorts the tree height (A, B). It is advisable to measure the tree height perpendicular to the deflection direction. (4.3.3).

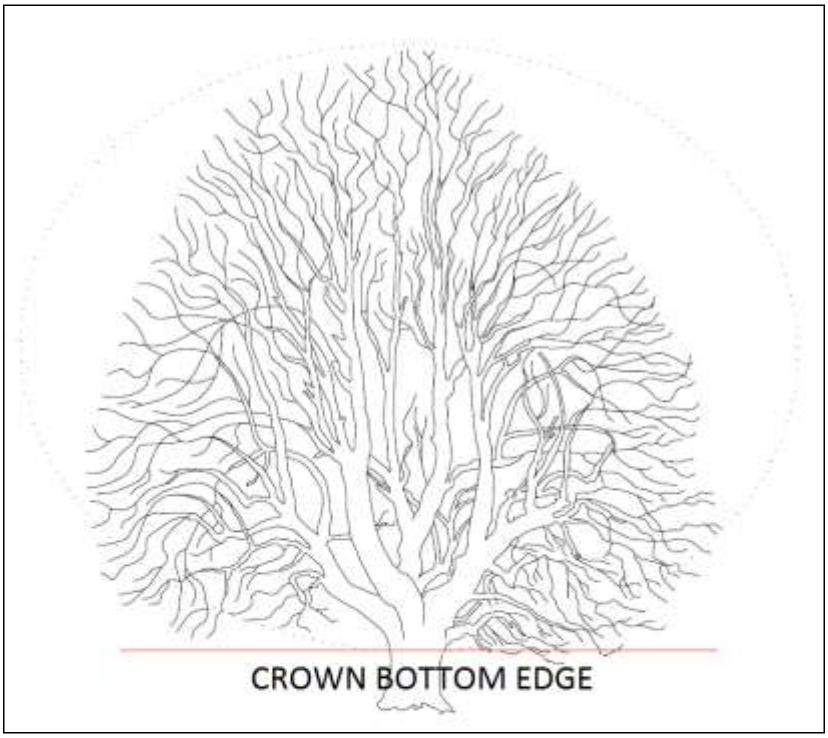

Fig. 7 Crown bottom edge measurement (4.4.2)

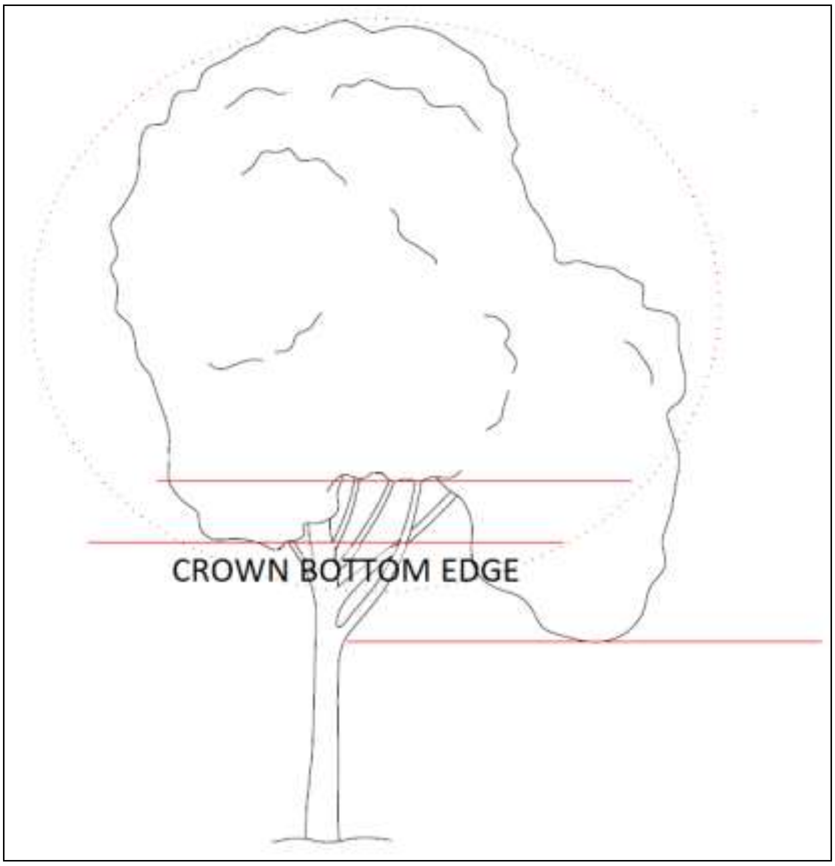

Fig. 8 Determining crown bottom height in the case of an irregular crown (4.4.2)

