

 Ontario

**Book**  
**2**

**Ontario  
Traffic  
Manual**

**March 2005**

# Sign Design, Fabrication & Patterns

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# Ontario Traffic Manual

## Foreword

The purpose of the Ontario Traffic Manual (OTM) is to provide information and guidance for transportation practitioners and to promote uniformity of treatment in the design, application and operation of traffic control devices and systems across Ontario. The objective is safe driving behaviour, achieved by a predictable roadway environment through the consistent, appropriate application of traffic control devices. Further purposes of the OTM are to provide a set of guidelines consistent with the intent of the Highway Traffic Act and to provide a basis for road authorities to generate or update their own guidelines and standards.

The OTM is made up of a number of Books, which are being generated over a period of time, and for which a process of continuous updating is planned. Through the updating process, it is proposed that the OTM will become more comprehensive and representative by including many traffic control devices and applications appropriate for municipal use, in addition to those for highway use. Some of the Books of the OTM are new, while others incorporate updated material from the Ontario Manual of Uniform Traffic Control Devices (MUTCD) and the King's Highway Guide Signing Policy Manual (KHGSPM).

The Ontario Traffic Manual is directed to its primary users, traffic practitioners. Book 2 is an exception, being directed at sign designers and fabricators. The OTM incorporates current best practices in the Province of Ontario. The interpretations, recommendations and guidelines in the Ontario Traffic Manual are intended to provide an understanding of traffic operations and they cover a broad range of traffic situations encountered in practice. They are based on many factors which may determine the specific design and operational effectiveness of traffic control systems. However, no manual can cover all contingencies or all cases encountered in the field. Therefore, field experience and knowledge of application are essential in deciding what to do in the absence of specific direction from the Manual itself and in overriding any recommendations in this Manual.

The traffic practitioner's fundamental responsibility is to exercise engineering judgement and experience on technical matters in the best interests of the public and workers. Guidelines are provided in the OTM to assist in making those judgements, but they should not be used as a substitute for judgement.

Design, application and operational guidelines and procedures should be used with judicious care and proper consideration of the prevailing circumstances. In some designs, applications, or operational features, the traffic practitioner's judgement is to meet or exceed a guideline while in others a guideline might not be met for sound reasons, such as space availability, yet still produce a design or operation which may be judged to be safe. Every effort should be made to stay as close to the guidelines as possible in situations like these, to document reasons for departures from them, and to maintain consistency of design so as not to violate driver expectations.

The specific purpose of Book 2 is to provide practical guidelines and sign patterns for the design and fabrication of traffic signs.

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Book 2 (Sign Design, Fabrication and Patterns) and its associated Book 2 Training Work Book for sign designers and manufacturers were developed with the assistance of a Stakeholder Advisory Committee organized by the Ministry of Transportation.

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**Electronic Master Sign Library (MSL) . . . . . CD-ROM**

**Note: A Training Work Book is available separately. For more information, contact:**

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## 1. Introduction

### 1.1 Purpose, Scope, and Content

Book 2 (Sign Design, Fabrication and Patterns) is part of a series of volumes that makes up the Ontario Traffic Manual (OTM). Book 2 is intended for those engaged in the actual practice of sign design and/or sign fabrication. Book 2 addresses the design and fabrication of traffic signs and includes a CD-ROM incorporating the electronic Master Sign Library.

The Master Sign Library (MSL) contains the electronic images of all signs in the various Books of the OTM developed to date and of the relevant guide signs in Book 8 (under development, based on the King's Highway Guide Signing Policy Manual (KHGSPM)). These sign images are presented according to a standard sign pattern template. For standard signs in OTM Books 5, 6, and 7, these sign images are drawn to 1/10 scale and are suitable for scaling up as appropriate to create actual full-size sign patterns for use in fabrication. For directional guide signs (Book 8/KHGSPM), the sign images are illustrative examples, but they cannot simply be scaled up as is, to create full size sign patterns, as the legends on these signs need to be custom designed for specific locations.

The MSL also contains a Sign Parts Library of sign elements, such as standard arrows, symbols, shields and markers, which need to be assembled by sign designers in some cases, especially for customized standard directional and information guide signs. The MSL also contains a list of standard sign blanks and a set of patterns for standard metal sign blanks, including holes for mounting.

The scope of Book 2 includes the following:

- **Sign design principles**, incorporating much of the material in Book 1b (Sign Design Principles) for ready access and use by the sign designer, and for completeness of Book 2 as a stand-alone document. **Rules and application guidelines for sign design**, including procedures and a sign design process flowchart, are also included. (Section 2)
- **Sign materials** (both sheeting and substrate) and selection criteria. (Section 3)
- **Sign fabrication techniques**, including substrates, background sheeting, assembly, and legend application. **Application guidelines for sign fabrication**, including procedures and process flowcharts, are also included. (Section 4)
- The approach taken in Book 2 with respect to the **Master Sign Library** (including Sign Pattern Template), and its elements, and application guidelines for use of the Master Sign Library. (Section 5)
- The electronic Master Sign Library, on a CD-ROM included as part of Book 2

Other Books in the OTM series provide practical guidance on a full range of traffic control devices and their application. A complete listing of the planned and currently available volumes is found in Book 1, and an illustrated master index of signs and signal displays is found in Book 1a (Illustrated Sign and Signal Display Index).

The other OTM Books are aimed at the traffic practitioner, and are not intended to provide sufficient detailed information to design and fabricate individual signs. Book 2 on the other hand

is not aimed at the traffic practitioner, but is intended to provide sufficient information to sign designers and manufacturers for the design and fabrication of individual signs.

Related to Book 2 are two Books yet to be developed, Book 3 (Sign Support and Installation), and Book 4 (Sign and Delineation Maintenance).

With the exception of Book 2, the OTM Books depict symbolic and English language signs only. Book 2 contains all the symbolic and English language signs, and also all standard French language and bilingual (English and French) signs developed to date. Where French language or bilingual versions of standard signs are available, they have not been illustrated in the other OTM Books, but are contained in the MSL as part of Book 2.

New signs were not introduced in the development of Book 2. The approach taken in the OTM is that new signs, with their application policies, are introduced where appropriate in the development and updating of the main policy Books, such as Books 5, 6, 7, 8, and 9. Where so introduced, the MSL will need to be revised to include the sign patterns for any new signs adopted.

Other documents, not in the OTM series, are also useful. These are listed in Appendix B, References.

## 1.2 Sign Numbering System

The sign numbering system used in Book 2 and in the Master Sign Library has been revised from the system used in the Ontario Traffic Manual Books 5, 6, and 7, and in the King's Highway Guide Signing Policy Manual. The OTM Books 5, 6, and 7 used the sign numbering system of the Ontario MUTCD, with some minor revisions and renumbering.

The sign numbering system used for many years in the MUTCD and the KHGSPM to distinguish standard-size signs from oversize signs was as follows:

- the standard-size sign almost always got the basic number designation (e.g., Ra-1) (there are a few exceptions where a reduced-size sign had the basic number designation, e.g., Rb-69 BICYCLE ROUTE is reduced size, suitable for use on an off-road bicycle route, but not for use on a road; the full-size sign for use on roads was given the designation Rb-169);
- the first oversize sign got a modified number designation, by adding 100 to the basic sign number (e.g., Ra-101);
- the second oversize (double oversize) sign got a modified number designation, by adding 1100 to the basic sign number (e.g., Ra-1101).

The sign numbers themselves did not convey the actual sign sizes. These had to be obtained from the sign description in the OTM source Book (5, 6, or 7) or the KHGSPM, or from the sign template in the MSL.

The revised sign numbering system now introduced into the OTM, and used for the first time in Book 2, is based on the previous sign numbering system, but differs from it. The basic sign numbers are retained, but instead of a number indicating

whether the sign is standard size, oversize, or double oversize, the actual dimensions of the sign in millimetres are shown, along with a suffix: 'B' for bilingual signs or 'F' for French. If the standard sign is English, symbolic, or considered understood in both languages, no suffix is used. When Books 5, 6 and 7 are next updated, their sign numbering system will be brought into conformance with the new sign numbering system used in Book 2.

The sign numbering system used in the Master Sign Library (MSL) is the new numbering system, but with several slight variations. The main body of the MSL is made up of directories of Sign Pattern Templates (SPTs), one directory for each major classification of signs (regulatory, warning, temporary conditions, etc). Each SPT for a regulatory, warning, or temporary conditions sign has one or more cut images at 1/10 scale, which are used to fabricate that sign for one or more sizes. The variations of the numbering system used for the SPTs are as follows:

- (1) The SPTs in the SPT directory are labelled by the basic sign number, e.g., Ra-001 (This is the Ra-1 sign, but a three-digit number is used to ensure that the signs within each sign category (e.g., Ra) are listed in true alphanumeric order).

- (2) Each SPT has the basic sign number (e.g., Ra-1) displayed in the upper right part of the title bar at the top.
- (3) Each SPT has listed on it, in the parameter blocks below the depicted sign pattern, the available sizes for that sign. The sign number used for each of these variations is the base sign number together with the sign size in parentheses (e.g., Ra-1 (0600 x 0600)).
- (4) Finally, for each available sign size, a 1/10 scale cut image of the sign is attached to the SPT. The sign number used for the cut image will match the sign number in (3) (e.g., Ra-1 (0600 x 0600)). Note that although the SPTs for directional guide signs also have a 1/10 scale sign image, it is illustrative only, and is not intended to be a cut image for fabrication.

A comparison example of the old and new numbering system is as shown in Table 1.1 (Numbers in parentheses in the column headings refer to the numbered points directly above).

**Table 1.1 – Comparison of Old and New Sign Numbering Systems**

Old Numbering System	Book 2 – New Numbering System		
	SPT* Directory (1)	SPT Sign Title (2)	SPT Size Variants & Cut Images (3) & (4)
Ra-1	Ra-001	Ra-1	Ra-1 (0600 x 0600)
Ra-101	Ra-001	Ra-1	Ra-1 (0750 x 0750)
Ra-1101	Ra-001	Ra-1	Ra-1 (1200 x 1200)
Rb-27	Rb-027	Rb-27	Rb-27 (0600 x 0750)
Rb-127	Rb-027	Rb-27	Rb-27 (0900 x 1200)

\* SPT = Sign Pattern Template

### 1.3 Revisions

As established at the outset of the OTM development, the concept of the OTM is to have a series of individually bound Books making up the various components of the overall manual, rather than to produce the Books in loose-leaf binders into which periodic revisions can be inserted. In the OTM concept, Books are revised and updated as complete units, rather than piece-by-piece, to overcome distribution uncertainties, and the uncertainty of knowing whether a given version contains all the latest revisions. To identify the most recent versions of any OTM Books, the reader is advised to contact MTO or the publisher, as noted immediately following the Foreword.

### 1.4 Metrication

All sign dimensions on the sign patterns are shown in metric dimensions, in millimetres. (This is consistent with most other engineering practice, where dimensions are typically given in metres and millimetres. However, note that the first editions of Books 1, 1A, 5, 6, and 7 all provide dimensions in centimetres. **The use of millimetres for sign dimensions is new to the OTM, and is introduced for the first time in Book 2.** When Books 1, 1A, 5, 6 and 7 are next updated, their sign dimensions will be expressed in millimetres in conformance with the new sign dimensioning system used in Book 2.) This is satisfactory for smaller signs using the standard metric sign blanks. A problem arises, however, when dealing with extruded panels.

Extruded aluminum panels and aluminum overlay panels are manufactured in Imperial dimensions (feet, inches). What this means in practice is that the metric sign patterns have to be adapted to fit the extruded sign panels in Imperial dimensions. This may typically be done using one of the following approaches:

- The metric dimensions shown on the sign pattern template may be converted to their soft Imperial equivalent (e.g., 300 mm = 12 inches), even though 12 inches really equals 304.8 mm. See Table 2.10. The sign details are then developed entirely in Imperial units, and they will fit the extruded panels. This is quite a common practice.
- In the second approach, the dimensions of the extruded sign panels are converted from Imperial units to metric units, using a hard metric conversion. Note however that the overall metric sign dimensions shown on the sign pattern template are rounded. For example, a 1200 mm x 3000 mm sign shown on the template really means a four-foot by ten-foot sign. These dimensions need to be converted to true (hard) metric, which means 1219 mm x 3048 mm. The sign details are then developed entirely in metric units to fit the extruded panels. The metric dimensions of the various sign elements (text, symbols, arrows) are used as shown on the sign pattern template. They are then positioned on the extruded panels (Imperial units), according to the guidelines and rules for sign design and spacing of and between elements. Because the extruded panels are higher and wider than their soft metric equivalent, this means that spacings of and between elements are slightly larger than if the extruded sign panels were manufactured in the true metric size depicted on the sign pattern template.

More detail is provided in Section 2.15 (Sign Design Process). Section 2.14 (Rules for Sign Design) contains Table 2.10 (Imperial to Metric Conversion Chart) for letter heights.

## 1.5 Bilingual and French Language Sign Patterns

Bilingual (both English and French) and French language only sign designs are not shown in the OTM Policy Books, such as Books 5, 6, and 7. However, those bilingual and French language only versions of the signs, which have already been developed by the Ministry of Transportation Ontario (MTO), are included in the Master Sign Library. As noted earlier, any bilingual or French language only sign patterns will be shown in the sign number by the suffix 'B' or 'F' respectively.

Occasions may arise where new bilingual or French language only versions of signs are required. The French language text of any sign that is to be installed on a Provincial Highway located within an area or areas designated by the French Language Services Act must be approved by MTO's French Language Services Office. Private sector companies that supply and/or install signs to the Ministry of Transportation should request official translations through their MTO Contract Administrator if they are not already provided within the contract.

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## 2. Guidelines for Sign Design

This section outlines guidelines for traffic sign design (sometimes called sign detail). It includes both sign design principles (Sections 2.1 to 2.13), and the application of those principles, including a set of sign design rules (Section 2.14), and the recommended sign design process (Section 2.15) for the creation of actual sign designs. The sign design principles included in Book 2 are drawn from Book 1b (Sign Design Principles); they have been updated to include new information. They are included here to make Book 2 a manual that is essentially complete and self-contained.

A consistently applied set of sign design principles is necessary to facilitate driver understanding of, and response to, sign messages. For the sign design principles to be effective, they must be based on measured visual and mental abilities of road users.

The outline of sign design principles in the OTM is intended to assist OTM users in understanding sign design principles and related driver requirements. This knowledge will enable OTM users to:

- understand the design of existing signs in the OTM;
- design new local directional guide signs and other information signs;
- use the appropriate size of sign for a given application;
- use the appropriate sheeting material and/or level of illumination for a given application;
- mount each sign in an appropriate location;

- institute operational programs to ensure the ongoing effectiveness of signage.

In outlining general sign design principles, this section reflects traffic sign design principles that are considered to be good practice, applied currently by Ontario road authorities.

## 2.1 Standardization of Design

High travel speeds and increasingly complex driving environments require that signs be readily detected and understood at a glance. Uniformity and simplicity in design, position and application are crucial for speedy detection and recognition. It is therefore important that sign design principles be consistently applied, and that signs installed on all roads conform to the designs and standards represented in the Ontario Traffic Manual.

Uniformity in design includes sign shape, colour, dimensions, symbols, wording, lettering, borders, and reflectorization or illumination. Many of the sign designs in the Ontario Traffic Manual have been approved by the Traffic Operations and Management Standing Committee (TOMSC) of the Transportation Association of Canada (TAC) after a thorough review of various designs used in Canada, supplemented by test studies. Other signs have been approved by the Ministry of Transportation Ontario (MTO) or by other Ontario road authorities.

Sign patterns for standard OTM signs are provided in the Book 2 Master Sign Library (MSL). All sign shapes and colours are to be used as indicated in the MSL. In addition, all symbols are to be the same as those shown in Book 2, and wording on standard signs containing text is to be as indicated.

Uniformity of application is also an important element of standardization. Similar conditions should be signed in the same manner, regardless of actual location. It is recognized, however, that urban

conditions differ from rural conditions with respect to speed, frequency of intersections, traffic congestion, parking and competing lights and displays. Where such differences in the driver environment impact the sign message, sign application must take these differences into account. Where practical, the OTM presents separate guidelines for rural and urban areas.

## 2.2 Approaches to Sign Design

Most regulatory, warning, and temporary conditions signs (OTM Books 5, 6, and 7 respectively) have already been designed as standard signs, and are shown as such on the sign pattern templates in the Master Sign Library. The cut images shown on these sign pattern templates for standard signs can be used as shown, as described in Section 5 (Master Sign Library). They do not need, nor are they intended, to be redesigned. If operating speed, roadway width, or environmental considerations mean that in certain situations a given sign does not provide drivers enough time to see and react to the sign, the sign may be enhanced in one or more ways, such as larger sign size, sign repetition, or increased reflectivity.

Other signs, primarily directional and information signs, have a sign pattern template but need to be designed to a greater or lesser degree. These signs are “customized standard signs.” That is, they are built to a standard sign pattern template (included in the MSL for illustrative purposes, without cut images), but they need to be customized according to the local information message they convey, such as destination or street name, and to the amount and type of information on the sign. In practical terms, a higher (more generous) layout standard is often used for overhead signs than for ground-mounted signs. This is reflected in the principles for sign design, in Section 2.8 (Sign Design Elements and Arrangement), and in Section 2.14 (Sign Design Rules).

Other signs are “non-standard signs,” that is, there is no sign pattern template, and the size and message are designed for a specific purpose. Although the same sign design principles and rules apply to all signs (shape and colour coding according to type of sign, and sign design and layout rules), the sign designer will need to apply those principles primarily for customized standard signs and non-standard signs.

Section 5.1 describes the Master Sign Library, including the Sign Parts Library.

## 2.3 Driver Requirements

Sign design must take into account driver limitations in detecting signs in the roadway environment, processing the sign information, and selecting an appropriate response. Driver limitations determine requirements for letter size, the selection of font, contrast, retroreflectivity, spacing of sign elements and borders, message layout, and reading time, as well as longitudinal sign spacing and placement in the field. The more a sign meets driver needs, the more likely a driver will detect it, the more likely he or she will be able to read and understand the message, and the more likely he or she is to select the response desired by the traffic practitioner.

Traditional sign design does not explicitly consider these driver needs. In particular, no allowance is made for the fact that longer messages require more time to read and therefore greater legibility distance. Nor is sufficient distinction made, in terms of sign placement, between signs requiring the driver to make one of several choices and then complete a manoeuvre, as compared to signs that are “information only.” Instead, a particular distance is assumed, depending mainly on speed, and letter height is determined through an assumed driver ability of some number of metres legibility per millimetre of letter height. In the past this assumed

driver ability has been 0.6 metres legibility per millimetre of letter height (50 feet legibility per inch letter height), which does not encompass the majority of drivers, and assumes almost double the actual legibility distance of drivers with 20/40 vision, licensable under MTO regulations.

