- Planning
- TPO
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# THREATS

## Tree Hazard:
## Risk Evaluation and Treatment System

A method for identifying, recording & managing
Hazards from trees

## GUIDANCE NOTE FOR USERS

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*To be read in conjunction with THREATS pro forma, included at the end of this document*

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# 1 Preamble

## 1.1 Development history

**1.1.1** Work started on THREATS in 1998, when the author was engaged on a consultancy basis as a part-time highway tree surveyor/manager. A need was identified early in this commission for a method of quantifying the risk posed by trees identified as having structural defects. It was considered that the method should have several characteristics:

- It had to mirror and be in sympathy with typical tree assessment processes
- It had to record and analyse tree defects in such a way that it could be used for large scale tree inspections without impeding data collection
- It had to offer consistency of approach, definition and outcome
- It had to stratify tree risk such that intervention could be programmed as to urgency, roughly according to: immediate, scheduled and deferred
- It had to be transparent and comprehensible to non-specialists

**1.1.2** The framework was laid down based on a two-page data collection pro forma which:

- Recorded the fact of inspection
- Listed any observed defects
- Assessed the three components of tree risk (defect, target and impact – after Matheny & Clark (1994)[1])
- Contained an algorithm that provided for a relatively subtle interaction between these three components
- Arrived at a conclusion which was in tune with what can be termed 'unassisted arboricultural decision making' (aka gut instinct)
- Established a defensible hierarchy of response that included delayed intervention and phased reinspection

**1.1.3** Since its inception, THREATS has enjoyed several iterative amendments, chiefly based on feedback both from peer review (conducted in 2002 under the auspices of the Arboricultural Association), and from users of the method (who have always been encouraged to offer suggestions for improvement).

**1.1.4** The framework and algorithm had not been altered in over ten years, when the author was commissioned to prepare an amended version of the method specifically for use by Network Rail Infrastructure Ltd, known as THREATS – NR. This exercise led to an extensive and intensive review of the method whereupon it was found for the railway application that one combination of factors produced an unsatisfactory result. This led to a boundary change which has been carried across into the standard method: the outcome being on a borderline the change was equally satisfactory.

**1.1.5** In 2007 an in-depth comparative field trial was undertaken to examine 15 tree risk assessment systems, one of which was THREATS. Despite the trial group of eight arborists not having been trained in the use of the method, THREATS fared well in the tests, being preferred to and producing more consistent results than several other well-known systems, including that known as QTRA, in the use of which three of the eight users had been trained.

**1.1.6** THREATS and the new THREATS – NR are effective, simple and quick to apply. THREATS has been rigorously examined in numerous scenarios for over ten years and has been found to be fit for purpose.

## 1.2 Introduction

**1.2.1** The THREATS method has been designed to offer all those who have responsibility for evaluating and managing trees a means of assessing them for risk in a consistent fashion. THREATS also assists the user in determining the appropriate response to the level of identified risk.

**1.2.2** THREATS can be applied in a number of ways, making it a versatile tool for tree managers:

a) In its full form, most suited for smaller numbers of trees, THREATS is a detailed record of inspection; it can also be used in a compressed form to evaluate risk as part of larger scale tree surveys (see part 3)
b) It provides a framework for defining a defensible, phased response to identified hazards, where the immediate rectification of all safety-critical defects identified during a tree survey is not always possible
c) It can be used to reassure an anxious party that a tree has been found on inspection to be reasonably undangerous, or to demonstrate to a complacent party that a tree is unsafe, and that intervention is required
d) It can be used as part of a desk study to prioritise tree inspections, by means of Target Zoning treed areas as type-diverse as large gardens, woodlands, country parks and even towns (see part 4)
e) It can be used to quantify tree risk by ward, district, railway region etc, and by this means the effectiveness of tree inspection and management regimes can be monitored (the total THREATS score for a given area should generally decline with time under effective management)
f) It can be used retrospective to a tree failure to assess foreseeability

**1.2.3** THREATS takes established methodology for considering potential hazards from trees and puts this into a user-friendly framework by cross-referencing the factors that, in combination, define the level of risk for any given tree defect. In order to achieve this, THREATS relies on craftsman-level arboricultural knowledge, in the form of familiarity with tree defects, together with an judgement-based assessment of the likelihood of any given defect actually failing for the tree being assessed. In this context, the species of tree and, where pathogens are present, host/agent combinations, are frequently important.

**1.2.4** THREATS deliberately relates back to the authoritative work by Lonsdale (1999)[2]. Any further clarification required as to the nature of tree defects and the likelihood of them failing should lead the enquirer directly to this book as a starting point.

