

# **2** Cruise Design

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## **2.1 Cruise Objective**

The objective of the timber cruise is to obtain an unbiased estimate of the volume and quality of timber on a cutting authority area to a specified confidence interval or sampling intensity. The area cruised may be one or multiple cutblocks that will be appraised in one cutting authority and subject to one appraisal.

The information from the cruise is applied as follows:

1. For scale-based sales, the cruise provides the basis for determining the stumpage rate while the invoice is based on the scale.
2. For cruise-based cutting authorities, both the estimate of the stumpage rate and invoicing are based on the cruise.
3. For special cases, such as salvage sales, small sales and right-of-way sales, cruising standards may be varied by the Regional Executive Director in accordance with Chapters 4 and 6 of the [\*Coast Appraisal Manual\*](#) and [\*Interior Appraisal Manual\*](#).

## 2.2 Cruise Plans

Cruise plans are professional documents and must be:

1. prepared by a qualified registered or associate member (RPF, RFT, ATE) of the Association of BC Forest Professionals, or
2. supervised by a registered member (RPF, RFT) of the Association of BC Forest Professionals.

It is *mandatory* for licensees and Timber Sale Managers to submit plans to the District Manager prior to the commencement of a timber cruise. **In areas where district staff do not check cruise BCTS (in accordance with Policy 13.7), the Timber Sale Manager must maintain the cruise plans on file.**

The cruise plan is submitted to MFLNRO staff to allow for the development of field quality assurance schedules and to provide a basis for comparison against the final cruise submission.

Cruise plans must contain the items specified in:

- Section [3.2.1](#), and
- Forms section - [Figure A.6 FS 693 - Provincial Cruise Plan \(Page 1 of 2\)](#)

For an example of a cruise plan map, please see the following link:

[Sample Cruise Plan Map.pdf](#)

All forest and non-forest type areas must be identified on the cruise plan prior to field sampling. A non-forest type, as identified on the cruise plan map, is not sampled for appraisal (i.e., rock bluff, swamp, constructed linear tenure, creek, riparian reserve area, slide track and gravel pit). (See Section [2.8](#))

Timber type polygons must be contiguous and unique to each cutblock. If forest or non-forest types are not identified on the cruise plan each block must be compiled as a single forest type. All portions of a timber type polygon separated by a non-forest type may be considered as one contiguous timber type polygon.

**If the non-forest type is a constructed linear tenure, the portions of the timber type polygon must be separated by the tenure in such a way that the portions of the polygon would be one contiguous type if the tenure did not exist. Specific examples are portions of timber types that are across the road from each other or a polygon bisected by a pipeline. This rule does not apply to polygons that are connected (versus separated) by a constructed linear tenure (ex. polygons along a road system). This paragraph does not apply to non-built, cruise based roads in the Great Bear Rainforest North (GBRN).**

Timber type polygons that are 1.0 hectare or larger must contain at least 2 full measure plots and timber type polygons that are less than 1.0 hectare must contain at least 1 full measure plot. (See Section [2.4.2](#) for additional information)

Cruises are the responsibility of the district that contains fifty percent or more of the cruise area.

The cruise plan is a professional document and forms the basis for the statistical sample. It identifies the population to be sampled and the design that will be used to meet the minimum cruise standards. The cruise plan is the key document that provides assurances to the MFLNRO that the data supplied to the appraisal was collected in an unbiased manner.

Changes to a cruise plan should be rare and minor in nature and must be undertaken to affect unforeseen issues that affect good forest management or other minor operational issues.

The submitting forest professional recognizes that changes to a plan, such as a change in area or the removal of a plot(s) is biased and will have assessed the impact of the alterations against the principles of sampling identified in these standards. The submitting forest professional will submit a record of all relevant information that was used to develop the original cruise plan and final cruise map, including a rationale where changes have been made. This model is consistent with the direction of professional reliance.

For guidance on how to prepare a professional rationale, please refer to the document “Guidance for Professional Quality Rationales and Commitments” published by the ABCFP and available at:

[Guidance for Professional Quality Rationales and Commitments](#)

The District Manager will review each change on a case by case basis and determine if the change meets the intent of providing good forest management or addressing unforeseen minor operational issues.

A spreadsheet that can be used to assist in cruise design can be accessed at the following website:

[Cruising Calculations](#)

## 2.3 Sampling Error Objectives

Unless otherwise specified, sampling error objectives are based on full measure and count plots and are based on the total stand net merchantable volume prior to any partial harvest reductions.

The following standards apply to both clearcut and partial retention harvest systems.

For cutting authorities  $\geq 250$  ha (net merchantable area), the largest grid to be used in each type between full measure plots is a 250 metre square or staggered grid (6.25 ha per full measure plot).

For cutting authorities  $< 250$  ha (net merchantable area), the largest grid to be used in each type between full measure plots is a 200 metre square or staggered grid (4.0 ha per full measure plot).