Several criteria must be met for a sign to be effective. Initially, it must command attention or be easily detected by the person who needs the information (i.e., it must have good conspicuity). It must be legible at the appropriate distance (in time to read the whole message and take the necessary action). At busy urban locations, signs, traffic signals and markings can easily be hidden by large vehicles and seen only briefly. Therefore signs should be readable quickly, as drivers often have only a second or two to interpret and respond to the message. The message must obviously be understandable, otherwise the user will not know whether or how to respond to it. If the meaning of the message (e.g., a new symbol) is not immediately understood, driver error or delay can easily result. If a new symbol is introduced, an educational text tab may be used temporarily to aid understanding.

Other, perhaps less obvious, criteria are that the information on the sign should be easily rejected if it is irrelevant for the driver, and that the action to be taken in response to the message should be immediately obvious. Drivers often are in situations where there is a great deal of information from the roadway environment (not only signs). It may not be possible to attend to and process all of this information fully. The driver must be able to glance at the sign and determine rapidly whether the information is relevant and should be processed, retained and acted upon. As all signs are possible sources of relevant information, the driver must first take in and process the information at a superficial level before it can be decided whether it is relevant. This takes time and mental effort, which the driver may not have under conditions of input overload

and stress. The appropriate action should not require a significant amount of thinking and decision time, and should not violate driver expectation, especially if the action involves a manoeuvre which must be taken quickly (e.g., change lanes to exit or to avoid exiting ahead).

Finally, signs are most likely to be obeyed when they appear to be reasonable to the driver, and when they augment the roadway message rather than contradict it. For example, the use of speed signs to lower speed, in the absence of changes in the roadway, is likely to be ineffective.

In summary, the effectiveness of highway signs depends on several factors:

- **Conspicuity** – does the sign attract attention given the background in which it is placed;
- **Legibility** – at what distance can drivers read the sign;
- **Information load** – do drivers have sufficient time to read the entire message;
- **Comprehension** – do drivers understand the meaning of the message, and any symbols or abbreviations used;
- **Driver response** – do drivers make the desired action as a result of reading the sign.

## 2.4 Shape and Colour Codes

Signs that are similar in function are typically designed to be the same shape and to use the same colour combinations for legends, backgrounds and borders. Shape and colour codes serve to organize pieces of information into larger units and establish message redundancy. Drivers can recognize sign colours and shapes at far greater distances than they can distinguish symbols

or read sign text. Colours can be identified first and therefore colour coding is the most effective way to help drivers locate particular signs (e.g., guide signs) quickly. The shape and colour codes alert the driver to the general function of the sign. They simplify the driving task by enabling the road user to judge in advance the nature of the expected response and to prepare accordingly. For example, drivers can recognize the shape and colour of the STOP sign before they can actually read the sign text. In fact, the STOP sign is one case where the shape and colour convention has made the sign so familiar to drivers that actually reading the text has become unnecessary.

All signs in the OTM have been allocated to classes and sub-classes, according to the specific function of the sign. For example, Class R represents regulatory signs, which regulate the flow of traffic by instructing drivers on what they must or should do. Sub-class Ra, within Class R, refers to right-of-way control signs, which regulate the right-of-way of vehicles and other users at locations where their movements may otherwise be in conflict.

Unique sign shape and colour codes have been assigned to each sign class, with further shape and colour distinctions provided for some sub-classes, and in some cases even within the sub-class. For example, Class R regulatory signs are generally rectangular in shape and have white backgrounds with black legends. Sub-class Ra signs include some signs with shape and colour codes that follow the general rule for Class R, but also some special signs, such as the STOP sign and YIELD sign, which have their own unique shape and colour codes. Shape and colour codes for sign classes and sub-classes are illustrated in Table 2.1.

Clearly, shape and colour codes are a powerful element of sign design. Therefore, all signs must follow the shape and colour codes indicated in the OTM. Precise sign shapes are specified in the OTM Book 2 Master Sign Library. Sign colours must be in accordance with the ASTM (American Society for

Table 2.1 – Shape and Colour Codes for Signs

Class	Sub-Class	Shape Code	Colour Code			Comments
			Back-Ground	Message	Border	
<b>R</b> Regulatory	<b>Ra</b> Right of Way Control		Red	White	White	Shape reserved for STOP sign
	<b>Ra</b> Right of Way Control		White	Red	Red	Shape reserved for YIELD sign
	<b>Ra</b> Right of Way Control		White	Black	Black	Various Pedestrian Right of Way Control Signs
	<b>Rb</b> Road Use Control		White	Black	Black	A green annular band shall indicate a permissive message A red annular band with interdictory stroke shall indicate a prohibitive message
	<b>Rb</b> Road Use Control		White Black	Black White	Black White	A green annular band shall indicate a permissive message A red annular band with interdictory stroke shall indicate a prohibitive message
	<b>Rb</b> Road Use Control		Blue	White	White	Reserved for School Area Signs
	<b>Rc</b> Miscellaneous Control Signs		White	Black	Black	
<b>W</b> Warning	<b>Wa</b> Physical Conditions		Yellow	Black	Black	
	<b>Wb</b> Traffic Regulations Ahead		Yellow	Black	Black	Some messages contain other colours to adequately represent symbols
	<b>Wc</b> Intermittent Moving Hazards		Yellow	Black	Black	
	<b>Wc</b> Intermittent Moving Hazards		Blue	White	White	Reserved for School Area Signs
<b>Tc</b> Temporary Conditions			Orange	Black	Black	
<b>Information</b>	<b>G</b> Guide Signs		Green Blue White	White White Black	White White Black	Some signs in this group may contain minor elements of other colours
	<b>G</b> Guide Signs		Green White	White Black	White Black	
	<b>G</b> Guide Signs		Black	White	White	Some signs in this group have a brown background, or a white background with a blue message and blue border
	<b>M</b> Highway Markers		Black Green Brown	White White White	White White White	Some signs in this group may contain minor elements of other colours
	<b>M</b> Highway Markers		Black Green	White White	White White	
<b>Tab Signs</b> ALL Classes	ALL Sub Classes	 	Colours on tab signs to be the same as on primary sign			

Testing and Materials) Specification D 4956-01a (or its subsequent revisions), typically used by manufacturers of signs and sign sheeting materials. A similar specification available in Canada is the CGSB (Canadian General Standards Board) Specification 62-GP-11. Sign colours specified in the OTM are based on ASTM Specification D 4956-01a.

To ensure immediate recognition of signs, it is important that the correct shades of the colours are used. Also, signs required at night must retain the same colour by night as by day through use of retroreflective sheeting or internal or external illumination. See Section 2.9 (Reflectorization and Illumination). Signs discolour with age, due to ultraviolet radiation and deterioration of retroreflective sheeting. To alleviate this problem, regular programs for sign maintenance, inspection and inventory are recommended. This will be covered in the upcoming OTM Book 4 (Sign Maintenance).

## 2.5 Text Legends

Many of the signs in the OTM are text-based, as it is difficult to clearly convey certain complex messages using symbols. In determining the text to be used on a sign, font, letter height and the use of upper case versus mixed case letters must be considered.

### 2.5.1 Fonts

A font is a selection of type of one face, or style, including letters and numbers of unified design and given size. The font type determines the appearance of the letters, as well as the ratio of letter height to letter width, stroke width of the letter relative to letter height, the kerning or space between letters and the spacing between words.

At the time of publication, the sign fonts used in the OTM are primarily the FHWA 2001 Canadian Edition, Series C, D, E, and E(m) or E (modified) fonts prescribed by the FHWA and used by the MTO. See Figure 2.1. The Canadian edition includes French characters.

The FHWA Series C, D, and E fonts were originally developed as upper-case fonts only, while the Series E(m) font was developed for use of both upper- and lower-case characters. The letter width to letter height ratio, the stroke width to letter height ratio and the spacing between letters all generally increase as the font series progresses from C to D to E to E(m). For letters of equal height, a number of studies have shown that Series E and E(m) letters are significantly more legible than Series C or Series D letters of the same height. Series C and D fonts are typically used for regulatory signs, which are quite familiar to drivers and are often easily recognized by their shape and colour codes, while Series E and E(m) are used for directional guide signs, which have unique messages and rely for effectiveness on whether or not they can be easily read.

Figure 2.1 – Example of FHWA Fonts



Less frequently used fonts for sign text in the OTM are: Series B and F, Helvetica Medium, Helvetica Bold Condensed, Century Bold, and Century Condensed Bold.

The Clearview font was recently developed specifically for traffic signs. Because of the increased openness of Clearview characters, it takes up 12% less sign space than words in Series E(m), while providing the same amount of legibility. When Clearview font spacing is increased to 112%, the letters occupy the same sign space as the Series E(m) font. In this case, legibility is improved by 16% for drivers aged 65 and older. Some studies have suggested that daytime legibility relative to Series E(m) is not changed by using Clearview. Based on the cited advantages indicated by some studies, Clearview is currently being reviewed by several road authorities for its potential application. At this time Clearview is not part of the MTO standard and therefore is not used in the Master Sign Library.

### 2.5.2 Letter Height

In order for a sign to be effective, it must be legible at a distance which allows a driver to read it and carry out any required actions before reaching the sign. When the message is lengthy (e.g., several destination names, or complex construction information), drivers will need more time to read the entire message than for a sign with a single symbol or a word or two. In addition, if the driver must carry out some action, such as a lane change or a stop before reaching the sign, then it must be legible at a distance that allows the driver both to read it and respond before reaching the sign. One of the key factors in ensuring sign legibility at the required distance is the letter height. For details on calculating letter height which is adequate for the majority of drivers, see Section 2.7 (Calculating Letter Height and Symbol Size).

### 2.5.3 Upper and Mixed Case

While upper case letters are more legible for unfamiliar words, mixed case (upper and lower case) has better legibility for familiar words. This is because words in mixed case form a distinct shape. If the driver knows the word he or she is looking for, it will be possible to recognize the shape of the envelope created by the unique pattern of dots, letter ascenders and descenders, well before the letters can be individually resolved. Mixed case is most appropriate for guide signs because drivers generally have a particular destination in mind and are looking for that word. Mixed case will not be as legible as all upper-case where drivers do not know what message to expect, for example, advance signs for construction zones.

Signs in most of the sign classes have traditionally used upper case letters. For most signs, it is desirable from the standpoint of driver familiarity and uniformity to maintain consistency with existing sign standards. However, in the case of directional guide signs, tourist signs and street name signs, mixed case should be used to support improved word recognition. Cardinal directions on information signs (e.g., north, west) may be shown in upper case when used in a mixed case context, to draw attention to the word and to make the word function almost as a symbol. Based on long-standing practice, MTO uses mixed case for place names/destinations on guide signs, except for those on non-freeway ground-mounted signs, where all upper case is used.

### 2.5.4 Horizontal Reduction

When a sign message does not fit onto a sign blank, there may be a tendency to reduce the width of the letters until the message fits. Squeezing text alters the typeface, therefore reducing legibility, and should be avoided. On those

rare occasions when horizontal reduction cannot be avoided, the length of a word should be reduced by no more than 10% to make a message fit onto a given blank size. If the message still will not fit on the sign blank, the next lower font series may need to be used (i.e., move from Series D to Series C).

## 2.6 Symbolic Legends

Symbols can convey in a single image the same message that may require several words of text. Therefore the symbol size is generally considerably larger than individual letters, making the sign legible at greater distances (on average, double the distance) as compared to the equivalent word message. Due to the significant legibility benefits of symbol signs, their use is encouraged wherever practical.

In order to be effective, though, the meaning of the symbol must be understood by a high percentage of the driver population. It is therefore recommended that, when a new symbol is designed, it is tested with representative drivers and not simply shown to other traffic practitioners. Methods to do this are described in Section 2.13 (Process for Assessing and Revising Sign Designs). Testing, which is followed by any redesign necessary to eliminate driver confusion, should alleviate difficulties in comprehension. Where symbols are understood by fewer than 85% of drivers, educational tabs may be used to assist comprehension. Good initial design will avoid signs which are ineffective and/or which require expensive educational campaigns to inform drivers of their meaning.

For details on calculating symbol size, see Section 2.7 (Calculating Letter Height and Symbol Size).

### 2.6.1 Arrow Type and Size

Arrows are used extensively as symbols on traffic signs for the following basic purposes:

- To indicate the direction and path of travel, with the arrowhead indicating direction and the shaft indicating the path of travel;
- To indicate the direction and path of travel, but with the arrowhead pointing down rather than up (e.g., exit only ramp signs);
- To indicate the distance ahead on the road to which a sign condition refers, with the arrowhead indicating the direction of the road ahead;
- To indicate dimensions on or around the road (e.g., vertical or lateral clearance), with the arrowhead indicating the direction of the associated dimension.
- Various types of arrows and their meanings are illustrated and summarized in Table 2.2.

When an arrow with a full shaft is used, care must be taken to avoid having too short a shaft, relative to the dimensions of the arrowhead. A shaft at least double the length of the arrowhead is preferred.

Patterns for all arrows are available in the Sign Parts Library in the MSL.

### 2.6.2 Interdictory and Permissive Symbols

The convention of using interdictory and permissive symbols superimposed on other symbols is applied throughout the OTM. The interdictory symbol consists of a red annular band or circle with a diagonal red stroke. This symbol signifies that the action represented by the symbol inside the circle and covered by the diagonal red stroke is prohibited. The diagonal red stroke runs from the

Table 2.2 – Shape and Function of Arrows

Type	Shape and Orientation	Interpretation
I (a)	 <p>Horizontal with short tapered shaft</p>	<p>Shall indicate the dimension or extent of a parking restriction.</p>
I (b)	 <p>Vertical downward with short untapered shaft</p>	<p>Shall indicate the dimension under an above-road structure or shall indicate the application of an above-road sign to a traffic lane.</p>
I (c)	 <p>Vertical upward with short untapered shaft</p>	<p>Shall indicate that the sign message applies ahead.</p>
II (a)	 <p>Horizontal or angled with full untapered shaft</p>	<p>Shall indicate direction and path of travel at the location of the sign.</p>
II (b)	 <p>Vertical upward with full untapered shaft</p>	<p>Shall indicate direction and path of travel at and beyond the location of the sign.</p>
II (c)	 <p>Angled with full untapered shaft</p>	<p>Shall indicate that the sign message applies to the lane the arrow points toward.</p>
III (a)	 <p>Vertical upward with full untapered curvilinear shaft</p>	<p>Shall indicate direction and path of travel for some distance beyond the location of the sign.</p>
III (b)	 <p>Vertical downward with full untapered curvilinear shaft</p>	<p>Shall indicate a path resulting in the opposite direction of travel at the location of the sign (the U-turn).</p>

top left of the circle to the bottom right, or from the top right to the bottom left, at an angle of 45 degrees to the horizontal. If the diagonal stroke at this angle obliterates the symbol representing the prohibited action, an angle as close as practicable to 45 degrees should be used.

The permissive symbol consists of a green annular band or circle surrounding another symbol. This symbol signifies that the action represented by the symbol inside the circle is permitted. By inference, an action contrary to that represented by the symbol inside the circle may be prohibited.

For some applications, such as turn control signs, it is strongly recommended that the interdictory symbol be used rather than the permissive symbol. The interdictory symbol is preferred for both comprehension and enforceability, since it more directly indicates the action prohibited. With the permissive symbol, the driver must go through an additional step to interpret that actions contrary to the permitted one(s) are prohibited. For example, it is not necessarily clear to all drivers that a permissive turn control sign indicating that right turns and straight through movements are permitted means that left turns are not allowed. Also, permissive regulatory signs for moving traffic may be more difficult to enforce than interdictory regulatory signs.

Permissive signs, however, do have a practical role in the OTM. In some cases it is awkward to express a message using an interdictory sign where a permissive sign is straightforward, for example, signs indicating permitted parking durations. The permissive sign also is used to indicate that an upstream prohibition indicated by an interdictory sign, such as a no passing restriction, is no longer in effect. There are still other applications, such as signing for heavy truck routes, in which the permissive and prohibitive systems can work together. In this case, the permissive signs are typically used to indicate a continuous route

preferred for heavy truck use, supplemented by prohibitive signs installed where there is a demonstrated problem with trucks using a non-designated route

### 2.6.3 Logo Design

With the new tourist signing system, numerous logos are being used on traffic signs. In some cases these logos were developed for letterheads and are intended to be viewed at arm's length. Such logos are not easily recognized on highway signs where they are seen at 100 m or more for a second or two. For easy recognition, logos should be:

- Simple in design – small details will not be resolvable at distances at which highway signs are read;
- Simple in colour – use of colour should be restricted so that the different coloured areas can be resolved at a distance – 3 or fewer colours are preferable;
- Evaluated at the distance at which drivers will have to read them – a design which is attractive when viewed at arm's length, may be cluttered and difficult to resolve at long distances when seen briefly.

## 2.7 Calculating Letter Height and Symbol Size

A number of factors must be considered to ensure that signs are legible at an appropriate distance. The following steps should be used to determine the minimum letter height on a text sign, or the symbol size on a symbol sign, to accommodate the majority of the driving population:

- (1) **Reading Time** – Calculate the time required to read a sign with a given message.
- (2) **Decision Time** – Determine the time required to make a decision and initiate a manoeuvre, (if one is required).
- (3) **Manoeuvre Time** – Determine the time to complete any required manoeuvre before reaching the sign.
- (4) **Required Legibility Distance** – Determine the distance at which the sign must be legible, based on the travel speed (usually the speed limit) and the sum of the times obtained in Steps 1, 2 and 3 above.
- (5) **Minimum Letter Height** – Calculate minimum acceptable letter height using set ratios for legibility distance-to-letter-height, specific to the font used.
- (6) **Symbol Legibility** – Calculate symbol size based on legibility distance and the width of the critical detail in the symbol.

This process, while based on reasonable driver requirements, tends to be conservative, since it does not fully account for redundant information. For example, the presence of advance guide signs will likely reduce the time required to recognize and read a sign at a freeway exit.

As is noted in Section 2.13, this process was not used to arrive at many current sign designs. Because most regulatory signs and warning signs contain few words or symbols, and are for the most part very familiar to drivers, and because relatively few signs require that a manoeuvre be completed before the sign is reached, it is likely that future analysis will show that most current signs meet driver needs. The signs which are of real concern in terms of letter height are those with long messages, with information that is new to the driver, or which

must be read in their entirety. These signs include some guide signs, tourism signs, advance construction notification signs and left turn restriction signs.