**1.2.5** It is stressed that THREATS is not designed to provide 'The Answer' to the question of tree safety, and is not, therefore, a substitute for properly informed arboricultural judgement. Instead, it aims to offer a framework for systematically and consistently quantifying this judgement, allowing tree managers to arrive at their decisions through a logical, defensible and transparent process.

**1.2.6** When the method was being constructed, the interaction between the Hazard Rating Calculation (THREATS section 7) and the Appropriate Response (section 8) was mapped out into 120 possible outcomes (5 x 6 x 4 outcomes). These were grouped into seven 'Threat Categories' that reflected, in the author's opinion, a satisfactory range of responses to any given outcome. In order for any derived set of possibilities to result in the 'correct' response (i.e. a response that matched up with unassisted arboricultural decision making), a weighting score was attached to each option within the three factors. Ensuring that this algorithm worked was beyond the author's limited mathematical capabilities, and was delegated to his wife (who is quite literally a former rocket scientist). Said rocket scientist also reviewed and modeled outcomes for the THREATS – NR variant.

**1.3 Legal framework in the UK**

This is well-trodden ground, so only the briefest of summaries is offered here[3]:

**1.3.1** There is an obligation of reasonable safety owed by site owners both to visitors and to those adjacent to a site under the Occupiers' Liability Act 1957 (OLA 1957, i.e. the principle of Duty of Care) and 1984, such that an occupier may be held liable for losses (physical harm to life and/or property) arising from an accident to a third party, where the cause of the accident was both reasonably foreseeable and reasonably preventable, bearing in mind all the circumstances pertaining to the situation.

**1.3.2** These circumstances include specific consideration for children; under s2(3)(a) of the OLA 1957, 'an occupier must be prepared for children to be less careful than adults'. The case of Tomlinson v Congleton Borough Council ([2003] 1 A.C. 46; [2004] UKHL 47), the 'shallow pond case', expanded on this requirement by stressing the need to consider the inequivalence of danger relative also to people of reduced mobility.

**1.3.3** A considerable body of case law has established that, in order to be in a position to foresee and indeed to prevent harm arising from a tree failure, it is necessary to subject the tree or trees in question to 'regular inspection', with this inspection undertaken by someone competent both to identify any defects present and to interpret their significance for public safety.

**1.3.4** Regular inspection is a notoriously vague concept, with intervals applied ranging from every six months to five years. The author considers that the former is unworkable and the latter potentially ineffective. The definition that this author proposes is that:

> '*A tree should be inspected at a regularity that is appropriate to its condition, within its context, with a maximum interval between systematic expert inspections of five years within Risk Zones 1-4*'[4] (Please refer to Table 2 at page 12)

For this definition to work in practice, and indeed for the occupier to discharge his Duty of Care at all, a baseline knowledge of the tree stock for any given site is essential.

## 2 Notes on applying THREATS

### 2.1 Completing PART I, the tree inspection record

**2.1.1** Survey details
This section serves as the record of complaint where a problem tree is reported to the tree manager, and/or a record of inspection, is a mix of desk-based and fieldwork.
The 'surveyor details' box should be initialed on completion of the survey, as prompted, as well as having the surveyor's name and position recorded in full.
The 'origin…' box fixes the time of the incoming complaint, though it can also identify a more routine survey, such as "storm damage inspection".
The 'survey date & time' box effectively pegs the response time to the log of complaint; this should prompt the tree manager to consider carefully how urgent the complaint sounds…
The 'weather conditions' box notes the weather both at the time of the log of complaint, e.g. "strengthening wind", as well as when the tree is inspected.
'Other notes' should cover any other information provided by the complainant, such as "reports ground moving at base of tree"…

**2.1.2** Description of tree
'Owner…' & 'tree no…' are self-explanatory
'Location' could be "outside No.21 Acacia Avenue", a GPS waypoint reference (see section 3), a highway chainage and so on.
'Species' & 'age class' are self-explanatory.
'Size category' refers to the stem size bandings listed in section 6 of THREATS under 'Agents' (see 2.2.3).

**2.1.3** Description of failure indicators
The prompt in brackets tells the user how to deal with a tree that has more than one indicator: all indicators should be recorded, but the one that should be scored in Part II of THREATS is that which gives greatest concern. The list of failure indicators is taken from Lonsdale (ibid.). Whilst it is hoped that the THREATS list is exhaustive, as with all the best pro forma there is an 'other' box provided.

It is important that every visible indicator is recorded. However, the indictor that requires the most urgent attention is the one that should be scored (first) in Part II (though of course any other defects that might be present should be considered for remediation at the same time).

The nature of the hazard from each indicator is explained very briefly, to assist the user in his/her assessment of their significance. Identified indicators should be flagged in the tick-boxes provided. Field use of THREATS suggests that it is helpful to record the precise nature of the indicator(s) identified and also, at this stage, to suggest what target might be vulnerable should the indicator(s) fail, hence the notation space provided.