For coastal **and interior** cruises, a ratio of three (3.0) count plots to one (1.0) full measure plot cannot be exceeded on the cruise plan even if sampling error is achieved.

For cruises where cruise grades will be used in the appraisal, the minimum tree count must be met even if the sampling error requirement has been achieved.

For coastal cruises where cruise grades will not be used in the appraisal and for all interior cruises, there is no required minimum number of trees per plot when the sampling error requirement is achieved.

The minimum tree count requirements include tree classes 1, 2, 3, 5, 7, 8, 9 and not tree classes 4 and 6.

There is no need to change count plots to measure plots in the field if measure plots are dropped due to boundary influence in the field, provided the correct measure/count ratio is identified on the cruise plan and the minimum number of measure plots per type has been achieved (see Section [2.4.2](#)).

The following table serves as a guide to the various cruising standards itemized below:

Situation		Section that details the applicable cruising standard	
Rights of Way		2.3.6	
Coastal Cutting Authority	Northern Great Bear Rainforest	Cruise Based Cutting Authority	2.3.5
		Cruise Based Road permit	2.3.6 (1)
		Road Rights of Way appraised with adjacent cutblock	2.3.6 (2)
	Non-Northern Great Bear Rainforest	Cruise Based	2.3.4
		Scale Based	2.3.1
Interior Cutting Authority	At least 35% of net merchantable volume of all coniferous species is red and grey attack Lodgepole Pine		2.3.3
	Less than 35% of net merchantable volume of all coniferous species is red and grey attack Lodgepole Pine	General Cruise Based	2.3.2
		Scale Based	2.3.1

For further guidance, refer to *Policy 13.7 Timber Cruising* at the following Internet site:

<https://gww.nrs.gov.bc.ca/flnr/timber-pricing/timber-measurement-policies>

### 2.3.1 Scale Based Cutting Authorities

- Unless otherwise stated, the scale-based cutting authority sampling error objective is 15.0% at 2 SE based on the total stand net merchantable volume prior to any partial harvest reductions.
- Single Stem – the options are:
  - i. 100% cruise of the cut trees,

- ii. Achieve at least a 15.0% sampling error on the cut trees at 2 SE using variable radius plots, or
- iii. Sample using at least 2 variable radius measure plots/ha and at least 2.0 cut trees/plot.

**The sampling error requirement will be waived if the following **three** conditions have been met:**

1. A systematic grid of equal intervals (square or staggered, but not rectangular) and spacing of 100 metre by 100 metre, or less, has been established in each type,
2. a. For cutting authorities of 20.0 ha net merchantable area or larger in size, a maximum ratio of 1.0 count plot to 1.0 full measure plot has not been exceeded, or  
b. For cutting authorities less than 20.0 ha net merchantable area in size, only full measure plots are used, and
3. An average of at least 4.0 trees per plot per block has been met.

If the minimum tree count cannot be achieved with a BAF 2 prism, then the minimum tree count requirement will be waived.

### **2.3.2 General Cruise Based Cutting Authorities – Interior Only**

The following standards apply to all general cruise based cutting authorities within the Interior as described in the [Interior Appraisal Manual](#):

1. 8.0% at 2 SE on all plots, and
2. If count plots are used, a 2 SE of 12.0% on full measure plots must be achieved.

All other scale based standards apply, except that the sampling error cannot be waived.

### **2.3.3 Mountain Pine Beetle Cruise Based Cutting Authorities**

The following standards apply to all MPB cruise based cutting authorities:

1. Each block within the cutting authority must contain at least 35% red and grey attack Lodgepole pine net merchantable volume of all coniferous species. The net volume is the post-reduction cruise volume compiled to the interior standard merchantability specifications.
2. Cutting authorities must:
  - achieve a 12.0% sampling error objective at 2 SE using measure and count plots, or

- the sampling error will be waived as per the scale based standards specified in section [2.3.1](#)(1) or (2).
3. Cutting authorities that do not meet the MPB standards must meet the standards in section [2.3.2](#) to be a cruise based cutting authority.

### 2.3.4 General Cruise Based Cutting Authorities – Coast Only

The following standards apply to all general cruise based cutting authorities within the Coast area as described in the [Coast Appraisal Manual](#):

Cutting authorities must:

1. achieve a 10.0% sampling error objective at 2 SE using measure and count plots, and an average of at least 4.0 trees per plot **per block**, or
2. The sampling error will be waived if the following conditions have been met:
  - a. For cutting authorities of 40.0 ha **net merchantable area** or larger in size:
    - i. A systematic grid of equal intervals and spacing of not greater than 100 metres by 100 metres has been established, and
    - ii. Only full measure plots are used and an average of at least 4.0 trees per plot **per block** has been met.
  - b. For cutting authorities less than 40.0 ha **net merchantable area** in size:
    - i. A systematic grid of equal intervals and spacing of not greater than 70 metres by 70 metres has been established, and
    - ii. A maximum ratio of 1.0 count plot to 1.0 measure plot has not been exceeded and an average of at least 4.0 trees per plot **per block** has been met.
  - c. In addition, within any stand-alone polygon less than 5 ha **net merchantable area** in size (regardless of cutting authority size) the following requirements must be met:
    - i. A systematic grid of equal intervals and spacing of not greater than 70 metres by 70 metres has been established, and
    - ii. A maximum ratio of 1.0 count plot to 1.0 measure plot has not been exceeded.