Tourism signs have been developed using a process which considered driver requirements, and the standards developed and described in Book 9 (Tourism and Commercial Signs, not yet developed) will be based on this process. However, guide signs and information signs are continually being developed to suit the requirements of specific locations. The method outlined in this section should be used to determine appropriate letter heights for these signs. The reading times given do not apply to variable message signs. These are discussed in Book 10 (Dynamic Message Signs).

### 2.7.1 Reading Time

Reading time should be considered to be on the order of 1/2 second per word or number (with 3 seconds as a minimum for total reading time, if no decision or manoeuvre is required), and 1 second per symbol. If some of the sign information is redundant, then **reading time should be calculated for the critical words only.**

For example, when drivers read destination signs, they do not need to read every word of each destination. If they are looking for Avenue Road, they do not need to read both “Avenue” and “Road”, since the road is assumed. Similarly, if they are looking for Avenue Road, they only need read the “Yonge” of “Yonge Street” to realize that this is not the destination they are looking for and they can go quickly to the next line in the sign.

Furthermore, if drivers are reading a list of destination names, they only need to read the arrow direction for the place name they are searching for.

**Reading Time [secs]**

= 1 \* (no. of symbols)

+ 0.5 \* (no. of words and numbers)

**Notes:**

- (1) The time of 1/2 second per major word is an approximation. If the sign is confusing to drivers, or does not contain the information that the driver is expecting or looking for, then reading time will be longer. In fact, a sign with more information can be read more quickly than one with less information, if the former sign contains the information that the driver is looking for and the latter sign does not. Where there is any potential for confusion, signs should be tested to ensure the sign design is optimal. Differences in reading time between a good and a poor sign can be several seconds. And it is not only legibility that is affected. In general, the longer it takes to read a highway sign, the more errors there will be in responding to it.
- (2) Minimum reading time should be considered to be 3 seconds, where no decision or manoeuvre is required. Signs legible for less than this time are too easily missed simply because a driver may have to glance elsewhere, or the sign may be blocked from view by other traffic in the short period of time available. Where a decision or manoeuvre is required, the minimum reading time plus decision time should be considered to be 3 seconds.
- (3) If there are more than 4 words on a sign, a driver must glance at it more than once, and look back to the road and at the sign again. This glance away and back takes

approximately 3/4 second. For every additional 4 words and numbers, or every 2 symbols, an additional 3/4 second should be added to the reading time.

- (4) When the sign is very close, it is seen on an angle, and becomes difficult to read. It is assumed that the sign is not read for the last 1/2 second. This is called the "out-of-view time." Therefore, 1/2 second is added to the required reading time. The only exception to this is signs requiring a manoeuvre before the sign is reached, as they would not be read at this close distance.

**2.7.2 Decision Time**

Once a driver has detected and then read the sign, he or she is in an alerted state, ready to make a decision and initiate a manoeuvre. The time required to do this is the decision time. Many signs are for information only and do not require any response. Decision time can be considered to be zero in these cases.

Most signs that do require a decision, require a straightforward one, e.g., stop, or reduce speed. For these signs, given that drivers are in an alerted state and the choice about what to do is very limited, decision time can be considered to be 1 second. If the driver is presented with several choices about what to do, or if the decision is complex because of the roadway layout, then longer decision times will occur. In such situations, up to 2.5 seconds may be required.

**2.7.3 Manoeuvre Time**

The requirement to complete a manoeuvre, and the type of manoeuvre required can add significantly to the total time required for a driver to read and respond to a traffic sign, and consequently to the

distance at which a sign must be legible. For example, where there is no advance sign, and a road name sign is placed at an intersection, considerable legibility distance is required. The distance must be sufficient to allow drivers to read the name, and in response, to change lanes, and to slow down prior to turning. Therefore it must be recognized at a greater distance than an advance road name sign, which simply alerts the driver to an intersection ahead, but does not require a driver to complete any actions before reaching the sign.

There are two main types of manoeuvres: lane changes and speed reductions, including those resulting in a total stop.

For lane changes, manoeuvre time is a sum of the time required to search for a gap in traffic and the time to actually perform the lane change. Gap search time increases as traffic volume increases, since it is more difficult to find suitable gaps in traffic. Lane change manoeuvre time is calculated for passenger vehicles using Table 2.3.

For speed reductions, a constant deceleration rate of 8.8 km/(h\*sec) is assumed, described as a reasonably comfortable braking rate, in the Transportation and Traffic Engineering Handbook. Therefore, the manoeuvre time can be calculated as follows:

**Manoeuvre Time (for speed reduction) [secs]**

$$\frac{V^2}{2 \times 8.8 \times 1000} + 0.5$$

If the speed reduction results in a stop, as required for a STOP sign, the final speed is zero, and the above equation is simplified to the following:

**Manoeuvre Time (for stopping) [secs]**

$$\frac{V}{8.8} + 0.5$$

**2.7.4 Required Legibility Distance**

The required legibility distance is calculated as follows:

If **neither** a manoeuvre **nor** a decision is required,

**Total Time Required [secs]**  
 = Reading Time + Out-of-View Time  
 = Reading Time + 0.5 secs (min. 3.5 seconds)

If a manoeuvre **is** required,

**Total Time Required [secs]**  
 = Reading Time + Decision Time + Manoeuvre Time

**Legibility Distance [metres]**  
 = Total Time Required [secs]  
 \* Travel Speed [km/h] \* 0.28 [(m/sec)/(km/h)]

**Table 2.3 – Lane Change Manoeuvre Time**

Traffic Volume	Gap Search Time [secs]	Lane Change Time [secs]	Total Manoeuvre Time [secs]
Low	3.5	4.5	8.0
High	5.3	4.5	9.8

### 2.7.5 Minimum Letter Height

Table 2.4 shows the legibility-distance-to-letter-height ratio according to font. Note that the ratio is higher for Series E(m) font than for the narrower Series C and D fonts that have poorer legibility. The higher ratio for Series E(m) font means that, for a given letter height, this font is legible from a greater distance than are Series C and D fonts. Clearview has the same legibility-distance-to-letter-height ratio as the Series E(m) font (but takes up 12% less horizontal space).

Minimum letter height is calculated as follows:

#### Minimum Letter Height [mm]

$$= \frac{\text{Legibility Distance to Letter-Height Ratio [m/mm]}}{\text{Minimum Letter Height [mm]}}$$

### 2.7.6 Symbol Legibility

The most legible symbols are those with bold strokes and simple, distinctive shapes (e.g., T-intersection, Y-intersection, Cross Road). The least legible symbols have small details that must be seen (e.g., Pavement Ends, No Trucks). The best symbol signs are legible at as much as 3 times the distance of the least legible (approximately 300 m versus 100 m average legibility for typical warning and regulatory symbol signs and a sample of

young, middle-aged, and elderly drivers). Because the legibility of symbols depends on the complexity of the design, as well as on the smallest critical detail that must be resolved, it is difficult to predict what the legibility will be without testing. It should be noted that there is an interaction between legibility and comprehension. Symbols that are poorly understood will be less legible than symbols with similar designs, in terms of size of detail and complexity, that are better understood.

### 2.7.7 Example

Consider a destination sign with two names and two arrows, placed 30 m from the intersection on a two-lane highway, where there is no advance signing (see Figure 2.2). This is a situation that can occur on secondary highways, but not on primary highways where advance signing is used. The driver potentially must slow from 80 to 40 km/h in order to turn at the intersection. Therefore the driver must be able to read at least two words and one arrow direction to make a decision. The driver must then begin to brake, and slow down to 40 km/h before reaching the intersection.

$$\begin{aligned} \text{Reading Time} &= T_r \\ &= (1 \text{ sec/symbol}) * (1 \text{ symbol}) \\ &+ (0.5 \text{ secs/word}) * (2 \text{ words}) \\ &= 2 \text{ secs} \end{aligned}$$

$$\begin{aligned} \text{Decision Time} &= T_d \\ &= 1 \text{ sec} \end{aligned}$$

$$\begin{aligned} \text{Reading Time + Decision Time} \\ &= 3 \text{ seconds (= minimum 3 seconds)} \end{aligned}$$

$$\text{Manoeuvre Time (for speed reduction)} = T_m$$

$$\begin{aligned} &= \frac{\text{Distance to Intersection [m]}}{\text{Speed [km/h]}} \\ &= \frac{30 - 40 \text{ km/h}}{80 - 40 \text{ km/h}} \end{aligned}$$

**Table 2.4**  
**Legibility-Distance-to-Letter-Height Ratios**

Font	Legibility-Distance-to-Letter-Height Ratio [m/mm]
Series C	0.42
Series D	0.42
Series E	0.48
Series E(m)	0.48
Clearview	0.48

Figure 2.2 – Example Sign



$$\begin{aligned} \text{Total Time Required [secs]} &= T_{\text{total}} \\ &= T_r + T_d + T_m \\ &= 2 + 1 + 4.5 \\ &= 7.5 \text{ secs} \end{aligned}$$

$$\text{Travel Speed [km/h]} = V_o$$

$$\begin{aligned} &= \frac{V_i + V_{\text{avg}}}{2} \\ &= \frac{60 + 70}{2} \\ &= 65 \text{ km/h} \end{aligned}$$

(where  $V_i$  = initial speed and  $V_{\text{avg}}$  = average speed)

$$\begin{aligned} \text{Required Legibility Distance [m]} &= D_{lr} \\ &= T_{\text{total}} [\text{secs}] * V_o [\text{km/h}] * 0.28 \text{ [(m/sec)/(km/h)]} \\ &= 7.5 \text{ secs} * 68 \text{ km/h} * 0.28 \text{ [(m/sec)/(km/h)]} \\ &= 143 \text{ m} \end{aligned}$$

(where 0.28 is the conversion factor from km/h to m/sec)

Since the sign is 30 m from the turning point, the speed reduction can continue for 30 m after the sign is passed. Therefore, required legibility distance can be reduced by 30 m to 113 m.

### Minimum Letter Height [mm]

$$\begin{aligned} &= \frac{D_{lr} [\text{m}]}{1000} \\ &= \frac{113 \text{ m}}{1000} \\ &= 0.113 \text{ m} \\ &= 113 \text{ mm} \end{aligned}$$

The calculations for letter height are based on values intended to ensure that the majority of drivers will have ample time to read signs and carry out manoeuvres. Sign blanks come in standard sizes and the maximum letter heights possible given the sign blank size may not allow the calculated letter height. To allow some flexibility for practical reasons, it is recommended that the actual letter height used be no smaller than 90% of the calculated value.

## 2.8 Sign Design Elements and Arrangement

Following on the development of some general guidelines for the design of sign text and symbols, this section considers how these elements are arranged on the sign face. Aspects of design to consider include the length of the message on a sign, the distribution of the legend on the sign, interline spacing and border space.

### 2.8.1 Message Length

For the purposes of reduced reading time and increased legibility, it is important to minimize the message length, **provided that the message does not become ambiguous**. A sign with a longer message will have to be legible from further back, and will therefore need to have larger text and a larger overall size, than a sign with a shorter message in the same environment and requiring the same driver response.

Message length will determine letter height, and therefore sign size. The method described in Section 2.7 (Calculating Letter Height and Symbol Size), which considers driver visual capabilities, reading time, decision time and manoeuvre time, should be used to calculate letter height.

### 2.8.2 Interline Spacing

Interline spacing is the vertical distance between lines of text. Sufficient interline spacing must exist on sign text so that the lines of text are legible from a distance. The general guideline is to provide a space of 0.5 to 1.0 times the maximum letter height between each pair of lines. Section 2.14 contains recommended rules for sign interline spacing.

For signs using mixed case text, the impacts on legibility and overall aesthetic effect caused by interacting ascenders and descenders (e.g., the vertical stroke of the letter 'b' and the vertical stroke of the letter 'p') need to be taken into account. If ascender/descender interference results with standard interline spacing, the space between the lines should be slightly increased and the legend centred vertically on the sign blank.

### 2.8.3 Border Space

Sign borders delineate the sign against its background environment, help direct driver attention to the message and can differentiate messages within groups of signs. Three kinds of borders are used on signs in the OTM:

- (1) **Inner Border:** a continuous narrow strip the same colour as the legend, just inside the edge of the sign. This type of border improves the appearance of the sign. The width of the inner border should be approximately 1.5% to 3% of the smallest outer dimension of the sign. For a 600 mm x 600 mm sign, this translates to about 10 to 15 mm.
- (2) **Outer Border:** a continuous narrow frame the same colour as the sign background, at the very edge of the sign. The outer border emphasizes the inner border by providing contrasting colour on both sides of the inner border. The outer border is used only on signs with light backgrounds and dark legends. The width of the outer border should be approximately 1.5% of the smallest outer dimension of the sign. For a 600 mm x 600 mm sign, this translates to about 10 mm.
- (3) **Background Space Around Legend:** empty background space between the legend and the inner border. This space is required so that the legend is clearly distinguishable from a border of the same colour.

On regulatory, warning and temporary conditions signs, the minimum clearance between the legend and inner border should be approximately 4% to 10% of the smallest outer dimension of the sign. For a 600 mm x 600 mm sign, this translates to about 25 to 60 mm.

On directional guide signs and other information signs, the minimum side clearance between the legend and the inside of the border should be equal to the height of the largest letter. The minimum vertical clearance between the legend and the top or bottom of the sign should be 0.67 to 1.0 times the largest letter height.

Section 2.14 contains recommended rules for sign design, including detailed rules for border size and cornering.

## 2.9 Reflectorization and Illumination

Signs that convey messages of warning, important regulations or essential directional information that are relevant during the hours of darkness need to be legible and conspicuous at night, as well as during the day. Since conspicuity depends to some degree on colour code recognition, the colour of the sign must appear the same by night as by day. The engineering tools used for maintaining a reasonable level of sign legibility and conspicuity at night are reflectorization and illumination.

### 2.9.1 Retroreflective Sheeting

Most signs are assembled by applying thin adhesive sheeting materials in the background and legend colours to a rigid sign blank. Some types of sheeting contain tiny glass beads or prisms that refract the light so most of it is reflected straight back to the source, which is a vehicle with headlights. Therefore, the light from the headlights is very efficiently used, with a significant amount of it reflected back towards the driver's eyes. Material having this property is known as retroreflective sheeting.

There are different types of retroreflective sheeting, ranging from Type I (Engineering Grade) to Type IX. Types of retroreflective sheeting are discussed in more detail in Section 3 (Sign Materials). In general, the higher the type number, the greater the amount of light reflected back to the driver's eyes, though this does not necessarily apply for Types VII, VIII and IX. Each type of retroreflective sheeting is characterized by a range of R-values. R is known as the coefficient of retroreflectivity and indicates the proportion of light reflected back to the driver. The units for R are candelas per lux per square metre ( $\text{cd}/(\text{lux}\cdot\text{m}^2)$ ). For a given type of retroreflective sheeting, the R-values vary according to colour, with darker colours having generally lower R-values.

R-values associated with each type of retroreflective sheeting are detailed in the ASTM Specification D 4956-01a (or its subsequent revisions), and this is the standard used in the OTM. In Canada, the CGSB Specification 62-GP-11 (or its subsequent revisions) also specifies retroreflective sheeting for some grades of sheeting. Specifications for retroreflective sheeting, including ASTM R-values for commonly used types of sheeting, are further discussed in Section 3 (Sign Materials).

### 2.9.2 Illumination

As an alternative or supplement to retroreflective sheeting, external or internal illumination of the sign may be used. As with retroreflective sheeting, all sign illumination must result in sign colours appearing the same by night as by day. Illumination may be by one of the following means:

- (1) A light behind a translucent sign face, illuminating the legend and/or background;

- (2) An attached or independently mounted light source designed to direct essentially uniform illumination over the entire sign face;
- (3) Luminous tubing shaped to the legend or symbol.

Ordinary street or highway lighting does not meet the requirements for sign illumination.

## 2.10 Contrast

Contrast refers to differences in colour or in brightness which allow a target, such as a sign message or symbol, to be seen against the sign background. Contrast is dependent on a property called reflectance, which represents the amount of light reflected back from a sign, relative to the amount of light shining on the sign. Contrast is defined in various ways. Contrast can be calculated according to the following formula:

$$\text{Contrast} = \frac{R_L - R_B}{R_B}$$

$$\text{Contrast Ratio} = \frac{R_L}{R_B}$$

Where:  $R_L$  is Reflectance of Legend; and  
 $R_B$  is Reflectance of Background

Contrast affects legibility. Where there is a low level of contrast (e.g., orange letters on a light blue background) legibility will be poorer than with higher contrast (e.g., black letters on a white background). Table 2.5 shows acceptable and recommended combinations for sign colours used in the Ontario Traffic Manual, based on contrast.

During the day, contrast is determined by the degree to which various colours reflect light. At night, light is provided by streetlights and headlights. Even with these light sources there is insufficient light reflected from a non-retroreflective sign to allow it to be read. In order to raise the level of light reflected back to the observer, retroreflective sheeting is used. See Section 2.9 (Reflectorization and Illumination). For a sign with retroreflective sheeting, reflectance at night is measured by the R-values of the materials used for the sign legend and background.

### 2.10.1 Positive Contrast Signs

For positive contrast signs (e.g., white legends on green or blue or red backgrounds), brightness contrast at night has a major impact on legibility. Laboratory studies have shown that:

- Legibility falls off rapidly for contrast ratios below about 4:1;
- Best legibility is found for contrast ratios in the region of 10:1 to 15:1;
- Beyond contrast ratios of 15:1, legibility very gradually decreases, but even at 100:1 it is still greater than at 4:1.

For this reason, sheeting combinations whose relative R-values (see Table 3.2 in Section 3) produce contrast ratios below a value of 4:1 or above a value of 100:1 are not recommended. At the upper end, laboratory studies have shown that night legibility is significantly reduced for Type VII legends on a Type I (Engineering Grade) background. Thus this combination is not recommended.

Some signs, such as STOP signs, are fabricated by screening coloured transparent ink onto white sheeting. When new, ink tends to have a lower R-value for a given colour than its equivalent level of

Table 2.5 – Acceptable Sign Colour Combinations Based on Brightness Contrast

Background Colour	Legend Colour											
	Red	Black	White	Orange	Yellow	Brown	Green	Blue	Purple	Light Blue	Coral	Brilliant Yellow-Green
Red												
Black												
White										D		D
Orange												
Yellow												
Brown												
Green												
Blue												
Purple							D	D				
Light Blue				D								
Coral												
Brilliant Yellow-Green				D								

Legend  Acceptable for day or night  
 Not recommended  
 D Acceptable only for day application or night with external illumination

sheeting, resulting in higher contrast ratios with the white sheeting. However, the ink fades more quickly than sheeting, and with time, contrast ratios fall below those for the same types of signs surfaced entirely with sheeting. For best results, it is recommended that components of screened signs (e.g., sheeting, ink, clear coating) be provided from the same manufacturer to ensure compatibility of the components.