This section completes the written tree inspection record and could, if required, stand alone.

### 2.2 PART II: The Risk Evaluation Sum

The Note is of critical importance: the given examples are just that and **must not** be treated as a substitute for good judgement based upon sound arboricultural knowledge.

**2.2.1** Failure Score

The prompt directs the user to consider known data on relative vulnerability of tree species to failure from observed defects, as well as the possibility of seasonal pre-disposing factors.

Examples of the former would include the differing persistence of dead wood on pedunculate oak (*Quercus robur* L.) and common ash (*Fraxinus excelsior* L.), and examples of the latter would include humidity during the high photosynthetic period (as an agent involved in summer branch drop), and autumnal gales (storm damage, windthrow, etc).

Thus a horse chestnut (*Aesculus hippocastanum* L.) with a heavily end-loaded limb surveyed in December might require a different entry in the 'Likelihood of failure' range than would the same tree if inspected in May.

Also important at this stage is a consideration of failure criteria, such as *t:r* ratio[5]. Where the tree's condition relative to failure criteria has yet to be established, the assessor should err on the side of caution (though overreaction to uncertainty should be avoided).

When considering 'Likelihood of failure', it is important to bear in mind two (almost) conflicting issues:

- Defects that might appear at risk of impending collapse often remain sound for years
- As well as the protection of life and property, another purpose of the survey is frequently to protect owner liability: the user should not take unnecessary chances – an identified defect that threatens a target is a 'foreseeable danger'

The numerical weighting of the score for each failure category gives an indication as to the approach required. The user should reserve 'Imminent/Immediate' for only the most hair-raising of defects, as suggested in the examples given.

The failure category 'Probable/Soon' might seem to cover many tree defects, though actually it should be reserved for clearly identified problems where failure in the near term is a reliable prognosis. This is where the oak/ash deadwood example is useful: on pedunculate oak it is not usually 'probable' that dead wood will detach 'soon', this process generally takes years and frequently occurs by piecemeal crumbling from the branch tip, with bark and sapwood disintegration to leave a robust desiccated heartwood spar. Ash trees, of course, shed their dead wood much more readily, and thus it *is* 'probable' that dead wood recorded on ash will detach 'soon'.

The failure category 'Likely, foreseeable' is the one that field use suggests most often applies to tree defects, and it is designed to reflect a guesstimated failure timeline in the two- to three-year range, and possibly a little more.

'Potentially with time' covers emergent defects that are likely to become hazards only slowly. A good example of this is given as 'robust dead wood', where we are thinking of pedunculate oak again.

'None apparent' is a category that becomes increasingly used the more trees one surveys with THREATS…

The important issues to consider are:

- How far advanced towards failure is the defective part? (Returning to our dead oak branch, it may indeed take many years to shed, but this tree inspection may be taking place years towards the end of that period)
- What is the known failure pattern of trees of survey species, and when and how do they or their constituent parts actually fail, and where does the identified defect fit into these questions?
- How does the defect relate to established failure criteria? If this is not known and cannot be established by visual inspection alone, then a suitable 'Control Measure' selection (see 2.3.1) might be 'Further investigation'

Again, sound arboricultural judgement is essential in making the appropriate selection, and in avoiding either complacency or over-reaction. However, where there is genuine uncertainty, the selection should be made one category higher (though not from score 8 to score 50).

**2.2.2** Target Score

There are three prompts here:

- The first is a reminder that, for example, the now well-known dead oak branch is unlikely to hit a target far outside its vertical drop zone (though a realistic possibility of ricochet off other branches should not be ignored)
- The second prompt is designed to highlight cases where people are at elevated risk: those 'trapped' in cars or unsighted whilst driving, the relative naivety of children to danger, whereby a higher Duty of Care pertains to them[6], and those whose physical or mental functions are impaired, with a consequent decline in their ability to be aware of or to react to/evade imminent danger. THREATS addresses this by upgrading any given target value by one level if, for example, unsupervised children are likely to be the human component of the target. A little common sense is necessary here: children ubiquitously traveling in cars, for example, would not warrant a rise in the target value of a road
- The third prompt directs users to the railway-specific variant THREATS – NR where the target is an active railway line

Targets are divided into two groups: Static and Target Occupancy. This is designed to help the user to identify the appropriate Target Score and has been field tested quite exhaustively.