Cruise based cutting authorities under this section, **other than BCTS sales**, will not require loss factor cruising as Call Grade Net Factor (CGNF) cruising will be used for appraisal purposes. **BCTS must continue to collect both loss factor and CGNF cruise data until CGNF is fully implemented across the Coast for appraisal purposes.**

Please note that for general cruise based cutting authorities within the Coast area, percent reductions (See [Section 5.9](#)) are not permitted and the net merchantable volume will be based upon 100% removal of the net merchantable area.



**2.3.5 Cutting Authorities within the Great Bear Rainforest North**

The following standards apply to all cruise based cutting authorities within the Great Bear Rainforest North (GBRN) as defined within the [Coast Appraisal Manual](#):

Cutting authorities must:

1. achieve a 10.0% sampling error objective at 2 SE using measure and count plots, and an average of at least 4.0 trees per plot **per block**, or
2. The sampling error will be waived if the following conditions have been met:
  - a. For cutting authorities of 40.0 ha **net merchantable area** or larger in size:
    - i. A systematic grid of equal intervals and spacing of not greater than 100 metres by 100 metres has been established, and
    - ii. Only full measure plots are used and an average of at least 4.0 trees per plot **per block** has been met.
  - b. For cutting authorities less than 40.0 ha **net merchantable area** in size:
    - i. A maximum ratio of 1.0 count plot to 1.0 measure plot has not been exceeded,
    - ii. An average of at least 4.0 trees per plot **per block** has been met, and:
      - a) A systematic grid of equal intervals and spacing of not greater than 70 metres by 70 metres has been established, or
      - b) A systematic grid of full measure plots not greater than 100 metres by 100 metres has been established with count plots offset halfway between the measure plots along either the North-South or East-West grid lines. For example, where ‘o’ represents measure plots and ‘x’ represents count plots, the following two designs are acceptable:



Cutting authorities in the Northern GBR will not require CGNF cruising as **loss factor cruising will be used for appraisal purposes. The exception is BCTS who must continue to collect both loss factor and CGNF cruise data until CGNF is fully implemented across the Coast for appraisal purposes.**

### 2.3.6 Rights of Way Cruises

1. Rights of Way cruises must:
  - i. Meet the 15.0% sampling error requirement using fixed or variable radius plots, or
  - ii. Establish a full measure variable plot every 100 metres along the right of way centre line. The first plot should be located at 50 metres (half the interplot distance) from the start of the centre line.
2. Where BCTS or Coastal Cruise Based (see Sections [2.3.4](#) and [2.3.5](#)) road rights of ways external to a cutblock are to be cruised and appraised with the cutblock harvest area, the following three options are available:
  - i. Extend the cruise grid of the adjacent timber type through the road right of way and establish any plots that fall within the right of way, or
  - ii. Identify the road right of way as a separate type at the cruise plan stage and establish a full measure variable plot every 100 metres along the right of way centre line. The first plot should be located at 50 metres (half the interplot distance) from the start of the centre line within that type; or
  - iii. Submit a rationale from a qualified registered professional stating the cruise data from the cutblock is representative of the road rights of way area.
3. Where timber on road rights of way within a cutblock is removed under a road permit (RP) after the block is cruised, the cruise plots that are within the area of the RP shall be included in the cruise compilation for the cutting permit and the area of the RP will be removed from the cruise compilation.
4. Rights of way areas not removed under a road permit must be included in the net merchantable area and must be sampled.

## 2.4 Sampling Patterns – General Conditions

Plots established within cutblocks from previous operational cruises may be used in new sampling plans if they meet the standards in this manual.

The minimum standards for appraisal cruising require the use of sampling techniques using systematic grids to locate the plots. The exception is a 100% cruise where all trees within the cutblock are measured.

All plots must originate from the net merchantable area. Plots in areas 100 percent reserved from cutting must not be used in the compilation.

Plots can be established using a predetermined management unit specific GIS grid or by using a local cutblock level grid system. Licensees must notify the district of which grid system they will be using. Once a grid system is selected by a licensee, it is to be used on all cruise plans completed by that licensee within an identifiable unit (e.g. a license management unit, operating area or drainage). In addition, the grid system must be consistent in each cutting authority. Grid system (see [Definitions](#)) refers to a GIS or local grid, and does not include grid interval.