### 2.10.2 Negative Contrast Signs

For negative contrast signs with black legends on white or orange backgrounds, the retroreflectance of the black sheeting is zero, and a contrast ratio cannot be calculated. (For other negative contrast signs, such as blue legends on white background, a contrast ratio can be calculated.) For such signs, nighttime legibility depends on sign luminance.

Studies show that with Series C letters, there is little impact of sheeting on legibility – legibility is as good with Type I as with Type IV sheeting. With Series D letters, Type III and IV sheeting increase legibility over that of Type I and II by about one-third. Signs with black backgrounds should generally be avoided, given the lack of reflectance of the majority of sign area and the resulting low illumination of the sign.

## 2.11 Selecting the Sign Size

Books 5, 6, 7, 8 and 9 of the OTM show sign designs and minimum sizes of signs, typically as related to type and speed of roads. Most signs currently in use are considered to meet the needs of the majority of drivers, based on experience in Ontario and elsewhere. However, these signs have not all been systematically analyzed in accordance with the sign design principles described herein. This is proposed to be done over a period of time, through the process outlined in Section 2.13. Over a period of time, revisions and refinements to the OTM will be made on a continuing basis. At any given time, the OTM Books and the minimum sign sizes shown therein represent best guidance and practice based on current knowledge at the time.

In some situations, it may be desirable to increase the sign size over those shown in the OTM. Much of the information discussed in the above sections (especially Section 2.7), including font, letter size, symbol size and sign layout with appropriate spacing and borders, can be used to determine whether increased sign size should be used. The standard sign size can then be adjusted to fit the next larger standard sign blank size available (See Table 5.1, Standard Sign Blanks, in Section 5). For most large guide signs, both overhead and ground-mounted, a height dimension is specified and the width dimension is dependent on the message length. When the size of this type of sign is

increased beyond 3.6 m (12 feet), the width of the sign is increased in even 600 mm (2 foot) increments, with the exception of the 4.57 m (15 foot) sign width.

Some of these situations where larger sign size may be desirable, include the following:

- If there are factors that impact the amount of time a driver can devote to reading the sign, such as a complex and distracting background environment, heavy traffic volumes and a high density of intersections and driveways requiring complex choices, consideration should be given to moving up to the next larger blank size, to increase the distance at which the sign is legible.
- Similarly, in areas where high collision rates or high conflict rates are attributable to drivers failing to notice the sign, consideration should be given to increasing the sign size.
- If there is a known challenged driver population in a given area, such as in the vicinity of a senior citizens' centre, consideration should be given to moving up to the next larger sign blank size.

If the required sign size is prohibitively large and if attempts to redesign the sign have not succeeded in the short term, consideration should be given to using a higher intensity sheeting to improve nighttime legibility. For example, increasing the intensity of sheeting from Type II to Type IX for both legend and background has the equivalent impact of increasing night legibility distance by 15 to 30 m, or increasing the letter height by 25 to 50 mm for nighttime conditions only.

It may not be economically feasible to install all new signs and to replace all damaged and aged signs with the sizes required to accommodate 85% of the driving population. In this case, priority should be given to signs that are higher on the sign hierarchy (see Book 1).

In some situations, however, there are constraints on maximum sign size. In city centres, locations for installing guide signs are limited due to competition from other signs, limited boulevard space, pole structural limitations, and the like. The surface area of overhead signs mounted on freeway truss supports is limited to 42 square metres (450 square feet), with a maximum height of 2.75 m (9 feet), due to wind loading forces. Under some circumstances, available horizontal space is the controlling factor. A sign mounted over a roadway lane may have to be limited in horizontal dimension to the width of the lane, so that another sign may be placed over an adjacent lane. For ground-mounted signs, specific sign structures (i.e., vertical supports and cross-arms) are designed to accommodate specific sizes of signs. For larger signs, a stronger structure must be used.

## 2.12 Bilingual Sign Design

Signs with text in both English and French may be installed in designated areas, conforming with municipal and provincial policies (see Book 1, Section 8 for information on bilingual signing policy). Bilingual messages can be presented either on the same sign or on separate signs. If both languages are shown on one sign, one of two options must be used:

- English text on the left side and French text on the right side; or
- English text on the upper portion of the sign with French text below.

If a pair of signs is used instead, the English text must be presented first and its French text equivalent must be located beyond it. The signs should be placed far enough apart so that both are legible, but close enough so that their individual

messages can be recognized as being equivalent. For longer texts, the two-sign approach is preferred, to avoid overloading the driver with what may appear as a lengthy message.

Bilingual signs must conform to established sign design principles for application, location, position, colour, shape and size. They must employ the same symbols, arrows and borders, and where possible must maintain the same fonts and equivalent letter heights as their corresponding English-only versions. Sign patterns for bilingual signs are shown in the Master Sign Library. See also Sections 2.14 (Sign Design Rules) and 2.15 (Sign Design Process).

## 2.13 Process for Assessing and Revising Sign Designs

A cursory analysis would suggest that most signs currently in use probably do meet the needs of the majority of drivers, despite the fact that they were designed in the absence of explicit knowledge of driver needs. However, a systematic analysis is required because there are signs which appear to be inadequate. Given the aging of the driver population and the increasing complexity of the road network, it is important that such signs be considered for redesign. In addition, such an analysis is needed to ensure that sign sizes designated for various road types and speed zones are appropriate.

Due to the time required to complete an analysis of this depth, it is not possible to incorporate the analysis results for the sign designs of the first few OTM Books to be released. A process has been started, however, which will eventually lead to the update of sign designs as required throughout the entire Ontario Traffic Manual (see Book 1, Sections 2.5 and 5.12). The process involves the following steps:

- (1) On an interim basis, for each edition of the Ontario Traffic Manual, use the current versions of the regulatory, warning, temporary conditions, and guide signs included in the OTM Books, specifying different minimum sizes of signs for different speed ranges, according to rule of thumb and commonly used sign blank sizes. Increases above these minimum sizes may become desirable when other factors and sign design principles are taken into account.
- (2) On a longer-term basis, adopt a procedure for sign review and revision, involving the Ontario traffic engineering community, through the Ontario Traffic Manual Committee (OTMC) and its subcommittees. This procedure is envisaged as follows:
  - (a) **Existing Signs** – Identify those signs which appear most problematic, and subject them to systematic analysis of driver requirements, to determine the appropriate letter height. Develop and test for comprehension alternative sign designs for any signs that are found to be deficient, or that appear to require significant increases in sign size. Discuss alternatives at the OTMC and approve the approach preferred by the OTMC, which would be incorporated in the next edition of the relevant Book of the OTM. Over time, all existing signs should be reviewed in this manner.
  - (b) **New Signs** – Any new sign designs (all categories) should be developed on the basis of current knowledge of driver needs, as discussed in Section 2.3. If the resulting sign designs are very large or are substantially larger in size than existing signs, raising questions as to feasibility, this may require an alternative sign design or an alternative signing approach.

### 2.13.1 Comprehension Testing

When signs are developed, they are frequently tested in a number of ways. Generally they are shown to a committee, usually of traffic engineers or related professionals, who comment on the adequacy of the design. Several alternative designs may be shown to focus groups to determine driver preference. They may then be mounted at a test location, and any public feedback about them is recorded before a final design emerges. **However, none of these methods ensures that a sign will be adequately legible for unfamiliar drivers,** or that it will be comprehended by the majority of drivers. Traffic engineers have a much greater familiarity with traffic engineering terms, and messages such as “limited sight distance” which may be very meaningful to them, turn out to be poorly understood by the general public. Focus groups reveal preference, which may have to do with attractiveness of a design, but not necessarily with the ability of individual drivers to comprehend a sign, particularly when it is viewed very briefly as the driver passes by.

To ensure adequate legibility, the procedure for determining letter height described in Section 2.7 should be followed. To ensure that the majority of drivers understand the sign it should be tested with a representative sample of drivers – on the order of 200, with varying age, education and language backgrounds. Such studies were carried out to ensure the bilingual freeway signs, installed in 1993, would be comprehended by the majority of drivers.

If a sign must be produced quickly, there may be insufficient time for a systematic test. In this case, there are some simple steps that will assist engineers to develop a sign likely to be understood by the general public. The sign, or signs if there are alternative designs, must be shown to a sample of the general public. Office employees who are familiar with engineering language, even though

they are not themselves engineers, are not ideal candidates because of their “inside knowledge”. A minimum sample would be 24 drivers, and this sample should include approximately one third under age 25, one third aged 26 to 55, and one third over 55 years. Less experienced rather than more experienced drivers are preferable. When there are several alternatives of one sign to be tested, it is preferable that each driver be tested with only one version of the sign, and at least 24 drivers be tested for each version.

Sample signs should be drawn up. Each sign should be placed in a background typical of the context in which it will be seen, e.g., on a freeway, at an urban intersection. Drivers should see the sign for a few seconds only – this is generally the length of time they have to figure out a sign on the roadway. Drivers should then be asked simply what the sign means and their answer recorded. This technique is preferable to using a multiple choice approach, because it will reveal potential confusion. For example, the SLIPPERY WHEN WET sign is interpreted by some drivers as WINDING ROAD AHEAD. Where fewer than 80% (20/25) of drivers tested understand the sign, redesign is required. The drivers’ wrong answers will assist in determining what aspects of the design need to be changed.

Where comprehension is poor, and redesign is required, it is often the case that only small changes need be made. For example, the comprehension of the SLIPPERY WHEN WET sign was greatly improved by merely adding drops symbolizing falling rain.

The purpose of signs is to convey information to drivers. Signs which are poorly comprehended are ineffective. While education campaigns can assist in helping drivers understand a new sign, such campaigns are costly, and must be repeated to reach drivers new to the road or new to the area. It

is far more preferable to use a method of sign development and testing that helps ensure that the majority of drivers comprehend the sign without education being required.

## 2.14 Sign Design Rules

Sections 2.1 to 2.13 addressed general sign design principles. This section addresses recommended rules for detailed sign design (based upon design principles outlined above, translated into specific rules). The sign design process is described in Section 2.15, for various kinds of signs.

The recommended rules for sign design included in this section have been developed over many years, by sign designers at MTO and other road authorities. Some of these rules have been extracted from the King’s Highway Guide Signing Policy Manual (KHGSPM). These rules were reviewed, and have been updated and expanded for the purposes of Book 2.

There are many sign design and placement considerations/factors, but not all of them directly affect the detailed sign design (spatial arrangement of the various sign elements on the face of the sign). Table 2.6 lists the factors affecting detailed sign design.

### 2.14.1 Standard Signs

For standard signs, there are existing sign designs in the MSL, which prescribe the sign design elements listed above. No further design of standard signs is necessary, although it will sometimes be necessary to choose numbers or letters that apply to the situation at hand, such as speed limits or parking time limits (day of week; hours of day).

**Table 2.6 – Factors Affecting Detailed Sign Design**

<b>Factors <i>Directly</i> Affecting Detailed Sign Design</b>	<b>Comments</b>
Sign size	
Sign shape	Defined by sign type (see Table 2.1)
Colour	Defined by sign specification and type
Length of message(s)	
Font type and size	
Upper/lower case letters, or all upper case	
Character spacing (kerning)	
Interline spacing	
Border space	
Maximum number of words	
Maximum number of lines	
Legend chunking	Logical sets of words
Symbols (type and size)	
Arrow type and size	
Mounting (side/overhead)	
Freeway or non-freeway	
<b>Factors <i>Indirectly</i> Affecting Detailed Sign Design</b>	<b>Comments</b>
Background material (retroreflectivity)	Affects legibility at night, and hence may affect sign size; defined by sign specification
Legend material (retroreflectivity)	Affects legibility at night, and hence may affect sign size; defined by sign specification
Contrast	Defined by background and legend materials; optimum range 4:1 to 15:1; may be up to 100:1
Illumination	Affects legibility at night, and hence may affect sign size
Horizontal mounting offset; Vertical mounting offset	Affects legibility and hence affects sign size and font size
Horizontal angle; Vertical angle	Affects legibility and hence affects sign size and font size

### 2.14.2 Customized Standard Signs

For customized standard signs (e.g., guide signs being the most common example), the rules for sign design need to be applied by the sign designer.

This section has primary application to directional guide signs, logo service signs, and Tourism Oriented Directional Signing (TODS).

Of all the sign types in the OTM, the design of directional guide signs is the most loosely and flexibly defined. As described in Section 2.2 (Approaches to Sign Design), directional guide signs are customized standard signs. They require a design effort which is intermediate between standard signs with fixed patterns and purpose-designed non-standard signs with no available patterns or template. While there are defined types of directional guide signs, and templates and examples for each type, the number of variables is large and the actual design is dependent on the specific situation. Hence, the examples shown on the directional guide sign pattern templates will almost never be built as shown, but will have to be adapted for the situation at hand. One of the main advantages of the sign pattern templates for directional guide signs is that they show the general appearance of the sign, along with the letter and numeral heights, and specific crowns, markers, symbols, and arrows to be used. To provide more assistance to the practitioner, recommended rules for directional guide sign design are included in this section.

#### *Style of Lettering and Legend Spacing*

- Message dimensions are to be determined first and outside dimensions second. Numeral and letter sizes for principal types of ground-mounted and overhead signs are shown in the Master Sign Library sign pattern templates for Directional Guide Signs. Prescribed numeral and letter sizes

for freeway guide signs appear in Table 2.7. Prescribed numeral and letter sizes for non-freeway guide signs appear in Table 2.8. Where no suitable examples and sign pattern templates are shown in the MSL, numeral and letter sizes can also be developed from first principles using the method outlined in Section 2.7 (Calculating Letter Height and Symbol Size).

- The numeral and letter sizes shown in Tables 2.7 and 2.8 were originally developed for highway speeds (100 km/h for freeways, up to 90 km/h for non-freeways). Sign sizes derived from such values may be larger than necessary for lower speed urban roads (60 km/h or lower). As described in Section 2.7 (Calculating Letter Height and Symbol Size), the numeral and letter sizes required are directly proportional to speed. Table 2.8 shows the numeral and letter sizes required for each of two posted speed ranges, 70 to 90 km/h, and 60 km/h or lower. The sizes for the 60 km/h or lower speed range in Table 2.8 were taken as approximately 75% of those shown for the 70 to 90 km/h range. If desired, the larger sizes may be used for all speed ranges, but for lower speed urban roads (where space for sign placement may be a constraint, for example), the smaller letter sizes may be used.
- Kerning (the horizontal spacing between characters in a text message, which varies in accordance with the characters on either side of the space) was previously developed manually with the use of tables, but is now spaced automatically in the sign design program.
- Names of places/destinations, streets, and highways on freeway guide signs (both overhead and ground-mounted) and on non-freeway overhead guide signs are to be composed of lower-case letters with initial upper-case letters. This also applies to non-freeway ground-mounted guide signs, except that destination names are all upper-case letters.

Table 2.7 – Letter Sizes for Freeway Directional Guide Signs

Mounting	Letter Size				
	Place Name/ Destination (Upper/Lower Case)	Road/Street Name (Upper/Lower Case)	Cardinal Direction (Upper Case)	Distances	
				1	km (Lower Case)
<b>Overhead</b>	410 mm (16")	410 mm (16")	380 mm (15")	410 mm (16")	300 mm (12")
<b>Ground-mounted</b>	340 mm (13.33")	410 mm (16")	300 mm (12")	340 mm (13.33")	250 mm (10")

Table 2.8 – Letter Sizes for Non-freeway Directional Guide Signs\*

Mounting	Letter Size				
	Place Name/ Destination Overhead: (Upper/Lower Case) Ground-mounted: (Upper Case)	Road/Street Name (Upper/Lower Case)	Cardinal Direction (Upper Case)	Distances	
				1	km (Lower Case)
<b>Overhead</b>	340 mm (13.33") UC/LC	340 mm (13.33") UC/LC (200 mm (8") for street names on signal mast arms)	250 mm (10")	340 mm (13.33")	250 mm (10")
<b>Ground-mounted</b> (Posted speed 70-90 km/h)	Major municipality: 200 mm (8") UC Minor municipality: 150 mm (6") UC, or as shown on SPT	200 mm (8") UC/LC or as shown on SPT	200 mm (8") or as shown on SPT	150 mm (6")	115 mm (4.5") or as shown on SPT
<b>Ground-mounted</b> (Posted speed 60 km/h or lower)	Major municipality or place name: 150 mm (6") UC Minor municipality or place name: 115 mm (4.5") UC, or as shown on SPT**	150 mm (6"), UC/LC or as shown on SPT**	150 mm (6") or as shown on SPT**	115 mm (4.5")	100 mm (4") or as shown on SPT**

**Notes:** \* Because of the variability in letter sizes on various signs, the letter sizes on the Sign Pattern Template (SPT) in the MSL take precedence over the general guidelines in Table 2.8.

\*\* For ground-mounted signs, and posted speeds of 60 km/h or lower: the reference to the SPTs for directional guide signs taking precedence means that the letter and numeral sizes shown on the SPTs may be reduced by approximately 25%.

- Cardinal directions and other word legends are to be in upper-case letters; metric unit designations (e.g., km) are to be in lower-case.
- Fonts for traffic signs are available from a variety of sources. Some sources are listed in Table 2.9
- Figure 2.3 illustrates the guidelines or “rules of thumb” that generally apply to text guide signs. Dimensions shown are scaleable and are based on the variable, H, which is equal to the height of the largest upper case letters appearing in the destination names. The height of lower case letters (called ‘x’ height) appearing in destination names, is 0.75 H.
- The vertical space above the top line of text to the top outer edge of the border (top edge of the sign) should be approximately H, and not less than 0.67 H. (Note that there are no inset borders on guide signs which have light legends on dark backgrounds.)
- The vertical space below the bottom line of text to the bottom outer edge of the border (bottom edge of the sign) should be approximately H, and not less than 0.67 H. Additional space may be required where descenders of lower case letters hang beneath the baseline for upper case text, to visually balance the clear space below the bottom line of text with the clear space above the top line of text.
- Vertical spacing between lines of upper-case letters should be approximately 0.5 to 0.75 H. Where the letter size in adjacent lines of letters differs, the spacing between lines should be approximately 0.5 to 0.75 times the average of upper-case letter heights in adjacent lines of letters. In both cases, additional space may be required because of ascenders and descenders of lower case letters. For example, if a descender from an upper row happens to be vertically aligned with the ascender from the row beneath it, a larger interline spacing should be provided, so that the text is legible.
- The horizontal space from the leftmost edge of text to the left inner edge of the border should be at least H. An alternate, equivalent definition is that the space from the leftmost edge of text to the left outer edge of the border (edge of the sign) should be at least H plus the border. The corresponding rule applies to the right side of the sign.
- The minimum horizontal separation between two words of text should be at least H.
- The minimum horizontal separation between two columns of text should be at least 2H.
- The horizontal space between the longest line of message text and the nearest (leftmost) part of an adjacent arrow to the right of the text should be approximately H. If the arrow is on the left side of the sign, the horizontal space between the longest line of message text and the rightmost part of the adjacent arrow should be approximately H.
- Horizontal reduction: as noted in Section 2.5.4, when a sign message almost fits onto a sign blank, but is slightly too long, the length(s) of the word(s) should be reduced by no more than 10% to make a message fit onto a given blank size. The reduction (compression) should be applied only to the words; full spaces between words and between words and sign edges should be retained. If the message will not fit on the given sign blank, even with a 10% reduction, then the sign should be made larger; if the sign cannot be made larger, it should either be redesigned, or a more compressed font should be used (e.g., Series C rather than Series D).