- The 'Static target examples' presuppose a cross-reference between the monetary value of the structure and the presence of people. This would not always be the case, so these examples should be used with some caution: a park bench is a low-cost item, but it may be that the one under consideration is frequently occupied by old ladies feeding squirrels
- The 'Target Occupancy examples' are included to guide the user through the park bench dilemma: the bench is properly scored as a low-cost item, rating a '7', but the old ladies would probably rate '20' (or perhaps '25' if very persistent), being 'frequent use' and 'constant traffic- pedestrian' respectively. With this example of course, the Control Measure, if required, would probably be the relocation of the bench

**2.2.3** Impact Score

The prompt is designed to help the user focus on the actuality of the impact potential of any given defect, once failed. For example, an unstable tree adjacent to a busy highway is obviously not hazardous if it leans heavily over the adjoining field. The same tree would be assessed differently if it inclined the other way.

The list of ‘Agents’ has been re-worked several times but ultimately, in the author’s view, remains somewhat unsatisfactory: tree size class, limb size and weight and likely momentum are deceptively complex issues. As such, this list represents the best iteration to date and the author would welcome any suggestions for improvement.

For this reason, the examples listed under ‘Degree of harm’ should be used as a good guide as to the appropriate Score. In simple terms, these can be thought of as killed, disabled, injured, hurt where people are concerned. However, care is needed to avoid over-reacting to the possibility of fluke injuries. In this connection, the user should remember that Duty of Care is discharged by mitigating ‘reasonably foreseeable’ dangers.

The agent to be scored will be either a whole tree or a part of the crown (single branches included), so the surveyor should consider either the stem size millimeter range (estimated at 1.5m above ground level), or the approximate weight of the vulnerable section, or revert to the examples.

It is essential that the agent of damage is considered with particular care: whole tree failure might be the assessed risk, but the impact score should relate only to how hard the target might be struck. For example a 25m tree toppling onto a target 20m away is likely to strike it only with relatively minor branches: the impact score should probably be 4 rather than 10.

The impact score is necessarily weighted to give low importance to a ‘recoverable injury’: the point being that a balance should be struck between the retention of desirable trees with public safety. Whilst the thought of a collapsing tree inuring or killing someone should give the surveyor pause, the possibility of a minor injury ought not to lead to mistimed intervention. Apart from anything else, in large, district-wide surveys, not all hazard trees identified can be remediated simultaneously.

**2.2.4** Risk Evaluation Sum

This is the heart of the THREATS method: by mirroring the established decision making process employed by arboriculturists, the method takes the three scores from sections 4-6 to transform the surveyor’s arboricultural judgement concerning the relative safety of a tree into a number, capable of further manipulation.

### 2.3 Implementing Control Measures: PART III of THREATS

**2.3.1** Appropriate Response

Very simply, the number derived above is compared with the ‘Score range’ column to arrive at a Threat Category: this is the ultimate goal of THREATS, and provides the user with a quantified assessment of the risk.

The ‘Threat Categories’ are both numbered and described, so one might refer equally to a Category 3 tree, or to the same tree posing a ‘Slight’ threat. The word description is designed to give the user a convenient means of defining the risk to a non-specialist. Users report that this is a very helpful feature.

The ‘Action Required’ is deliberately prescriptive: too often unsafe trees are not afforded the intervention priority necessary to discharge Duty of Care. The balance between intervention and deferred action through reinspection shifts from the lower end of the scale where it restrains over-reaction, to the higher end where it requires a decisive response.

Occasionally, typically when first using THREATS, the user discovers on cross-referencing the Hazard Rating with the Threat Category, that an 'Action Required' seems at odds with his/her expectation. Repeated field-testing has suggested that this is due to an incorrect category assignment in Part II and not a flaw in the algorithm itself. Accordingly, if the derived outcome fails to match professional judgement, it is necessary to recheck the assigned categories to see whether one has been incorrectly attributed. In any event, if disagreement persists the author always recommends following professional judgement (though currently there are no instances of serious disagreement reported from practiced users).

At the lower end of the scale where, of course, by far the majority of trees are found, THREATS guides the user towards a more routine approach to Control Measures. However, THREATS stresses the need to reinspect a defective tree following circumstances that might cause its condition to deteriorate, including the passage of time. The obvious example of this is high wind speeds, and THREATS suggests what response should be appropriate following winds of different velocities, listed according to the Beaufort Scale (see Table 1).