The cruise plan must identify the grid interval for each timber type polygon.

The MFLNRO must be able to replicate plot location. The District office may request a copy of the grid and/or the method used to create the GIS grid.

### 2.4.1 Standards for the Location of Plots Using a Grid

The following section describes the types of grids that may be used in a cruise plan:

- a. **GIS Grid:** The grid locations are predetermined by the local management unit GIS grid.

If count plots are used in the cruise design, the most westerly plot on the most southerly line in the net merchantable area must be a measure plot.

- b. **Local Grid:** A local grid may be established using the following procedure:

- i. Project a line due south from the most western point of the net merchantable area and another line due west from the most southern point of the net merchantable area **for each cutblock**. Starting at the point of intersection of these two lines, lay the local plot grid on the map oriented in cardinal directions (N-S & E-W) to determine the plot locations (see [Figure 2.1 Example of Local Grid Design](#)).

**Each cutblock must have its own local grid. Timber type polygons within a cutblock may have different grid intervals but must originate from the same point of intersection as the cutblock.**

- ii. If count plots are used in the cruise design, the most westerly plot on the most southerly line in the net merchantable area must be a measure plot.

All possible sample points that can be established in the net merchantable area must be cruised, whether or not they were included in the original cruise plan. All plots must originate from the net merchantable area.

Plots cannot be moved within a timber type polygon, except as required in Section [2.4.2](#) to achieve the minimum number of plots in a timber type polygon.

The grid may be square or staggered **and of equal interval (rectangular grids are not permitted)**, however the option selected must be used consistently **within an identifiable unit**. Licensees **must notify the district as to whether grids will be square or staggered within an identifiable unit and once chosen, the cruise plans must be consistent with this notification**.

The cruise grid will be considered acceptable if the count to measure distribution is systematic and unbiased, and if the grid is established consistent with the above requirements. If the cruise plan is designed to waive sampling error as per the requirements of Section [2.3.1](#) or [2.3.3\(2\)](#), the count to measure ratio requirement will be waived if the grid design is consistent with Section [2.4.1](#) and the grid spacing and trees per plot are consistent with Section [2.3.1](#).