Table 2.9 – Suppliers of Sign-making Equipment and Software

<p><b>Gerber’s Graphix</b></p> <p><b>ND Graphic Products Ltd. – Toronto</b>                      4309 Steeles Avenue West                      Toronto, ON M3N 1V7                      tel: (416) 663-6416                      toll free: 1-888-NDGRAPH (634-7274)                      fax: (416) 663-5629                      e-mail: customerservice@ndgraphics.com                      web: www.ndgraphics.com</p> <p><b>ND Graphic Products Ltd. – Ottawa</b>                      1280 Old Innes Rd., Unit 802                      Ottawa, ON K1B 5M7                      tel: (613) 744-7446                      toll free: 1-888-NDGRAPH (634-7274)                      fax: (613) 744-0449                      e-mail: customerservice@ndgraphics.com                      web: www.ndgraphics.com</p> <p><b>ND Graphic Products Ltd – London</b>                      954 Leathorne Street                      London, ON N5Z 3M5                      tel: (519) 686-7870                      toll free: 1-888-NDGRAPH (634-7274)                      fax: (519) 686-9972                      e-mail: customerservice@ndgraphics.com                      web: www.ndgraphics.com</p> <p><b>SignLab</b></p> <p><b>Sign Equipment Canada Ltd.</b>                      142 Basinview Drive                      Bedford, NS B4A 3J8                      tel: (902) 835-1910                      toll free: 1-866-264-5096                      fax: (902) 484-7506                      e-mail: information@signequipmentcanada.com                      web: www.cadlink.com</p> <p><b>Oldham Robinson Integrated Technologies Inc.</b>                      444 Southcote Rd.,                      Ancaster, ON L9G 2W3                      toll free: 1-800-385-7247                      fax: (905) 648-9639                      e-mail: sales@oldhamrobinson.com                      support@oldhamrobinson.com</p>	<p><b>ScanVec</b></p> <p><b>Scanvec Amiable</b>                      International Plaza Two, Suite 625                      Philadelphia, PA 19113 USA                      tel: (610) 521-6300                      toll free: 1-800-229-9066                      fax: (610) 521-0111                      e-mail: info@ScanvecAmiable.com                      web: www.ScanvecAmiable.com</p> <p><b>FontLab Ltd.</b>                      PO Box 179                      Millersville, MD 21108 USA                      tel: (301) 560-3208                      toll-free: 1-866-571-5039                      fax: (301) 560-4155                      e-mail: orders@fontlab.com                      web: www.fontlab.com</p> <p>(Software and tools for font design, font conversion and font editing)</p> <p><b>FHWA Series Font Distributors</b></p> <p><b>FHWA Signs and Fonts</b>                      toll-free: 1-866-833-7933                      e-mail: sales@fhwa.ca                      web: www.fhwa.ca</p> <p><b>DGI</b>                      (Distribution)                      tel: (905) 846-8667</p> <p><b>Adobe® Illustrator®</b>                      This software package includes some Adobe® fonts which are used in the OTM.</p>
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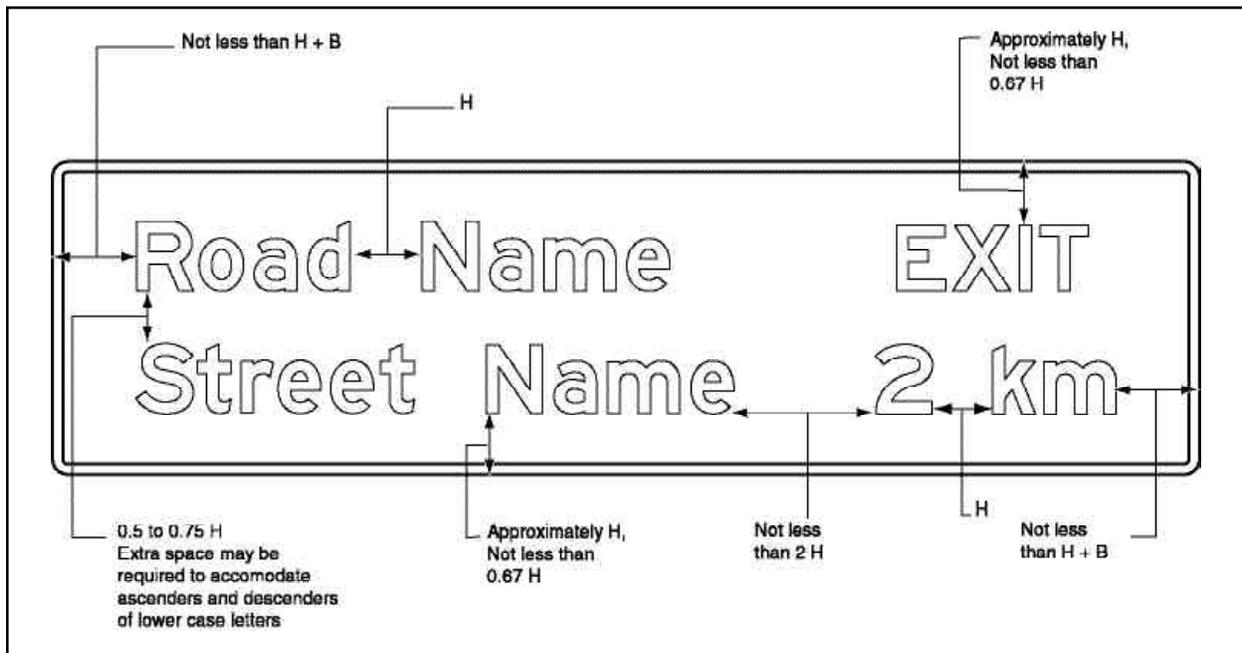
- Vertical reduction: When a directional guide sign message almost fits onto a sign blank, but is vertically slightly too large, the interline and vertical edge spacings may be reduced slightly to make a message fit onto a given blank size. Each vertical edge spacing and interline spacing on directional guide signs may be reduced by up to 25 mm. For example, for a two-line sign (one interline space and two edge spaces), a 75 mm vertical reduction (compression) would be acceptable, and for a three-line sign, a 100 mm vertical reduction would be acceptable.

*Letter Size: Metric to Imperial Correlation*

Standard sign blanks for regulatory, warning, and temporary conditions signs are shown in metric dimensions, and all sign pattern template dimensions are shown in metric dimensions.

As noted in Section 1.4 (Metrication), because extruded aluminum panels are manufactured in Imperial units of feet and inches, some designers still design such signs in Imperial dimensions. Note that the Sign Pattern Templates for extruded aluminum signs show metric dimensions. For design of extruded aluminum signs in Imperial units, for the various sign dimensions, the soft conversion of 300 mm = 12 inches applies; that is,

Figure 2.3 – Spacing Guidelines for Text on Directional Guide Signs



**Note:** H = Upper Case Letter Height  
 B = Width of Border

**Table 2.10 – Imperial to Metric Conversion Chart for Letter Heights**

Imperial (inches)		Metric (mm)
3	=	75
4	=	100
5	=	125
6	=	150
7	=	175
8	=	200
10	=	250
12	=	300
13.33	=	340
14	=	360
15	=	380
16	=	410
20	=	510
24	=	610

a 2400 mm width dimension shown on the SPT is really 8 feet. However, for design of extruded aluminum signs in metric units, then a hard conversion between Imperial and metric dimensions needs to be used (12 inches = 304.8 mm), except for the letter heights (see Table 2.10). If the hard conversion is not used, a metric sign design will not completely cover the panels cut to Imperial lengths.

For letter heights, Table 2.10 provides the Imperial to metric conversion chart.

*Limits on Destination Legends*

- On any major guide sign, it is preferable to show no more than two destinations or street names, with three as the absolute maximum. Diagrammatic signs may be an exception in certain situations.

- Directional copy, not exceeding three lines, may include symbols, route numbers, arrows, cardinal directions, and exit instructions. Regardless of how the various elements on the sign are assembled, they should not exceed three lines.
- Where two or more signs are placed on the same support, it is desirable to limit destinations or names to one per sign, or to a total of three in the display, to avoid driver information overload.
- Indiscriminate use of supplemental signs should be avoided.
- Where diverging highways provide alternate routes to the same destination, only one route should be posted. (That destination should normally be posted on one route only.)

*Abbreviations*

- Abbreviations are to be kept to a minimum. In the case of cardinal directions used with route markers on major guide signs, the words "NORTH", "SOUTH", "EAST", and "WEST" are not to be abbreviated.
- Suffix letters may be used, for example, on branch routes, where a suffix letter is an integral part of the route designation, or to interchange numbers that include a suffix letter following the exit number to indicate multi-exit interchanges. (For example, the exits at a freeway interchange may be numbered 76A and 76B, to show that there are two exits, and the correct one must be used for the desired destination or route.)
- The abbreviation for Queen Elizabeth Way is QEHW (no periods). It should be used only with a crown.

- Commonly used abbreviations are as follows:

Term	Abbreviation	
	English	French
Avenue	Ave.	Av.
Boulevard	Blvd.	Boul.
Circle/Cercle	Cir.	
Concession	Con.	Conc.
County/Comté	Cty.	
Court	Ct.	
Crescent	Cr.	
District	Dist.	Dist.
Drive	Dr.	Prom.
East*	E.	E.
Expressway	Expwy.	
Freeway/Autoroute	Fwy.	Aut.
Fort/Fort	Ft.	
Highway	Hwy.	Rte.
Junction	Jct.	Jct.
Kilometre(s)	km	km
Lake/Lac	L.	L.
Lane	Ln.	
Metre(s)	m	m
North*	N.	N.
Place	Pl.	Pl.
Parkway/Promenade	Pkwy.	Prom.
River/Rivière	R.	Riv.
Road	Rd.	Ch.
Saint	St./Ste.	St./Ste.
South*	S.	S.
Square	Sq.	Pl.
Street/Rue	St.	Rue
Township	Twp.	
West*	W.	O.

\* only as part of a destination name, e.g., North Townsville

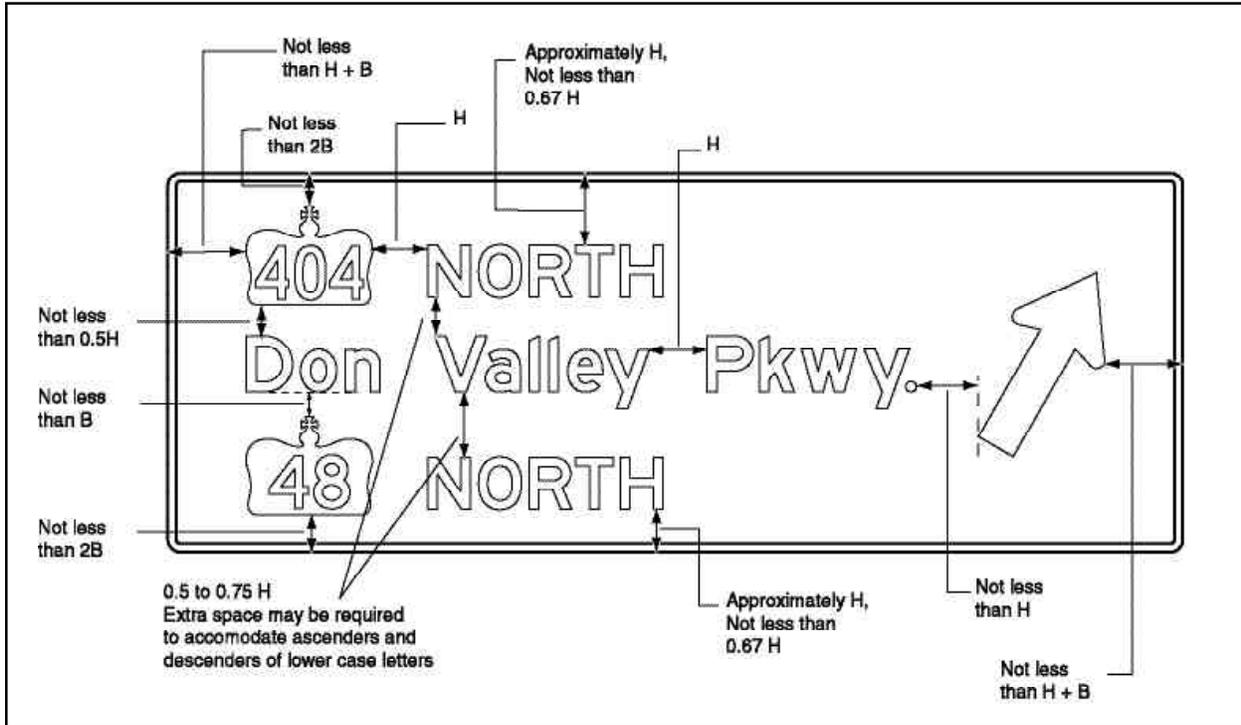
*Symbols, Crowns, Shields, Markers*

- Symbols are to be consistent with those used elsewhere in the OTM. Tab signs (word messages) may be used below symbol designs where required.

- Special effort should be made to balance legend and symbol components on the sign to achieve maximum legibility of the symbol.
- The specific size of the crown or shield is selected from the Sign Parts Library (see Section 5.1.4) as a function of road and sign type, and as specified on the Sign Pattern Template, if available. The size of the numerals in each crown, shield or marker is provided in the Sign Parts Library.
- Where the Sign Pattern Template does not show a specific size of crown, or where there is no SPT (e.g., diagrammatic signs), the following guidelines may be used: MC-5 and MC-6 are to be used for freeway to freeway applications. The most common use of the MC-6 is for large pull-through overhead signs over multiple lanes (e.g., 401/London). The MC-4 is to be used for other freeway signs (both overhead and ground-mounted); if space is tight, the MC-3 may also be used; if space looks too generous, the MC-5 may be used. Which crown to use is often governed by available space and visual balance and appearance. The MC-3 and MC-2 are generally used for ground-mounted signs on non-freeways.
- If a crown or marker is used to apply to a single line of adjacent text, the line of text should be centred vertically relative to the numerals in the crown or marker. If a crown or marker is used to apply to two (or three) lines of adjacent text, the lines of text should follow the usual interline spacing rules, and the crown or marker should be vertically balanced (centred) beside them.

- Figure 2.4 illustrates the guidelines or “rules of thumb” that generally apply to guide signs with arrows and crowns/markers/shields. Guidelines for clear horizontal space to the left of the legend and to the right of the legend are the same as for

Figure 2.4 – Spacing Guidelines for Text on Directional Guide Signs with Arrows, Crowns & Shields



**Note:** H = Largest Upper Case Letter Height  
 B = Width of Border

text guide signs, as discussed with reference to Figure 2.3. (The legend includes all text, arrows, crowns, markers, shields, and other symbols/graphics appearing on the sign.)

- Guidelines for interline spacing of text are the same as for text guide signs, as discussed for Figure 2.3 above.
  - The vertical space above the top of the crown, marker, or shield to the top outer edge of the border (edge of sign) should be at least equal to twice the border width. That is, the clear space between the top of the crown, marker, or shield and the top inner edge of the border should be at least equal to the border width. Similarly, the vertical space from the bottom of the crown,
- marker or shield to the bottom outer edge of the sign border (where the crown is in the bottom line) should be at least equal to twice the border width. That is, the clear space between the bottom of the crown, marker, or shield and the bottom inner edge of the border should be at least equal to the border width. The vertical space from the bottom of the crown to the next line of text should be approximately 0.5 H.
- The clear horizontal space between two markers or two shields on the same line, or between a marker and a shield on the same line should be at least H, measured at their nearest points.

Arrows

The specific size of the arrow is selected from the Sign Parts Library, as specified on the Sign Pattern Template for that particular sign (see Section 5.1.4 and the MSL).

Dimensions of arrows for use on guide signs are shown in the Sign Parts Library. Specific applications of arrows are as follows:

• **Ahead Arrows**

Short, upward pointing “ahead arrows” are used on some standard regulatory, warning, and temporary conditions signs. These arrows are already included on the standard sign pattern templates for these signs. They are also included in the Sign Parts Library if needed for other signs, e.g., non-standard signs. They are not used on directional guide signs. See Figure 2.5.

• **Parking Sign Arrows**

Short, horizontal arrows are used on parking restriction and permitted parking signs, and are already included on the standard sign pattern templates for these regulatory signs. They are also included in the Sign Parts Library if needed for other signs. See Figure 2.6. They are not used on directional guide signs.

• **Overhead Advance Sign Arrows**

When used on overhead advance direction signs, upward pointing straight arrows and upward curving arrows should be used to represent the through road and the lane(s) exiting from the through road, respectively (Freeway Advance Arrows). See Figure 2.7. The arrows must be located on the side of the sign closest to the exit lane. Various combinations of these arrows, with associated exit lane designations, are included in the Sign Parts Library, and are titled “Freeway Advance Arrows” (FAA) (formerly called “Revised Freeway Signing System” or “RFSS”).