**Table 1: Beaufort Scale, Specification on Land[7]**

| Beaufort Force | Description | Specification on land | Speed | | |
|---|---|---|---|---|---|
| | | | Knots | km/h | mph |
| 0 | Calm | Smoke rises vertically | Less than 1 | Less than 1 | Less than 1 |
| 1 | Very Light | Direction of wind shown by smoke drift but not by wind vanes | 1 - 3 | 1 - 5 | 1 - 3 |
| 2 | Light breeze | Wind felt on face, leaves rustle, ordinary wind vane moved by wind | 4 - 6 | 6 - 11 | 4 - 7 |
| 3 | Gentle breeze | Leaves and small twigs in constant motion, wind extends white flag | 7 - 10 | 12 - 19 | 8 - 12 |
| 4 | Moderate breeze | Wind raises dust and loose paper, small branches move | 11 - 16 | 20 -29 | 13 - 18 |
| 5 | Fresh breeze | Small trees in leaf start to sway, crested wavelets on inland waters | 17 - 21 | 30 39 | 19 - 24 |
| 6 | Strong breeze | Large branches in motion, whistling in telegraph wires, umbrellas used with difficulty | 22 - 27 | 40 - 50 | 25 - 31 |
| 7 | Near gale | Whole trees in motion, inconvenient to walk against wind | 28 - 33 | 51 - 61 | 32 - 38 |
| 8 | Gale | Twigs break from trees, difficult to walk | 34 - 40 | 62 - 74 | 39 - 46 |
| 9 | Strong gale | Slight structural damage occurs, chimney pots and slates removed, branches break from trees | 41 - 47 | 75 - 87 | 47 - 54 |
| 10 | Storm | Trees uprooted, considerable structural damage occurs | 48 - 55 | 88 - 101 | 55 - 63 |
| 11 | Violent storm | Widespread damage | 56 - 63 | 102 - 117 | 64 - 73 |
| 12 | Hurricane | Widespread damage | >64 | >119 | >74 |

The Beaufort Scale was originally developed for the Royal Navy in 1805 (by one captain Francis Beaufort) and was adapted for use by 'land-based observers' in 1906. As can be seen from the descriptions in Table 1, the land version frequently relies on the behaviour of trees under wind action (instead of on waves), such that, at higher wind speeds, the observations define failure thresholds.

The UK Meteorological Office uses the land version of the Beaufort Scale in issuing severe weather warnings to predict the likely level of damage from forecasted high winds. Thus the Beaufort Scale can be used to identify a measure of foreseeability of tree failure.

Concerning reinspection and possible future work to a tree, it is important to realise that the first time a tree is assessed using THREATS is not necessarily the last: in other words, a defect can and potentially should be re-evaluated at each successive regular inspection. By this means, the deferring of intervention, as opposed to reinspection, can be rolled on such that a defect may never, in fact, reach the state where intervention is required during the life of the tree. This recognizes the fact that trees exist on a very different timescale to people: what might appear a defect with, for example, a three-year critical time, in reality might never require remediation. By using THREATS, the surveyor is given a framework that justifies doing nothing.

In this way, hazard tree mitigation can be systematised towards proactive intervention based on necessity, rather than either the 'fire brigade tactics' of reactive response, or the frequently wasteful policy of cyclic pruning regardless of need.

Finally, the reinspection interval for Category 1 is reduced from five to three years where a) there is child-specific access and b) the target score is 20 or higher. This further precaution towards children reflects the view that it is not safe to leave trees with identified defects uninspected for over three years where children are present in significant numbers.

**2.3.2** Outline of Work Required

The prompt is designed to make the user consider the suitability of non-arboricultural solutions: can the target score of the old ladies' park bench be reduced, preferably to zero, by relocating it? The suggestions for remedial measures are not in any way intended to cover all the options, but merely to offer a few possibilities. In fact, no formal attempt has been made to tie this section into the method as a whole, as individual tree problems demand tailored solutions. Notation space is provided so that the surveyor can enter a more detailed description of the necessary work.

However, the practiced user will soon develop a correlation between the nature of the defect and the work required. Indeed, someone ticking the 'Tree removal' box having scored only an end-loaded limb should look again! The main intention of this section is to show how the level of tree work should be graded, with wholesale removal clearly identified as the measure of last resort.

It may be that more than one defect was originally identified: where this is the case, it may be advisable to score other defects using THREATS, as a guide to whether it is appropriate to prescribe additional treatments while the contractors are on site.

## 3 THREATS used in Large-scale Tree Surveys

**3.1** Up to now, we have examined THREATS as a stand-alone method for assessing individual trees, and it is obvious that the use of the full pro forma for a tree survey covering numerous specimens would be cumbersome. However, THREATS was designed from the outset for use in large-scale tree safety surveys; in fact, practiced users find that employing the method actually reduces time required per tree. Most proprietary tree management software has THREATS as a selectable option.

**3.2** 'Action required' and the 'Priority' for this would, in any case, be standard columns in any tree safety survey (albeit perhaps under different headings). The advantage of using THREATS in this context is that outcomes in the method provide a guide as to the appropriate entries in the columns that deal with recommended treatments and priority. For these reasons, the author and other THREATS users have found large tree surveys to be the most useful application of THREATS to date. In fact, practiced users find that the method actually speeds up the decision-making process and takes if anything less time than surveying without it.