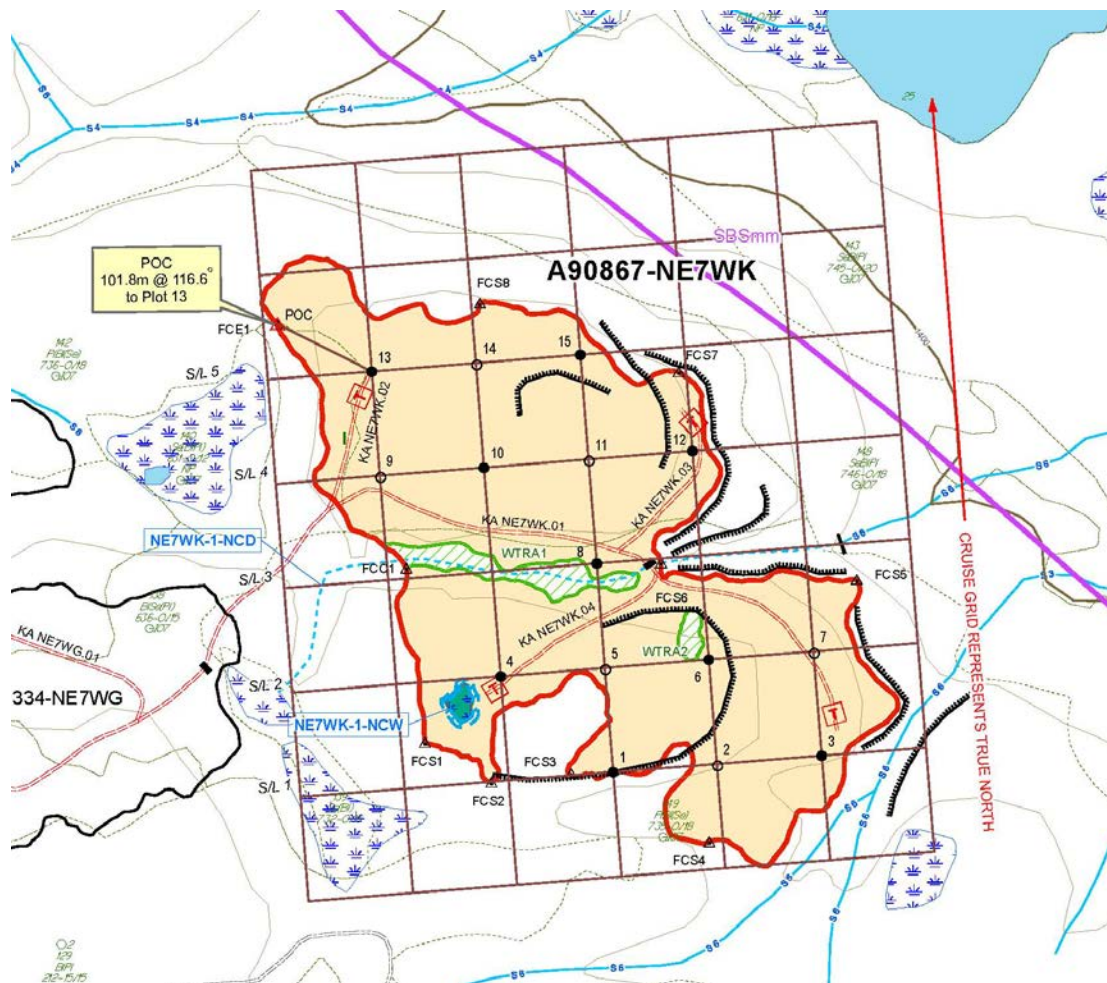


Figure 2.1 Example of Local Grid Design.

\* **Please note** – This example of a local grid is oriented to true north instead of map north. For a detailed explanation of the difference in these terms, please [see True North, Magnetic North and Grid North](#) in the Appendices. Some districts may prefer for cruise maps to be submitted with grids oriented to grid north – please refer to district or regional contacts for further information.

## 2.4.2 Standards for the Location of Additional Plots to Meet Section 2.2 Requirements

The following sections describe the situations and procedures to establish additional plots where the grid design does not meet the minimum one or two full measure plot per timber type polygon standard specified in Section [2.2](#).

### 2.4.2.1 Office Cruise Plan Procedure

Within the timber type, reduce the grid interval (using the same grid system) on the cruise plan by increments of 10 metres until the largest grid spacing that will meet the minimum plot establishment standards is achieved. **The grid should be reduced from the point where the grid originates (See Section [2.4.1](#)), but only for the type in which additional plots are needed, not for the entire block or cruise.**

#### Field Procedure

In the event that in the field, plots fall outside the timber type polygon, then use the procedure in the following table to establish the plot(s) inside the timber type polygon:

Sequence	Location	Sequence	Location	Sequence	Location	Sequence	Location
1	1/2 Grid North	2	1/2 Grid East	3	1/2 Grid South	4	1/2 Grid West
5	1/4 Grid North	6	1/4 Grid East	7	1/4 Grid South	8	1/4 Grid West
9	1/8 Grid North	10	1/8 Grid East	11	1/8 Grid South	12	1/8 Grid West
13	1/16 Grid North	14	1/16 Grid East	15	1/16 Grid South	16	1/16 Grid West

The procedure will be applied from the planned plot locations that fell outside the timber type polygon in the field. This procedure is used to obtain the required number of plots in the timber type polygon. If the plot cannot be established inside the timber type polygon using this procedure, attempt to establish the plot using this procedure with NE, NW, SE or SW bearings.

### 2.4.3 Standards for the Location of Additional Plots to Meet Sampling Error

Where plots must be added to an existing cruise to meet the sampling error requirement, they must be added in a systematic random manner. It is recommended to target the timber type (s) with the greatest variability. Determine the number of plots required using the coefficient of

variation statistic for the timber types from the compilation (See [Coefficient of Variation](#) in the Appendices).

The following procedures will be used where additional plots must be added to an existing cruise to meet the sampling error standard:

1. New Grid Design

- a. Determine a new grid design that will meet the new sample size requirements, using the same cruise grid orientation **and grid pattern**.
- b. If using a local grid, over-lay the new grid by positioning the new plot grid over top of the original plot grid at the point of intersection (See Section [2.4.1](#) (b)).
- c. If using a GIS grid, over-lay the new grid by positioning the first plot of the new grid over the most westerly plot on the most southerly line of the original grid (in the net merchantable area). Disregard the overlapping plot.

2. Existing Cruise Design

Additional plots must be systematically located on the existing cruise **grid**.

## 2.5 Other Timber Cruising Conditions

This section describes the timber cruising procedures that are required for situations where timber must be re-cruised, where it is unsafe to cruise, where patch cuts are used and where there is a combination of Timber Licence and Crown lands.

### 2.5.1 Standards for Re-cruising

#### Re-cruising is required:

1. If the cruise is of mature timber (> 120 years) and 10 years has elapsed since the fieldwork was performed.
2. If the cruise is of immature timber (< 121 years) and 5 years has elapsed since the fieldwork was performed.
3. If required in a reappraisal as outlined in the [Coast](#) or [Interior Appraisal Manuals](#).
4. As required by a check cruise ([Chapter 3 Quality Assurance](#)).
5. As determined by the Regional Executive Director.