Figure 2.5 – Ahead Arrows

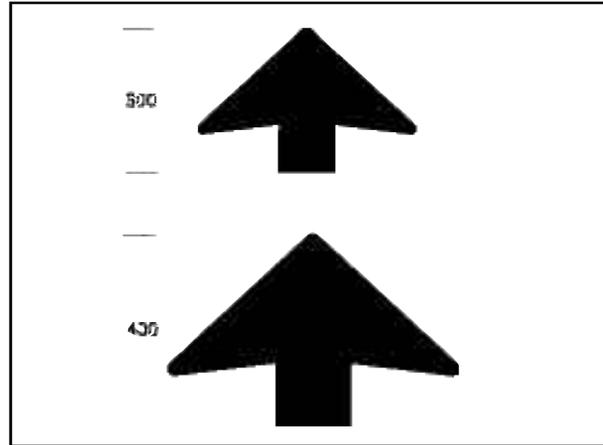
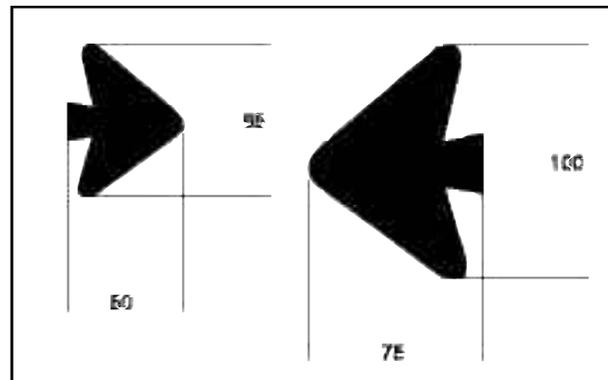


Figure 2.6 – Parking Sign Arrows

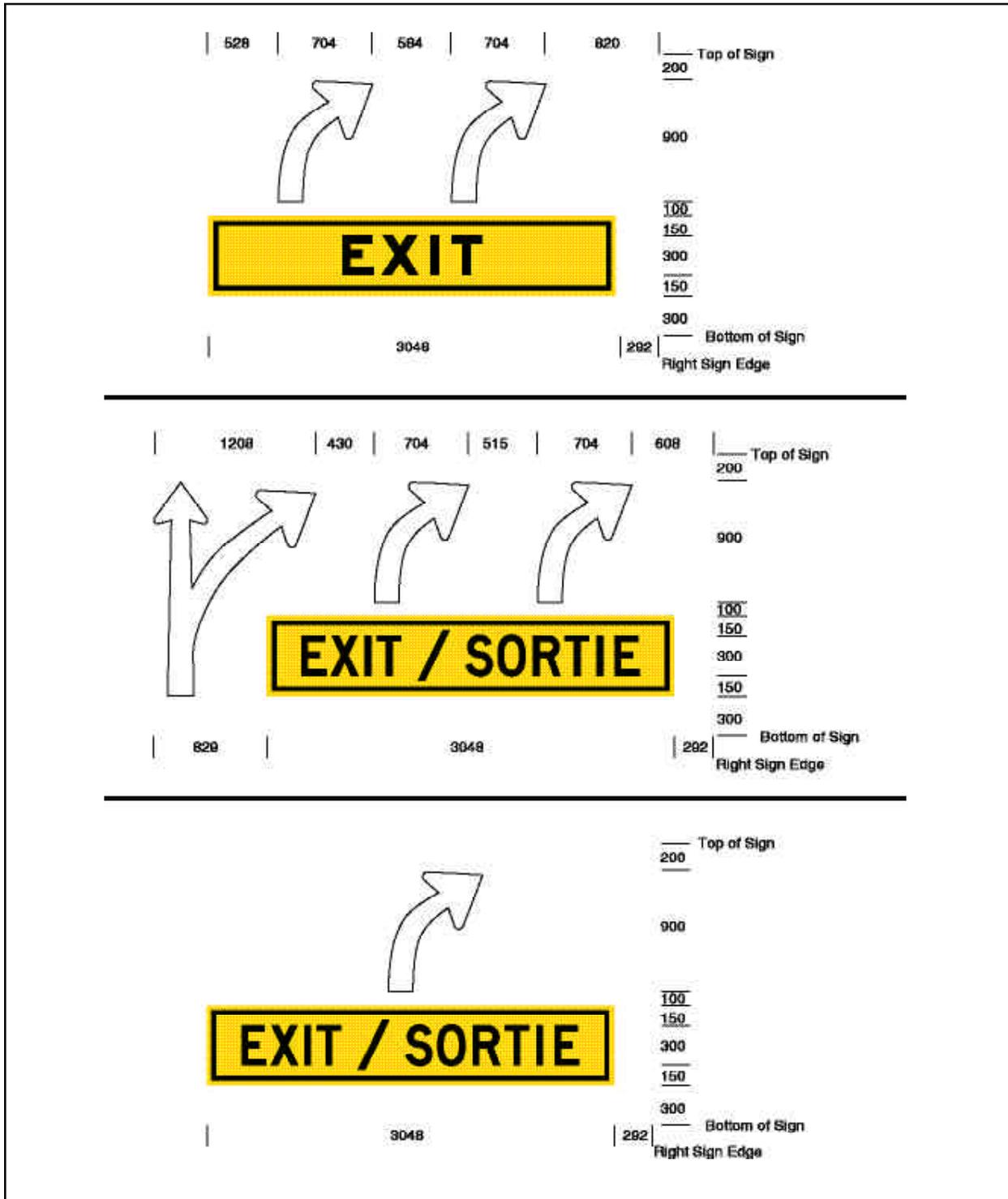


*Placement of Overhead Advance Sign Arrows:*  
The bottom of the arrow(s) is lined up relative to the bottom of the sign as shown in the Sign Parts Library (dimensions are shown).

The horizontal distance from the right edge of the black/yellow exit panel to the right edge of the sign (and hence the arrow placement relative to the right edge of the sign) is also shown in the Sign Parts Library.

The horizontal distance from the left edge of the black/yellow exit panel (or, if the exit panel applies only to the right arrow, from the left edge of the left arrow shaft) to the adjacent lines of destination text should be at least 2H.

Figure 2.7 – Overhead Advance Sign Arrows

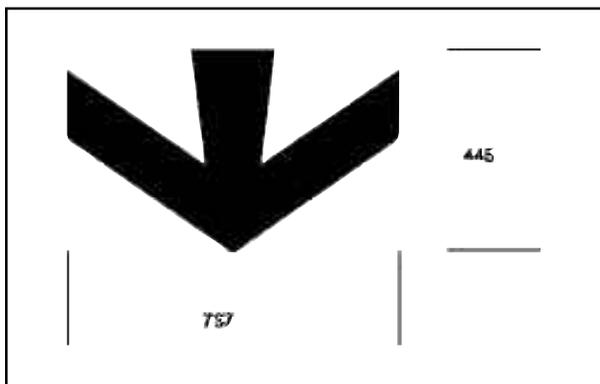


As shown on the FAA arrow blocks in the SPL, for a nominal 2100 mm (7 foot, actual 2133.6 mm) sign, the top spacing (from the top of the arrow to the top edge of the sign) is shown as 175 mm (7") or 200 mm (8"), depending on the arrow or arrows depicted. Again, for the 7 foot sign, the bottom spacing (from the bottom of the exit panel to the bottom edge of the sign) is shown as 300 mm (12"). If the sign is 8 feet or 9 feet high, then half the additional height is added to the top spacing and the bottom spacing. Hence, on a 7 foot sign, the top and bottom spacings are 175 mm (7") and 300 mm (12") respectively, on an 8 foot sign, they are 330 mm (13") and 460 mm (18") respectively, and on a 9 foot sign, they are 485 mm (19") and 610 mm (24") respectively.

• **Downward Arrows**

When used with overhead guide signs to designate the use of specific traffic lanes for drivers bound for a destination, route, or exit, the arrows must be downward pointing. In these cases, a separate arrow should be centred over each lane serving the destination appearing on the sign. Where space does not permit this (e.g., cantilever signs), downward sloping arrows may be used. There is one type of downward arrow (Lane Designation Arrow Tab), as shown in the Parts File in the Sign Parts Library. See Figure 2.8.

**Figure 2.8 – Downward Arrows**



Downward arrows are required on:

- exit signs to indicate the number and location of exiting lanes;
- over all lanes where freeway-to-freeway splits occur;
- over all lanes where signs indicate the major through highway (e.g., 401 East or 401 West);
- over all lanes where express/collector begins.

Where downward arrows are used over all lanes (e.g., signs indicating 401 East or 401 West), they are white arrows used on the blue or green background, positioned over the centre of the lane to which they apply. Where downward arrows are used to indicate exit lanes, they are black arrows on a yellow background panel along the bottom side of the sign. See FAA Parts File in the SPL. In such cases, because the legend is dark (black) against a lighter (yellow) background, both a yellow outer border and a black inset border are used for this lower panel. Both the yellow outer border and the black inset border are 37.5 mm (1.5") wide. The spacing from the bottom point of the arrow to the bottom edge of the sign should be 125 mm (5"), leaving a clear space of 50 mm (2") between the bottom point of the arrow and the inset border. The yellow panel itself is 600 mm (24") high times the width of the sign, and the spacing between the top of the downward arrow and the top of the yellow panel should be at least 37.5 mm (1.5").

Downward arrows are not required on advance or pre-advance signs indicating, e.g., "Morningside 1 km, Whites Road 3 km, etc."

• **Advance and Exit Arrows**

The use of advance and exit arrows is summarized in Table 2.11. When used on ground-mounted exit direction signs, arrows are to be upward slanting at an angle representative of the alignment of the exit roadway (or, on non-freeways, pointing left or right as the case may be), and they are to be located on the appropriate side of the sign corresponding to the side of the exit. These arrows are called Gerber arrows. The arrows to be used are as shown on the Sign Pattern Template, and are to be centred vertically. Three multi-purpose Gerber arrows are included in the Sign Parts Library, which can be adjusted to match the specified arrow on the SPT. See Figure 2.9. These arrows have the general designation A x-y or A x-y-z, where x is the width of the arrow head, y is the length of the arrow shaft adjacent to the arrow head, and z is the length of the arrow shaft tail connected at an angle to arrow shaft y. The shaft width is not directly shown in the SPL, but is about 38% of the width of the arrow head (x). When these arrows in the SPL are used and scaled up or down, the relative proportions of the arrow head width and the shaft width will be automatically maintained.

Where the size of arrow is not specified or is not known for a given sign, as a rule of thumb, the width of the arrow head should be equal to the height of the largest letter on the sign.

• **Diagrammatic Arrows**

Diagrammatic arrows are used on diagrammatic signs. A selected set of these arrows is included in the Sign Parts Library. See example in Figure 2.10. If one of these arrows in the SPL does not fit the situation at hand, the sign designer may need to draw a custom-designed diagrammatic arrow. On overhead signs, these arrows show the lane markings. On ground-mounted signs, they do not show the lane markings.

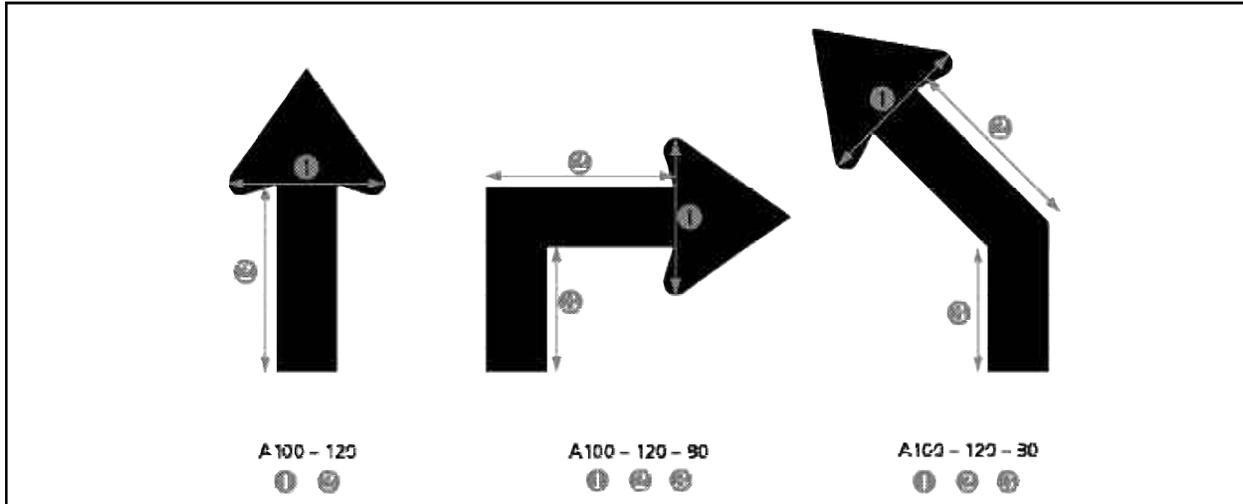
The minimum horizontal separation between a line of text and the nearest (leftmost or rightmost, as the case may be) horizontal part of an adjacent arrow should be approximately H. However, as noted above, the minimum separation between a line of text and a block of exit arrow(s) and EXIT panels should be at least 2H.

**Table 2.11 – Use of Arrows on Advance and Exit Guide Signs**

	<b>Advance Guide Sign*</b>	<b>Exit Guide Sign</b>
<b>Freeway: Overhead</b>	Yes FAA arrow(s), or Diagrammatic arrows	Yes Downward arrow(s)
<b>Freeway: Ground-mounted</b>	Usually No (Gerber arrows if used)	Yes Gerber arrows
<b>Non-freeway: Overhead</b>	Yes FAA arrow(s)	Yes Downward arrow(s)
<b>Non-freeway: Ground-mounted</b>	Yes Gerber arrows	Yes Gerber arrows

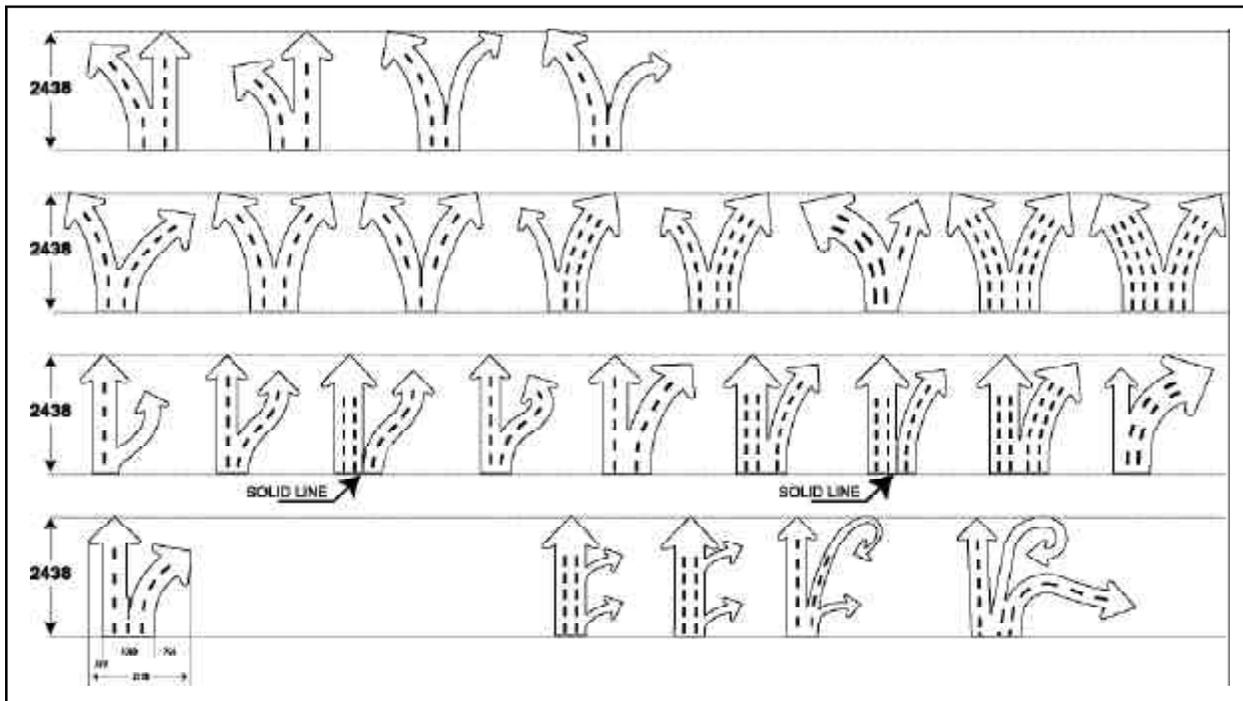
\* The Advance Guide Signs referred to in the table are generally within 60-100 m (non-freeways) or within 300-500 m (freeways) of the exit. Advance Guide Signs further upstream (typically 1 to 6 km) name the exit(s), but do not have arrows.

Figure 2.9 – Advance and Exit Arrows



**Note:** For the correct scale use the arrow head size, i.e., ① as the base dimension.

Figure 2.10 – Examples of Diagrammatic Arrows



*Centring and Justification Guidelines*

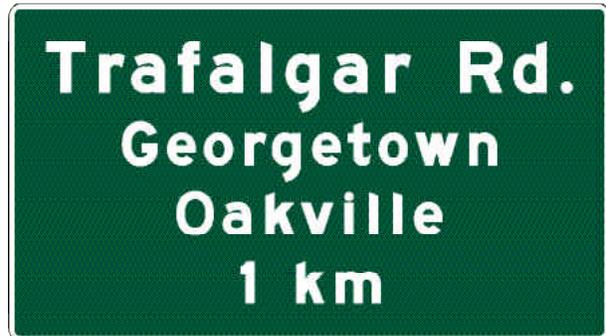
In addition to the spacing and arrow selection guidelines outlined above, there are guidelines for centring and justifying components of the legend for visual balance and clarity of the sign message. The following centring/justification guidelines apply to guide signs:

- If the sign consists of one column of text only (e.g., ADVANCE GUIDE sign (Gf-1)), the lines of text should be all horizontally centred about the central vertical axis of the sign face. See Figure 2.11.
- If the sign consists of two columns of text only (e.g., DISTANCE ASSURANCE sign (Gf-12), INTERCHANGE SEQUENCE sign (Gf-5)), the left column is left-justified and the right column is right-justified. See Figure 2.12.
- The text and graphic components of the sign message should be visually balanced to support maximum legibility. It may be necessary to fit the sign and message to the horizontal width of the sign (for example, over a specific number of lanes). Minimum spacings may be increased in order to achieve better visual appearance and message positioning.
- If the cardinal direction appears beside the crown or marker (e.g., TURN-OFF – RIGHT TURN sign (Gr-2)), the cardinal direction text in all upper case letters should be centred vertically relative to the numerals in the crown or marker. In this situation, the destination name should be centred beneath the line of text consisting of crown/marker and cardinal direction.
- In general, it is preferable on signs such as Gr-1 (CHANNELIZING – RIGHT TURN sign), Gr-2, and Gr-3 (CHANNELIZING – LEFT TURN sign), to have the cardinal direction beside the crown/marker on the same line, with the destination name centred beneath the line of text consisting of

crown/marker and cardinal direction. See Figures 2.13 to 2.16. On Gr-1, Gr-2, and Gr-3, the arrow should be positioned so as to be toward one end of the sign, and vertically centred on the full sign height. Gr-4 should show the horizontal left arrow underneath the legend block of the crown/marker, cardinal direction, and destination name.