**3.3** Finally, local authorities using THREATS for district-wide safety surveys can benchmark the effectiveness of their tree risk management regime by comparing total accrued every five years (the recommended interval for baseline inspections). This is a helpful tool when approaching considerations of Best Value & performance evaluation.

## 4 THREATS as Part of a Desk Study: Target Zoning & Tree Inspection Priorities

Even where the existing level of knowledge of the tree stock's condition is low (and likewise, perhaps, the resources for its inspection), THREATS can assist in the prioritizing of tree inspections, and can do so in two ways:

### 4.1 By considering the Target Score

The tree manager can evaluate his area of responsibility in the context of varied target value. At the larger scale this will be a fairly blunt tool, but even so a useful one. By referring to the target examples, and producing one's own list tailored to the locality, it is possible to arrive at a prioritised schedule of areas for inspection.

### 4.2 By considering the Impact Score

Cross-referencing known size of any trees present with their locations can further prioritise the inspections: clearly the damage potential from young *Sorbus* is much lower than from mature *Platanus*, and even in areas where baseline knowledge of the stock is low managers usually have *some* idea of the nature of the population.

### 4.3 Example

Based on these factors, a THREATS-prioritised list for a locality could look something like this:

a) Various mature trees adjacent to playground
b) Raywood ash avenue along dual carriageway
c) Lapsed pollards in pedestrian precinct
d) Mixed age/species planting in hospital grounds
e) Several mature horse chestnuts in public parks
f) 30-40 year old trees at lower school
g) Mature pines lining roads in Victorian residential district
h) Trees flanking cycle-way through park
i) Area of woodland designated as a Public Open Space

See Table 2 for an example Risk matrix for target zoning.

## Table 2 Example matrix for risk zoning and tree inspection

| Risk Zone | Land use (examples) | Frequency of access | Tree attributes (wh known) | Level of inspection | Frequency of inspection |
|---|---|---|---|---|---|
| 1 | Major road or busy junction where cars static under tree(s)<br>School buildings or immediate environs and school main access / busy playgrounds<br>Urban centre<br>Hospital buildings / main access | Constant to very frequent access /occupancy including frequent access by unsupervised or partially supervised children | Maturing or mature trees | Arboricultural | Annual<br>(consider basic inspection after severe weather conditions) |
| | | | Young trees or mature trees regularly managed as pollards | Basic | Quinquennial for young trees, triennial for mature trees managed as pollards |
| 2 | Busy road / footway pavement or road junction / bus stop with peak times traffic where cars or pedestrians static under trees<br>School grounds or less well-used playgrounds<br>Frequently used buildings including college buildings | Very frequent to frequent access / occupancy including regular access by unsupervised or partially supervised children or by people with reduced mobility and other impairments that elevate risk | Maturing or mature trees | Arboricultural | Biennial or annual as driven by tree condition<br>(consider basic inspection after severe weather conditions) |
| | | | Young trees or mature trees regularly managed as pollards | Basic | Quinquennial |
| 3 | Peak times traffic (pedestrian or vehicular) including main access to colleges, or buildings with regular use | Some access throughout the day but busy during peak times, or sporadic use / access by unsupervised or partially supervised children or by people with reduced mobility and other impairments that elevate risk | Maturing or mature trees, especially if large | Basic or refer for arboricultural inspection if required | Triennial or more frequent as driven by tree condition |
| | | | Young trees or mature trees regularly managed as pollards | Basic | Quinquennial |
| 4 | Occasional traffic or use including most rural roads and regularly used woodland paths | Sporadic access only | Mature or large trees | Person with good working knowledge of trees, or refer for basic / arboricultural inspection if required | Regular though casual observation |
| 5 | Infrequently used rights of way including minor woodland paths | Access is rare | Mature or large trees | Landowner / occupier should be familiar with tree stock, seeking advice where required | Occasional casual observation |
| 6 | No formal public access including private land with no rights of way / permitted paths | Access is not foreseeable | No applicable | None likely to be required | None likely to be required |

## 5 Concluding remarks

**5.1** THREATS has been designed as a way of utilizing existing arboricultural knowledge, not replacing it. Essentially, therefore, the method is a codification of a tool that tree managers use every day: professional judgement.

**5.2** THREATS is a consistent, logical and transparent way of standardizing the assessment of tree risk, and of describing that risk to non-specialists. It will also assist the tree manager in justifying works budgets and in phasing tree work.

**5.3** THREATS restrains over-reaction to some hazards, whilst demanding rapid intervention for others. As such, it can highlight a dangerously slow response, hopefully in time to implement necessary control measures.

**5.4** In THREATS – NR, Britain's rail infrastructure operator has a unique and bespoke system to assist in controlling risk from lineside trees, as well as those on third party land capable of falling on the railway.