In order to determine the maturity of timber for the purposes of this section, the following procedure will be used:

Review the Net Immature % of the Block Summary report from the post-reduction compilation. If the Net Immature is >50.0 %, the timber is immature. If the Net Immature is ≤50.0 %, the timber is mature.

### 2.5.2 Unsafe to Cruise

Where it is unsafe for cruisers to sample the stand, the preferred methodology is to establish cruise plots in the same timber type (where it is safe to cruise) adjacent to the unsafe area.

The sampling intensity must be sufficient to reliably estimate the attributes of the unsafe area.

As appropriate, the damage codes will be determined by a procedure subject to mutual agreement by the licensee and the Regional Executive Director, or Timber Sales Manager and Regional Executive Director.

If a safe portion of the same type is not available adjacent to the unsafe area, the methodology of determining cruise volume and value is subject to mutual agreement between the licensee, or Timber Sales Manager, and the Regional Executive Director.

If an individual plot cannot be completed safely, it will be dropped and the reason documented.

### 2.5.3 Cruising Patch Cut Silviculture Systems

The following sampling procedure must be used for cruising patch cuts:



1. Outline the proposed block including the outside boundaries of the patches.
2. Overlay an appropriate grid over the gross block area that will ensure the sampling design requirements are achieved on the entire block area (See Section [2.3](#)). **Each type within the cut block may have different grid intervals but must originate from the same point of intersection as the cutblock (See Section [2.4.1](#)).**
3. Patches that are 1.0 ha in size or greater will be unique timber types and will have the required minimum number of plots (See Section [2.2](#)).
4. Patches smaller than 1.0 ha may be aggregated and considered as one timber type in the compilation. These aggregated areas may be considered “partial cut” in the Interior for appraisal cost estimate purposes. Cruise data for this timber type should be representative of the patch cut areas.
5. Areas between the patches may be compiled as a unique timber type (Example 1) or aggregated with patches smaller than 1.0 ha as one unique timber type (Example 2). Appropriate percent reductions are to be applied in the compilation.

Example 1 (Refer to [Figure 2.2 Example of Patch Cut block.](#)):

Gross Block – 30.0 hectares. Cruise grid covers the whole block.

Type 1: 12 patches less than 1.0 hectare each. Total = 6.0 ha (Patches identified as letters A to L)

Type 2: area between all the patches where some incidental volume will be removed, 15.0 hectares (e.g. skid trails and selection harvest = 20% volume removal or 80 % volume reduction)

Type 3-8: 6 patches, each one is greater than 1.0 ha, totalling 9.0 ha. Each patch must be cruised. (Patches identified as numbers 1-6)

Total of 15.0 ha clearcut and 15.0 ha at 80% volume reduction

Example 2 (Refer to [Figure 2.2 Example of Patch Cut block.](#)):

Gross block area – 30.0 hectares

Types 1-6: 6 patches, each one is greater than 1.0 ha, totalling 9.0 ha. Each patch must be cruised. (Patches identified as numbers 1-6)

Type 7: Area between patches and patches less than 1.0 ha (total 21.0 ha)

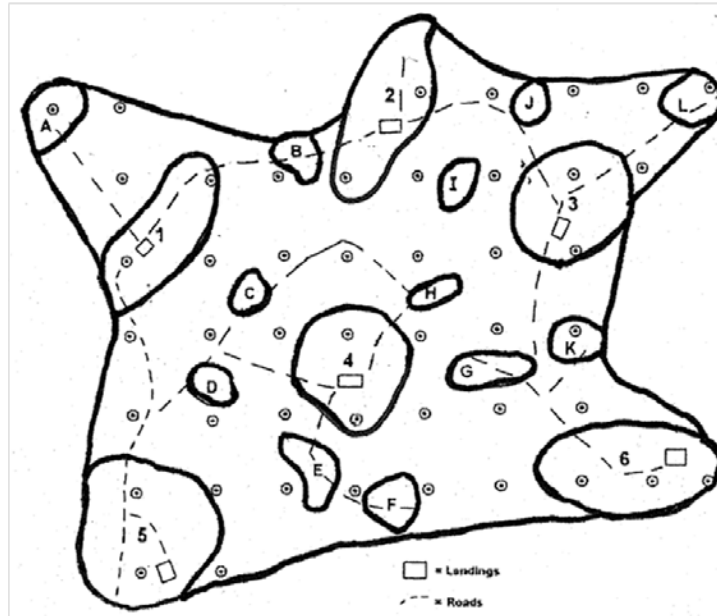
Amount of harvest on skid trails and incidental harvest between patches = 3.0 ha

12 patches equalling 6.0 ha (Patches identified as letters A to L)



$(6.0 + 3.0)/(30.0 - 9.0) = 9.0/21.0 = 42.9\%$  to be removed (57.1% volume reserved)