- If horizontal space does not permit the design approach outlined in the point above, the cardinal direction can appear below the crown or marker. The cardinal direction text should be centred horizontally beneath the crown or marker. In this situation, the destination name should be centred across the width of the sign.

**Figure 2.11**  
**ADVANCE GUIDE Sign (Gf-1)**



**Figure 2.12**  
**DISTANCE ASSURANCE Sign (Gf-12)**



Figure 2.13  
CHANNELIZING – RIGHT TURN Sign (Gr-1)



Figure 2.14  
TURN OFF – RIGHT TURN Sign (Gr-2)



Figure 2.15  
CHANNELIZING – LEFT TURN Sign (Gr-3)



Figure 2.16  
TURN OFF – LEFT TURN Sign (Gr-4)



*Sign Border Sizing and Cornering*

- **Metal** sign blanks should have both **rounded corners** and **rounded borders**.
  - Blanks 890 mm or less in dimension should have a blank corner radius of 40 mm.
  - Blanks 900 mm or greater in dimension should have a blank corner radius of 50 mm.
- **Plywood** sign blanks should have both **squared corners** and **squared borders**.
- **Aluminum extrusion** signs should have **squared corners** and may have **squared** or **rounded borders**.

Where an inset border is used, the inset sign border must be the same colour as the legend, and the outer border must be the same colour as the sign background. An inset border is not used on guide signs which consist of a light-coloured legend on a dark-coloured background (except for black downward arrows on an overhead yellow exit lane panel, where this panel has an inset and an outer border).

The dimensions shown in Tables 2.12, 2.13 and 2.14 for sign border sizing and cornering, for metal blanks, plywood blanks, and aluminum extrusions respectively, are given in reference to the radii illustrated in Figure 2.17.

**Table 2.12 – Sign Border and Cornering Dimensions: Metal Blanks**  
(all dimensions in millimetres (mm))

Smaller Sign Dimension	Inset Border		Corner Radius			Edge Border Thickness	Corner Radius	
	Edge	Thickness	R1	R2	R3		R1	R4
up to 200	7.5	7.5	20	12.5	5	7.5	20	12.5
300	10	10	30	20	10	10	30	20
450	12.5	12.5	40	27.5	15	12.5	40	27.5
600	12.5	12.5	40	27.5	15	12.5	40	27.5
750	12.5	12.5	40	27.5	15	12.5	40	27.5
900	20	20	50	30	10	20	50	30

**Table 2.13 – Sign Border and Cornering Dimensions: Plywood Blanks**  
(all dimensions in millimetres (mm))

Smaller Sign Dimension	Inset Border		Corner Radius			Edge Border Thickness B	Corner Radius	
	Edge	Thickness	R1	R2	R3		R1	R4
200	20	20				20		
300	20	20				20		
450	20	20		Plywood		20	Plywood	
600	25	25		Squared		25	Squared	
750	25	25		Corners*		25	Corners*	
900	25	25				25		
1200	25	25				25		

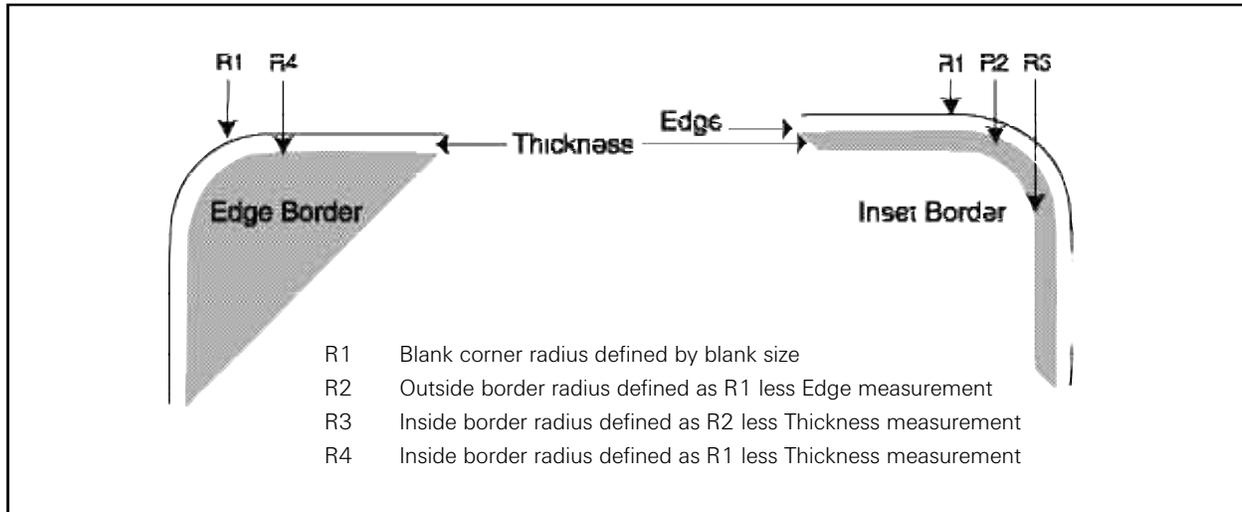
\* Some road authorities use rounded corners and borders; some others use squared corners with rounded borders.

**Table 2.14 – Sign Border and Cornering Dimensions: Aluminum Extrusion**  
(all dimensions in millimetres (mm))

Smaller Sign Dimension	Inset Border		Corner Radius			Edge Border Thickness B	Corner Radius	
	Edge	Thickness	R1	R2	R3		R1	R4
ALL	35	35	100**	50	15	50	100**	50

\*\* Aluminum extrusion blanks are cut with squared corners. Many road authorities use squared borders. If rounded borders are used, use R1=100.

Figure 2.17 – Sign Border and Corner Radii



*Size of Guide Signs*

- The size of guide signs (and other customized standard signs and non-standard signs) is determined from the length of message and the size of lettering necessary for proper legibility.
- Overhead and large ground-mounted signs are generally designed to have widths of even, nominal 600 mm (actual 2 foot) increments. Extrusion lengths in even numbers of feet are the most common. Of lengths in odd numbers of feet, the most common extrusions are 2.743 m (9 feet), 3.352 m (11 feet) and 4.572 m (15 feet). Aluminum extrusions can be ordered in almost any sign width (extrusion length).
- Under some circumstances (especially for overhead signs), available space is the controlling factor. A sign mounted over a roadway lane may have to be limited in horizontal dimensions to the width of the lane, so that another sign may be placed over an adjacent lane.

- Under other circumstances, where lane designation arrows are used, a minimum width of overhead signs is required, for positive driver guidance. Minimum sign widths for lane designation arrows centred over 3.65 m (12 foot) lanes should be as follows:

Sign centred over 2 lanes	4.9 m (16 ft)
Sign centred over 3 lanes	8.5 m (28 ft)
Sign centred over 4 lanes	12.2 m (40 ft)

- The maximum size (area) for the overhead signs on a single overhead sign structure is limited to 42 square metres. The maximum height of an overhead sign is 2.75 m. The maximum height and width for ground-mounted signs are generally about 3.00 m and 4.80 m respectively. For both overhead and ground-mounted signs, available space may limit the area, width, or height of the sign to smaller values.

**Table 2.15 – Standard Print Colour Specifications for Ontario Traffic Signs**

Colour	Name	Spot Colour	Process Colour			
		Pantone® Matching System (PMS)	Cyan (C)	Magenta (M)	Yellow (Y)	Black (K)
	Black	426	0	0	0	100
	Blue	294	100	56	0	18.5
	Brown	469	0	51	94	60
	Chartreuse*	389	18.5	0	83	0
	Green	342	100	0	69	43
	Orange	152	0	51	100	0
	Red	187	0	91	72	23.5
	White	N/A	0	0	0	0
	Yellow	116	0	15	94	0

\* Another term for chartreuse is 'strong yellow-green'.

*Colour*

- The sign background and legend colours are to be used as shown on the Sign Pattern Templates.
- In the case of an express-collector type facility, the background colour for guide signs on collector lanes is to be reflective blue, whereas the reflective green background is used for guide signs on express lanes.
- The standard print colour specifications for Ontario traffic signs are shown in Table 2.15. Colour specifications for sign sheeting are defined in the ASTM D 4956-01a specification (daylight luminance and chromaticity coordinates).

*Overhead Signs*

Overhead signs are beneficial on many roads, especially multi-lane roads, because they afford all drivers a view of the directional information, but they are more costly than ground-mounted signs.

Various factors may justify the installation of overhead directional guide signs. They are not always definable in specific numerical terms, but the following conditions deserve consideration:

- Freeway configuration, especially urban freeways
- Three or more lanes in each direction
- Traffic volume at or near capacity
- Complex interchange design
- High traffic speeds
- Closely-spaced interchanges
- Restricted sight distance
- Multi-lane exits
- Large percentage of trucks
- Consistency of sign message location through a series of interchanges
- Junction of a major route with another freeway
- Left exit
- Insufficient space for ground-mounted signs
- Background street lighting
- Road authority policy

*Differences between Overhead and Ground-mounted Signs*

The sign design rules for letter and numeral size for overhead and ground-mounted directional guide signs are summarized in Table 2.7 (Freeways) and Table 2.8 (Non-freeways). Other sign design rules for overhead and ground-mounted directional guide signs are basically the same except:

- For overhead signs and ground-mounted freeway signs, use Series E(m) font. For non-freeway ground-mounted signs, use Series E font or, as specified on the Sign Pattern Templates, even Series D or C.
- On overhead diagrammatic signs, show lane markings. On ground-mounted diagrammatic signs, do not show lane markings.

**2.14.3 Diagrammatic Guide Signs**

Diagrammatic guide signs are a special case of customized standard signs.

Diagrammatic guide signs have proved to be effective for some types of overhead freeway interchange signing, e.g., destination signing in advance of a complex or unusual freeway interchange. Diagrammatic signs work well for conveying information about unexpected or unusual manoeuvres which can be displayed with a simple graphic. They are recommended for signing driver expectation violations, such as a left exit or some freeway-to-freeway interchange splits (see Figure 2.18). However, diagrammatic signs sometimes are overused, or are used where the information could be provided in a simpler manner. They are not recommended for signing situations that are either very simple and more efficiently handled through conventional interchange signs (e.g., single right either/or exit lane) or so complex that a graphical representation would confuse drivers (e.g., double

**Figure 2.18 – Example of Diagrammatic Guide Sign**



lane drop followed by a fork (multiple split ramp)). For more information on the functionality of diagrammatic guide signs, see Book 8 (Directional and Information Signs) (under development).

*Usage Location*

- Graphics on a diagrammatic sign display the approximate geometry of the intersection along with essential directional information.
- Diagrammatic messages may be used as pre-advance guide signs to convey directional information some distance in advance of the interchange or freeway exit (not less than 1 km in advance of the gore area and not at the beginning of a deceleration lane taper).
- Diagrammatic signs should be used as supplementary signs; they are not to replace standard Advance and Turn Off signs.
- Generally, diagrammatic messages should be limited to unexpected or unusual manoeuvres that can be displayed with a simple graphic.
- These signs may be considered for use at interchanges with the following types of design:
  - left exit
  - left exit in combination with single right exit
  - major fork
  - two right exits, where there is insufficient space for conventional signing.

- Each location is to be evaluated on its own needs. The mere fulfillment of the above conditions does not justify the installation of these signs.

#### *Usage not Recommended*

Diagrammatic signs are not recommended at the following types of interchanges:

- single right exits, including diamond interchanges
- common cloverleaf interchanges
- interchanges with collector-distributors
- interchanges with double lane drops followed by a fork (multiple split ramp)
- very complex interchanges (where it is difficult to design graphics that will be simple and yet will accurately portray the geometry of the interchange).

#### *Design Rules*

The following design rules apply to diagrammatic signs:

- The graphic component should be simple and portray only what is necessary for the driver to understand the required exit manoeuvre relative to the main road. Additional details depicting the exiting path characteristics beyond the exit point should be avoided.
- Wherever possible, route symbols or numbers, rather than route names, should be used to provide exiting and destination information.
- Diagrammatic arrows are used on diagrammatic signs. A selected set of these arrows is included in the Sign Parts Library. If one of these arrows in the SPL does not fit the situation at hand, the sign designer may need to draw a custom-designed diagrammatic arrow. On overhead signs, these arrows show the lane markings. On ground-mounted signs, they do not show the lane markings, because of space limitations.
- The spacing rules of sign message around diagrammatic arrows are somewhat different than for non-diagrammatic arrows. The horizontal spacing between sign text (words or crowns and markers) and the nearest point on the diagrammatic arrow (on the same horizontal line) should be at least H. Depending on the configuration of the diagrammatic arrow, another useful check is to ensure that the nearer end of the longest text line is aligned horizontally with the left or right extremity of the arrow, as the case may be (that is, it is not closer to the arrow than this). This helps to maintain clarity by ensuring that the text blocks do not encroach too closely into the arrow space. This last check may not be applicable for some unusually shaped diagrammatic arrows.
- The information on the sign should be limited to three arrows with not more than one destination per directional arrow. In the exceptional case where two through route symbols are required, the second symbol should be positioned beside the first.
- Deceleration lanes should not be shown on the graphics components.
- The graphic components should be designed so that the through route is the visually dominant portion of the graphic (except for a major fork).
- On overhead signs, lane lines must be included where applicable on the graphics. Lane markings on freeway diagrammatic signs should be 50 mm wide.
- The stem length of the arrow must be sufficiently long to depict the lane configuration upstream of the split. The stem of the arrow representing the road upstream of the split should be at least 25 percent of the total height of the graphic component.

- Destination information must be clearly related to the appropriate arrowhead.
- Exit information text related to a given route marker should not be placed so that it extends above the top of the route symbol, but this text should be below it or to the side.
- Where an off-ramp is tangential to the beginning of a curve in the through route, a curved arrow should be used to indicate the through route.
- Letter size standards should not be reduced on diagrammatic signs. In many cases, the addition of graphic components requires a substantial increase in the overall size of the sign panel.

#### 2.14.4 Non-standard Signs

For non-standard signs, the rules for sign design need to be applied by the sign designer, as an existing sign or pattern cannot be used as is. If the non-standard sign is like a directional guide sign in nature, the rules as outlined in Sections 2.14.2 and 2.14.3 should be used.

Many non-standard signs are more like standard signs in nature, such as warning or temporary conditions signs, where the shape and relatively small size are more restrictive. A common type of non-standard sign is a new warning sign required by municipalities, other road authorities, or contractors for special purposes. In such cases, the rules as outlined below should be used.

Non-standard signs are signs for which there is no sign pattern template, and the size and message are designed for a specific purpose (see Section 2.2). If a new signing need arises, it is desirable that such a non-standard sign be designed from first principles and tested. Once it is designed, and proven effective, it should be considered for addition to the appropriate Books of the OTM, so

that other jurisdictions with the same needs can draw upon the existing design and so uniformity in signing is encouraged. At this point, the sign would become a standard sign with an existing pattern. See also Section 2.13 (Process for Assessing and Revising Sign Designs).

The following guidelines and rules apply to the design of non-standard signs:

- Consult the OTM and other North American signing manuals to determine whether signs with a similar purpose exist, from which the new non-standard sign can be adapted.
- Apply the existing sign colour and sign shape codes (see Section 2.4) to reflect the function of the new sign.
- Determine if a symbol alone or in combination with text can convey the sign message. If a symbol is to be used, design the symbol according to the guidelines provided in Section 2.6. Graphics and symbols should be kept simple; unnecessary details cannot be read at speed. Do not over-complicate or overuse graphics or symbols.
- If text is to be shown on the sign, develop a simple, concise message that minimizes the number of words while maintaining comprehensibility. Follow the guidelines for font and upper/mixed case provided in Section 2.5 (Text Legends). Be careful to avoid information overload (too much information crowded onto a small sign with small fonts).
- For signs including text, determine whether a bilingual sign is required, decide on the overall signing approach from the options described in Section 2.13 (Process for Assessing and Revising Sign Designs), and develop bilingual text messages.

- Calculate the letter height and/or symbol size for the sign using the process described in Section 2.7 (Calculating Letter Height and Symbol Size). Alternatively, use a font size shown on the Sign Pattern Template for a similar type of standard sign.
- Draft the layout of the sign, using similar approaches for interline spacing, borders, clear spaces and other layout guidelines as those shown on similar standard signs.
- Determine the requirements for retroreflective sheeting based on the functionality of the sign and the guidelines provided in Section 2.9 (Reflectorization and Illumination) and Section 3 (Sign Materials).
- View the sign design from a suitable distance. Often a design that looks clear and readable on the desk or computer screen does not appear so at a distance.

Using the above guidelines, develop alternative layouts for comprehension testing. For example, a text only version, a symbols plus text version, versions using different symbols, etc., could be developed. The comprehension testing should follow the process outlined in Section 2.13.1 (Comprehension Testing).