**5.5** Tree owners and managers are reminded that the most important letter in THREATS is the 'S' for '**System**': having a system in place is essential to enable Duty of Care to be discharged.

*Julian Forbes-Laird*

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*Note*

*Whilst competent arboriculturists are welcome to try THREATS for themselves, the author and Forbes-Laird Arboricultural Consultancy Ltd wish to stress that they accept no responsibility whatsoever for any consequences arising, whether directly or indirectly, from management decisions arrived at using the method, in the absence of training in its application by the author and continuing professional development by the user.*

*References*


1 'A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas', NP Matheny & JR Clark, ISA Books 1994
2 'Principles of Tree Hazard Assessment & Management', Dr D Lonsdale, TSO 1999
3 For further reading see:
'The Law of Trees, Forests & Hedgerows', Charles Mynors, Sweet & Maxwell 2002 ($2^{nd}$ Edition pending)
'Liability for death and injury from falling trees or branches: a review of the present position under English law' JFL, Arboricultural Journal Vol 32. No. 3, December 2009
4 Definition provided by the author
5 'The Body Language of Trees', C Mattheck & H Breloer, TSO 1994
6 Mynors, op. cit. p. 142ff
7 Revised from the original by George Simpson, 1906
8 'Veteran Trees: A Guide to Good Management', Helen Read, English Nature 2000

# TREE HAZARD: RISK EVALUATION AND TREATMENT SYSTEM - THREATS

**PART I: TREE INSPECTION RECORD**

**1] Survey details**

| | | | |
|---|---|---|---|
| **Surveyor details (initial on completion)** | | | |
| **Origin, date and time of inspection request** | | **Survey date & time** | |
| **Weather conditions** | **At log** | **At site** | |
| **Other notes** | | | |

**2] Description of tree**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Owner if known** | | | | | | | |
| **Tree no. if applicable** | | **Location** | | | | | |
| **Species** | | | **Age class (circle)** | Y MA EM M OM V | **Size category (circle)** | S M L VL | |
| **Other notes** | | | | | | | |

**3] Description of failure indicators (Circle Item no. to identify defect scored in Part II; always score most hazardous defect)**

| Item | Indicators | ✓ | Hazards | List defect and target details |
|---|---|---|---|---|
| 1 | Altered exposure | | Tree vulnerable to windthrow/storm damage due to e.g. loss of companion | |
| 2 | Unstable root plate | | Tree at imminent risk of toppling | |
| 3 | Root damage | | Tree topples. Compare damage with failure criteria: $R:R_{w.}$ Also consider health loss | |
| 4 | Root decay (fungi) | | Tree vulnerable to windthrow/toppling, possibly without further warning (see 3) | |
| 5 | Stem/limb decay (fungi) | | Stem/limb fracture causing crown elements to collapse (consider type of decay) | |
| 6 | Inadequate stem taper | | Failure risk due to e.g. excessive crown raising or D/h deficiency | |
| 7 | Target cankers | | Possible weakening/failure of affected area, especially if located on stem 'hot spot' | |
| 8 | Exudates | | Indication of (internal) disorder; if from lower stem, Honey Fungus infection? | |
| 9 | Stem hollow, decayed, cracked inc. shear cracks | | Stem fracture/buckling, causing crown to collapse. Consider *t:r* value | |
| 10 | Lapsed pollard | | Re-growth epicormic in origin & possibly weakly attached; possible decay at knuckles | |
| 11 | Overweight, subsiding, or lion-tailed limbs | | Limb failure due to an excess of mass over strength or to end-loading | |
| 12 | Bark congestion | | Fibre buckling of leaning/subsiding area indicating possible forthcoming collapse | |
| 13 | Reactive growth | | Member fails if repair (reactive growth) unsuccessful in stabilising defect | |
| 14 | Inclusive bark | | Fork fails causing leader/limb to fall | |
| 15 | Fractured limbs; storm damage | | Broken limbs/hanging breaks could fall; crown destabilised: further failures likely | |
| 16 | Bark necrosis | | Cambium death causing xylem dys-function: affected area dies, decays & fails | |
| 17 | Dieback; poor foliage | | Dead areas become unsafe. Various biotic and abiotic causes; roots damaged? | |
| 18 | Dead wood | | Branches fall | |
| 19 | Prolific ivy | | Possible obscuration of defects and excessive winter sail area | |
| 20 | Other/None (specify) | | | |