Total of 9.0 ha clearcut (Types 1-6) and 21.0 ha at 42.9% volume reduction (Type 7)



**Figure 2.2 Example of Patch Cut block.**

### 2.5.4 Schedule "A" (Private) and Schedule "B" (Crown) Lands

Cutblocks containing more than one type of land, as per the following table, are to be cruised and compiled as follows:

<b>Cutblock Configuration</b>	<b>Can Be Cruised As One Type?</b>	<b>Additional Compilation Requirements</b>
Schedule A (Private) and Schedule B (Crown) Land	Yes	Schedule A and Schedule B lands are to be compiled separately. <i>Do not include plots established in Schedule A (private) land in the Schedule B (Crown) compilation if Schedule A lands are typed out separately from Schedule B lands.</i>
Tree Farm Licence (TFL) and Timber Licence (TL)	Yes	A separate summary page for each timber mark is required.
Timber Licence and other Crown land not in a TFL (i.e. Forest Licence)	Yes	Timber Licence and other Crown lands are to be compiled and appraised separately. <i>Do not include plots established in Timber Licence land in the Forest Licence (FL) compilation if TL lands are typed out separately from the FL land.</i>

For the scenarios listed above, if a timber type includes more than one type of land, all plots within that type of land must be included in each of the required compilations.

## **2.6 Types of Cruises**

### **2.6.1 One Hundred Percent Cruise**

A 100% cruise requires that all trees are measured as per the appraisal specifications.

Each tree in a 100% cruise cutting authority must be numbered or marked as a cut tree.

### **2.6.2 Fixed Area Plot Sampling (See Section [4.3.1.13](#))**

Fixed area plot sampling is a method of using sample plots with a fixed size (area) for selecting the trees to be tallied. The plots are normally circular or square. It is also known as sampling without replacement since trees are not included in more than one sample plot.

The fixed area plot size must be consistent by timber type and count plots are not permitted in fixed area plots. Border plots are permitted in fixed area plots.

For additional information on fixed area plots and calculating sample size, please see the appendix on [Additional Sampling Information](#).

### **2.6.3 Variable-Plot Sampling (Prism or Relascope)(See Section [4.3.1.15](#))**

Variable plot sampling is a method of selecting trees to be tallied based on their size and not the frequency or density of the trees in the stand. The main advantage with using the variable plot instead of the fixed area method is that the probability of tree selection is proportional to the size (basal area at breast height) of the tree. Variable plots are more efficient to measure than fixed area plots because a plot perimeter is not required since every tree has its own plot radius and can be assessed for in/out status with an angle gauge (e.g., prism or relascope).

For additional information on variable plot sampling, calculating sample size, and calculating coefficient of variation (CV) please see the appendix on Additional Sampling Information.

## 2.7 Double Sampling (See Section [4.3.1.10](#))

Double sampling consists of sampling certain characteristics within a sample instead of measuring those characteristics throughout the sample. Double sampling improves the volume estimate by species.

Double sampling requires the use of two types of prism plots, the measure plot and the count plot. The measure and count plots together represent the main sample. Fixed radius plots are not used in this form of double sampling.

### 2.7.1 Measure Plots

The measure plots are conventional samples in which all variables for each tree are measured.

### 2.7.2 Count Plots

Count plots are samples where only the tree species and plot slope are tallied. All live and dead potential trees are tallied. Do not include any trees below the DBH limit or tree class 4 (dead useless) and tree class 6 (live useless) trees. DBH or DBH classes must be recorded where timber merchantability specifications may indicate a different DBH limit level from the field tally level.

Within each timber type, measure tree data is required in the measure plots for each species recorded in the count plots. Occasionally, a species is tallied in a count plot that has not been tallied in a full measure plot. This creates a situation where no measure data is available to compile the tree. This tree is called an ‘orphan tree’.

The procedure for dealing with orphan trees in count plots during **or because of** fieldwork is to record the measure information for the first occurrence (first tree from facing north (0°) and turning clockwise within the count plot) of the orphan species within the first count plot where the orphan species is encountered. If the orphan species is not measured in a measure plot in the same timber type, the data from the orphan species tree will be moved to the nearest measure plot in the **same** timber type **with the same BAF** and will be deleted from the count plot. This procedure will be completed after the fieldwork is complete or at the compilation stage. Orphan trees moved from a count plot to a full measure plot should be recorded using tree numbers 99, 98, 97, etc. Consideration will be given to waiving the sampling error if the minimum sampling error requirement is exceeded due to the shift in the tree count.

Where orphan trees are created **as a result of office changes** after the fieldwork, the options for dealing with an orphan species in a count plot are **(in order of preference)**:

- Change the orphan species to a species of similar tree form and value (if available) **in that same timber type**, or
- If a similar species is not available in the type, use the average data from the same species **in the nearest plot of** an adjacent type, or
- Delete all the count plots in that timber type from the compilation, or

- Return to the field and convert the count plot orphan tree to a measure tree and move it to a measure plot.