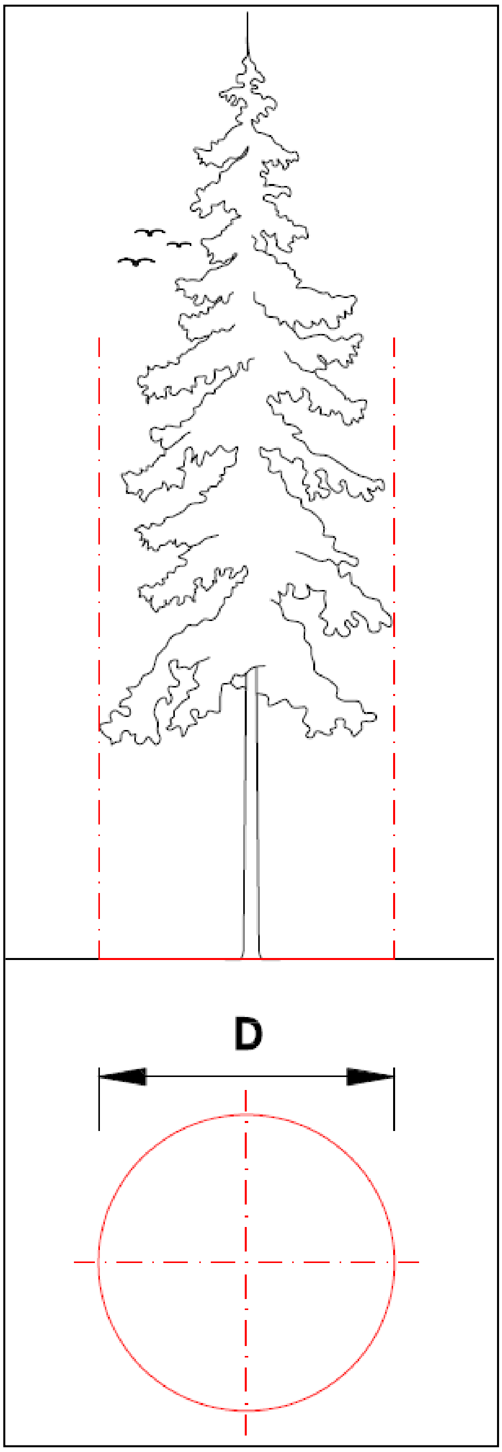

Fig. 9 Crown width measurement (4.4.1)

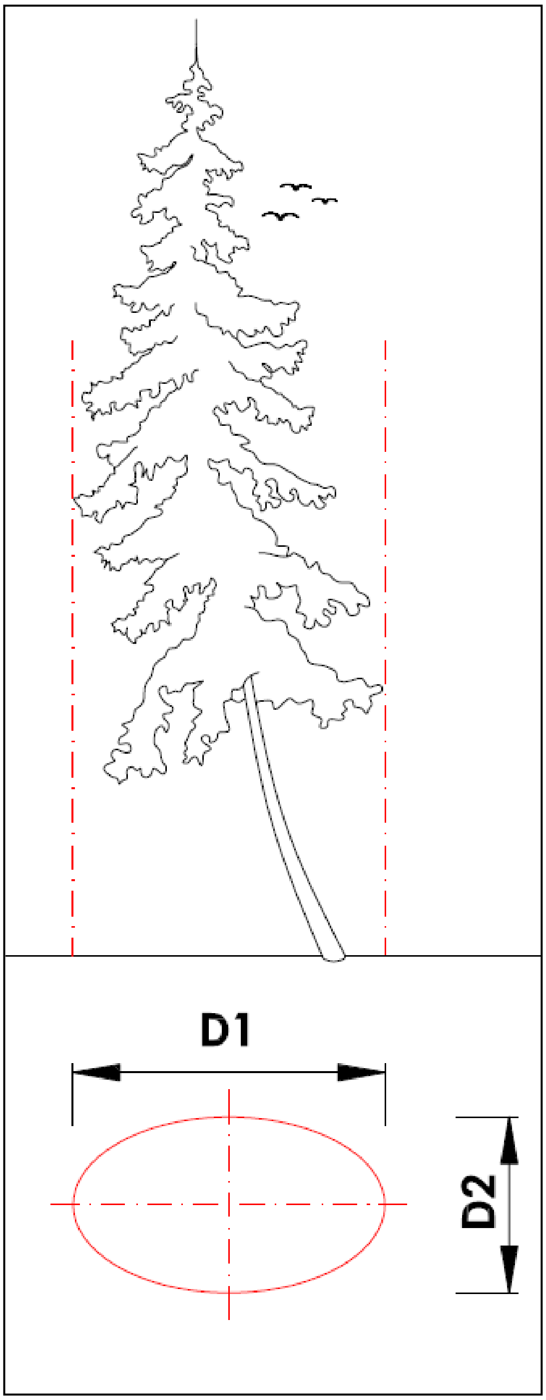

Fig. 10 Crown width measurement in the case of an asymmetric crown

Annex 18 List of Nature and Landscape Management Standards (Arborist Standards) developed

01 Inspection, assessment, planning

01 001 Tree assessment
01 002 Protection of woody plants during development activities

02 Work procedures

02 001 Planting of trees
02 002 Pruning of trees
02 003 Planting and pruning of shrubs and climbing plants
02 004 Crown security systems (cabling / bracing)
02 005 Tree felling
02 006 Protection of trees against lightning strike
02 007 Modification of woody plant site conditions
02 008 Woody plant stand establishment and management
02 009 Special tree treatment
02 010 Management of woody plants along public transport infrastructures
02 011 Care of woody plants along utility lines

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