## PART II: RISK EVALUATION SUM *NB: Examples given in sections 4-6 & 9 are neither prescriptive nor exclusive*

### 4] Failure Score

Consider identified defects in relation to species/clone history, established failure criteria & time of year

| Score | ✓ | Likelihood of failure | Example indicators |
|---|---|---|---|
| 50 | | Imminent/Immediate | Uprooting; Extreme root loss; Collapsing structure (i.e. primary failure has already occurred) |
| 8 | | Probable/Soon | Altered exposure; Primary decay fungus; Severe inclusive bark/root loss; Fragile dead wood |
| 2 | | Likely, foreseeable | Lapsed pollard; Overweight/subsiding limbs; Poor stem taper; Dieback |
| .8 | | Potentially with time | Early development of inclusive bark; Robust dead wood |
| 0 | | None apparent | No significant defects observed |

### 5] Target Score

Consider impact radius of identified defect against potential targets. Consider forward visibility available to drivers (Poor Forward Visibility / Good Forward Visibility) & whether vehicles are likely to be stationary, e.g. at junctions. If targets liable to include unsupervised children &/or the elderly or infirm, upgrade target value by one category. **For railway targets use THREATS NR**

| Score | ✓ | Value | Static target examples | Target occupancy examples |
|---|---|---|---|---|
| 40 | | Very high | Building 24 hour use | Constant vehicular traffic/busy playground |
| 25 | | High | Building 12 hour use, ≥11Kv power lines | Frequent vehicular traffic/constant pedestrian use |
| 20 | | Medium | Building/structure occasional use, <11Kv lines | Peak times traffic/intermittent use, PFV, e.g. commuter run |
| 15 | | Low | Garage, Summer house, Listed wall | Occasional traffic/sporadic use, GFV e.g. quiet rural road |
| 7 | | Very low | Unlisted wall, paving, garden features | Infrequently used access/public right of way/bridleway |
| 0 | | None | Grass | Hardly ever used, e.g. remote path |

### 6] Impact Score

Consider height of fall/momentum & whether e.g. lower branches would impede agent's descent

| Score | ✓ | Degree of harm and consequences (examples) | Agent: trees, mm, or branches, kg (NB size/weight for guidance only) | | |
|---|---|---|---|---|---|
| 10 | | Severe structural damage, vehicles crushed – passenger fatalities very probable | VL | > 750mm | > 500kg |
| 6 | | Moderate structural/ severe vehicle damage – fatal/disabling injuries likely | L | 350-750mm | 50-500kg |
| 4 | | Minor damage/probable disabling/hospitalising injury to pedestrians | M | 100-350mm | 10-50kg |
| 1 | | Fragile objects destroyed, superficial/recoverable injury to pedestrians | S | < 100mm | < 10kg |

### 7] Risk Evaluation Sum:

FAILURE SCORE_______X TARGET SCORE_______X IMPACT SCORE_______=

## PART III: IMPLEMENTATION OF CONTROL MEASURES

### 8] Appropriate Response

The use below of the word 'within' should not be taken to mean that delay is necessarily acceptable

| Score range | ✓ | Threat Category | Recommended action & Completion deadline | Code |
|---|---|---|---|---|
| 4000+ | | 7- Extreme | Evacuate/prevent access to impact site, emergency call-out of contractors | E |
| 2001-3999 | | 6- Serious | Close site if practical; arrange for work to be completed within 7 days | 7D |
| 1000-2000 | | 5- Significant | Arrange for work to be completed within four weeks maximum | 4W |
| 330-999 | | 4- Moderate | Remediate within 13 weeks, reinspect after SWE meantime (inc. gales to Force 7+) | 13W |
| 160-329 | | 3- Slight | Reinspect annually /after storms (Force 10+), expect to schedule work within 2 yrs | A |
| 50-159 | | 2- Minimal | Reinspect within 3 yrs if public access, schedule work as required | 3Y |
| 0-49 | | 1- Insignificant | Reinspect within 5 yrs if general public access or 3 yrs if child-specific access & TS ≥20 | 3/5Y |

### 9] Outline of Work Required

Consider amenity and conservation values of tree when selecting control measure

| Control measure | ✓ | Examples | Notes / Work specification |
|---|---|---|---|
| Target management | | Target value / vulnerability reduced by exclusion, diversion or relocation: e.g. anti-social planting / fence off & warn; re-route paths; relocate benches | |
| Further investigation | | Decay mapping to establish significance of defect: set results against failure criteria | |
| Install support | | Non-invasive brace to support vulnerable member / dividing union | |
| Localised pruning | | Reduce weight loading on vulnerable limb (including shortening dead branches to retain habitat) | |
| Limb removal | | Prune out dead/damaged/vulnerable growth | |
| General pruning | | Reduce crown by specified amount | |
| Crown removal | | Leave stem as a standing carcass (consider habitat-piling cord wood, preferably in dappled light) | |
| Tree removal | | Takedown and fell to ground level (consider habitat piling & also stump-grinding as a disease reduction measure) | |