Figure 2.3 Sample Cruise Tally Sheet (FS 205) – Card Type 9. illustrates how count plots should be recorded if they are used for cutting authorities that have different appraisal and timber merchantability specifications:

Figure 2.3 Sample Cruise Tally Sheet (FS 205) – Card Type 9.

## 2.8 Forest Typing

Forest types are areas of land identified on a cruise plan map with similar timber characteristics. They are generally identified from aerial photos and may increase sampling efficiency and provide a more accurate estimate of timber volume and value.

For more information on the general principles and procedures that may be used to describe forest types, see the document titled 'VRI Photo Interpretation Procedures' at the following web link:

[www.for.gov.bc.ca/hts/vri/standards/photo.html](http://www.for.gov.bc.ca/hts/vri/standards/photo.html)

Appraisal cruising recognizes four categories of stratification:

- 1. Forest Types (Timber Types):** Generally describe areas of similar inventory forest cover composition (e.g., first and second leading species by volume, age, height and site class). These areas contain merchantable timber and are sampled for appraisal. Timber type polygons must be contiguous and unique to each cutblock.
- 2. Non-Forest Types:** These areas are not sampled for appraisal (i.e., rock bluff, swamp, constructed linear tenure, creek, riparian reserve area, slide track and gravel pit). A non-productive area can be less than one hectare in size, but typing out of non-productive areas must be consistent (e.g., if a 0.5 ha non-productive area is typed out then all non-productive areas 0.5 ha and larger must be typed out).
- 3. Forest Reserves:** Describe areas reserved from harvest due to forest management purposes (e.g., Goshawk nest, visual quality reserve, wildlife tree patch). These areas may contain merchantable timber but are not sampled for appraisal.
- 4. Silviculture Treatment Units:** Describe areas that will receive different forms of silvicultural or harvest treatments. (e.g., stumping for root rot and partial cutting areas). These areas contain merchantable timber and are sampled. Treatment units may consist of an entire timber type, a portion of a timber type or a portion of multiple timber types.

## 2.9 Comparative Cruises

The [Interior Appraisal Manual](#) specifies the situations when comparative cruise data may be used for appraisal purposes.

The use of comparative cruise data is an exception and must be approved by the Regional Executive Director, except for Cruise Based Salvage Cutting Authorities (See Section 2.9.1). Sample design and methods used in a comparative cruise are subject to mutual agreement between the licensee and Regional Executive Director.

### 2.9.1 Cruise Based Salvage Cutting Authorities

For the purposes of those cutting authorities defined as cruise based salvage in the *Interior Appraisal Manual*, the comparative cruise method is as follows:

1. A qualified registered or associate member (RPF, RFT, ATE) of the ABCFP must provide a signed estimate of the:
  - a. average total height of the merchantable conifer stems in the cutblock
  - b. average total stems per hectare of merchantable coniferous and deciduous trees (standing and down) in the cutblock.
2. The registered or associate member of the ABCFP providing the estimate must include a description of how the estimate was generated and relevant supporting information.
3. The estimate will be used in the following table to generate a total coniferous and deciduous net merchantable volume per hectare:

**Table 2-1: Total coniferous and deciduous net merchantable volume per hectare (m<sup>3</sup>/ha) estimates for Cruise Based Salvage Cutting Authorities**

Average Total Stems per Hectare of Merchantable Coniferous and Deciduous	Average Total Height (m) of Merchantable Coniferous Stems							
	<15	15-16	17-18	19-20	21-22	23-24	25-26	27+
<b>200-299</b>	45	45	45	80	120	163	210	260
<b>300-399</b>	45	45	56	91	131	174	221	271
<b>400-499</b>	45	45	67	103	142	185	232	283
<b>500-599</b>	45	47	78	114	153	196	243	294
<b>600-699</b>	45	58	89	125	164	207	254	305
<b>700-799</b>	45	69	101	136	175	218	265	316
<b>800-899</b>	45	80	112	147	187	230	277	327
<b>900-999</b>	45	91	123	158	198	241	288	338
<b>1000-1099</b>	56	103	134	170	209	252	299	350
<b>1100-1199</b>	68	114	145	181	220	263	310	361
<b>1200-1299</b>	79	125	157	192	231	274	321	372
<b>1300-1399</b>	90	136	168	203	242	285	332	383
<b>1400-1499</b>	101	147	179	214	254	297	344	394
<b>1500-1599</b>	112	158	190	225	265	308	355	406
<b>1600-1699</b>	123	170	201	237	276	319	366	417
<b>1700-1799</b>	135	181	212	248	287	330	377	428
<b>1800-1899</b>	146	192	224	259	298	341	388	439
<b>1900+</b>	157	203	235	270	309	352	399	450