## 2.15 Sign Design Process

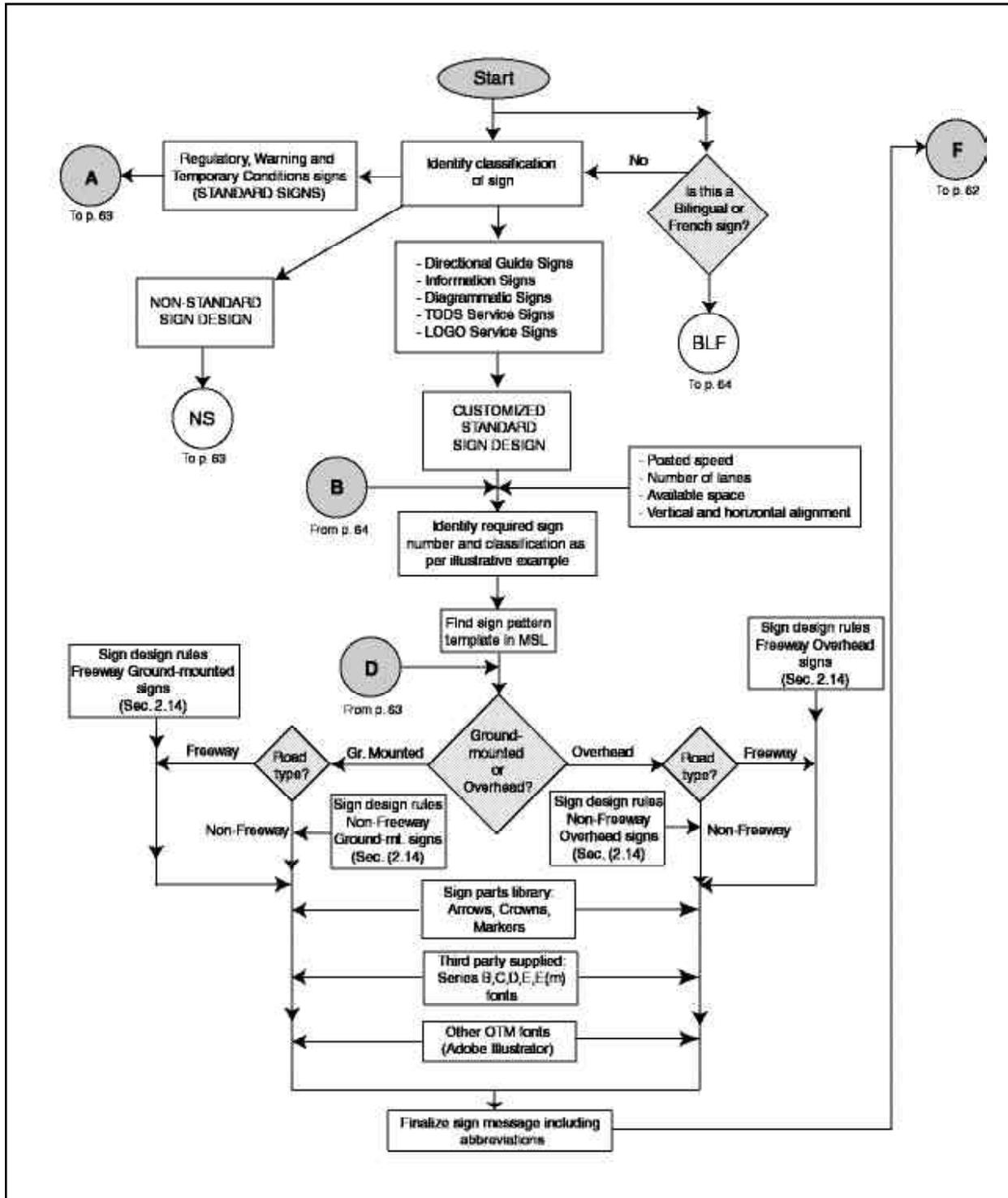
The sign design process is illustrated in Flowchart A, made up of four interconnected parts (Flowcharts A.1, A.2, A.3 and A.4). Flowchart A illustrates the sign design steps to be taken for standard signs, customized standard signs, and non-standard signs. It also illustrates the steps to be taken if a bilingual or French version of a sign needs to be developed. The sign design process described in this section is not intended to be

prescriptive, but rather to provide a useable guide for those who find it beneficial. Other approaches or sequences may be used, provided the end product meets the requirements.

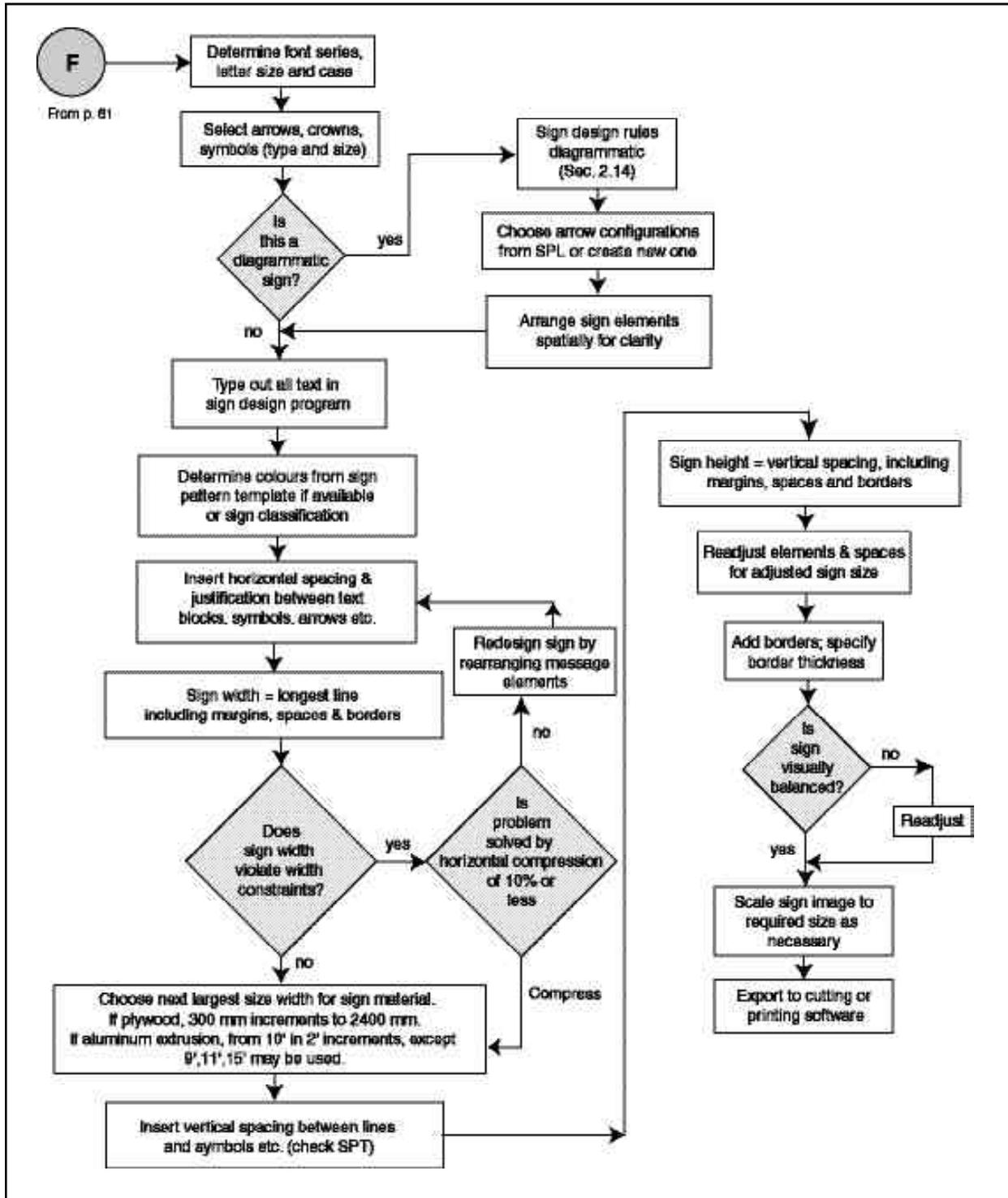
### 2.15.1 Sign Design Flowchart and Description

Flowchart A was conceived as a single large chart, but has been divided into several separate pieces for ease of publishing. Following the process described here, the chart is entered at the top, marked "Start." The first check is whether or not this is a bilingual or French language sign. If it is, one goes to the "BLF" circle, and proceeds to the last sheet (Flowchart A.4). After determining the characteristics of the sign, the process brings one back into the mainstream part of the flowchart. The next check is to identify the sign classification, and then to follow one of three streams: standard sign, customized standard sign, or non-standard sign. Each stream leads the user through the sign design process, ending with the export of the sign design to the cutting or printing software, and hence to the sign fabrication process, described in Section 4 and illustrated in Flowchart B and its sub-charts.

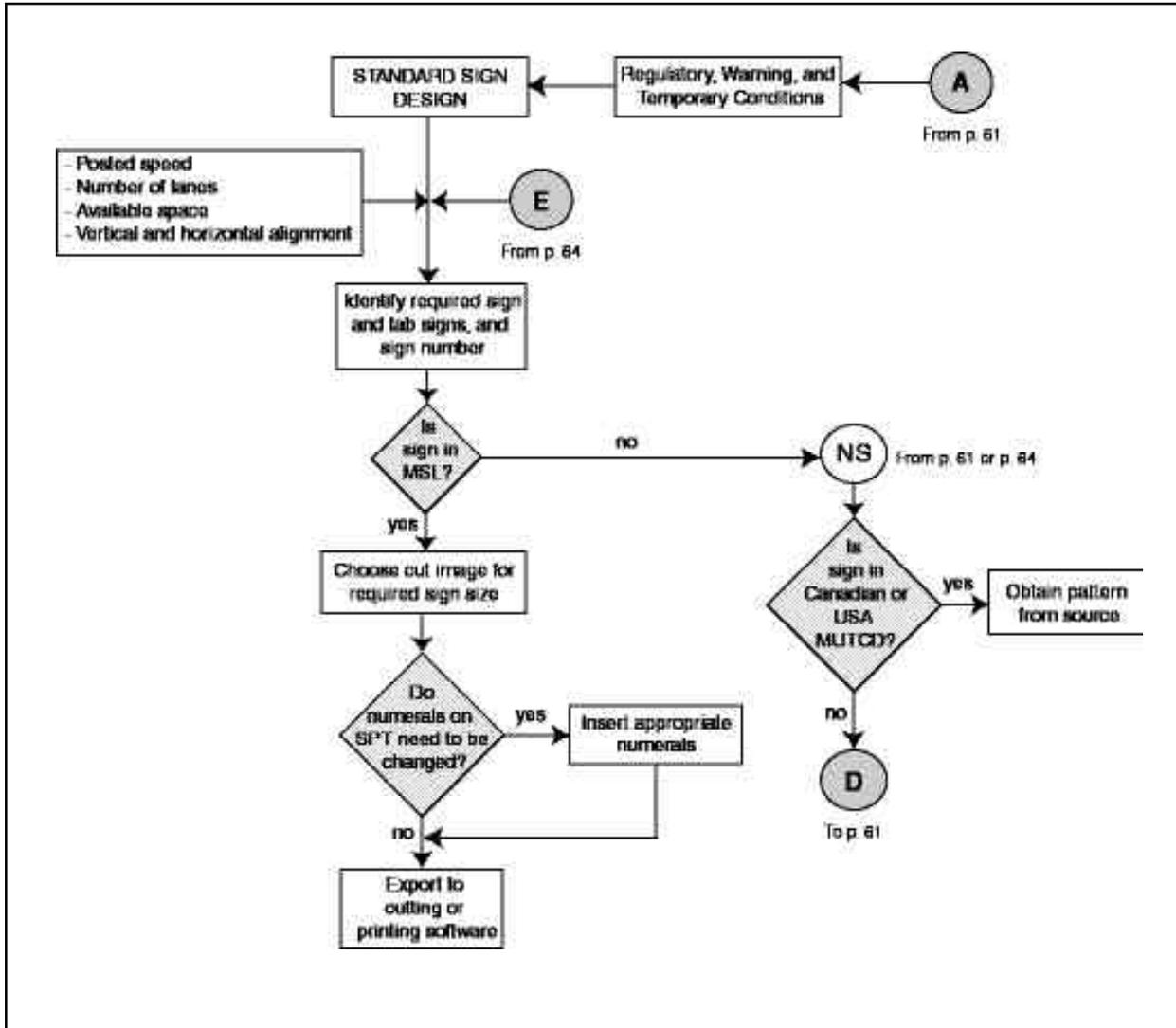
Flowchart A.1 – Sign Design Process



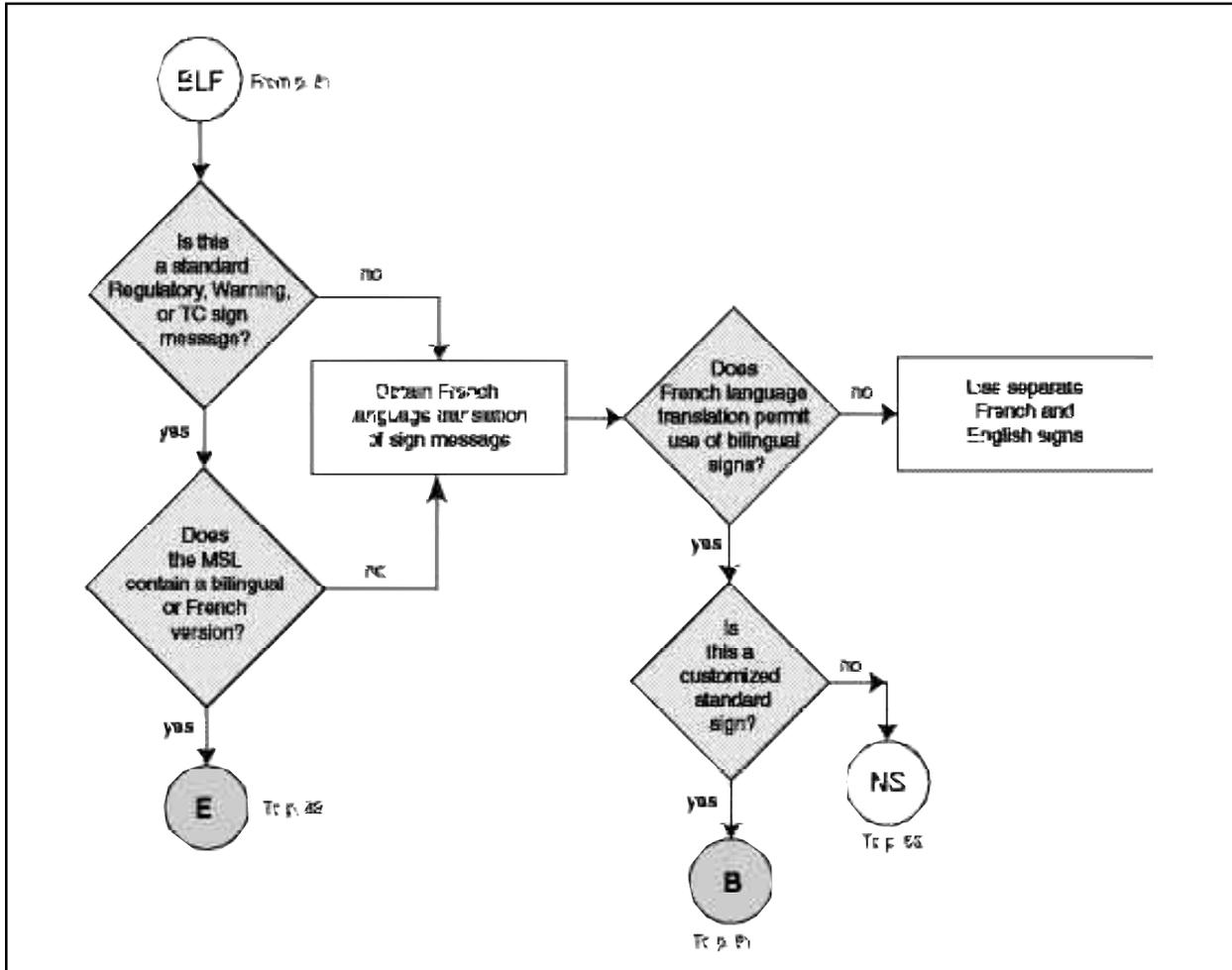
Flowchart A.2 – Sign Design Process – Customized Standard Sign Design



Flowchart A.3 – Sign Design Process – Standard Sign Design



Flowchart A.4 – Sign Design Process – Bilingual or French Language Signs



### 2.15.2 Application of Sign Design Process (Examples)

The application of the sign design process is illustrated here by use of examples. Some acronyms used in this section are: Master Sign Library (MSL); Sign Pattern Template (SPT); and Sign Parts Library (SPL).

#### Example 1

**Figure 2.19 – Standard Sign  
MAXIMUM SPEED (Rb-1)**



**Location data:** Required sign is 50 km/h, size is 600 mm x 750 mm.

Follow the steps outlined below.

- (1) Is a bilingual or French language sign required? No.
- (2) Identify class of sign: Standard sign.
- (3) Required sign is Rb-1; required size is 600 mm x 750 mm.
- (4) Locate Rb-1 Sign Pattern Template in MSL.
- (5) Is this the right template for the desired size? Yes.
- (6) Do the numerals on the Sign Pattern Template need to be changed? No.

- (7) Do borders have to be modified to fit border rules? No.
- (8) Use cut image for Rb-1, export for scaling up in cutting or printing software, either by applying scale factor from scale image or by applying absolute sign dimensions to the sign. See Section 4 (Sign Fabrication).

#### Example 2

**Figure 2.20 – Standard Sign  
MAXIMUM SPEED BEGINS (Rb-2)**



**Location data:** Posted speed is 60 km/h; two-lane road; no space constraints; ground-mounted sign; good vertical alignment; somewhat restricted horizontal alignment. These are the first 60 km/h signs after a long section of road that has had 80 km/h posted speed. To draw motorists' attention to the change in speed, an oversize MAXIMUM SPEED AHEAD sign and an oversize MAXIMUM SPEED BEGINS sign will be used. Note that the MSL does not contain standard oversize versions of these signs, so special oversize versions will have to be created.

Follow the steps outlined below.

- (1) Is a bilingual or French language sign required? No.

- (2) Identify class of sign: Standard sign.
- (3) Required sign is Rb-2; standard size is 600 mm x 900 mm; this special oversize sign will be 900 mm x 1500 mm (there is no standard sign blank of 900 mm x 1350 mm, which would maintain the same proportions).
- (4) Locate Rb-2 Sign Pattern Template in MSL.
- (5) Is this the right template for the desired size? No, because the proportions of the desired sign are 3:5 rather than 2:3. But no other template is given for this sign; this one will need to be adapted. Sign blank will be B-37, plywood. Create new image file, of desired dimensions 900 mm x 1500 mm. The letter sizes should be increased by 50% (900/600), and the vertical spaces should be increased so that the letters and numerals are proportionately spaced vertically approximately as shown on the original Rb-2 template.
- (6) Do the numerals on the Sign Pattern Template need to be changed? Yes, from 50 to 60. Remove the '5' and replace it with a '6' using the same font.
- (7) Do borders have to be modified to fit border rules? Yes. At this size, this is a plywood sign. From Table 2.13, the outer border (edge) is 25 mm and the inner border (thickness) is 25 mm, and the borders and corners are square, not rounded.
- (8) Use adapted image file for oversize Rb-2, use this as cut image and export for scaling up in cutting or printing software.

### Example 3

**Figure 2.21 – Customized Standard Sign  
TURN-OFF RIGHT TURN (Gr-2)**



**Location data:** Posted speed is 70 km/h; municipal two-lane road (one lane each direction); no space constraints; ground-mounted sign; good vertical and horizontal alignment.

Follow the steps outlined below:

- (1) Is a bilingual or French language sign required? No.
- (2) Identify class of sign: Directional guide sign, a customized standard sign.
- (3) Required sign is Gr-2; nominal size is 900 mm x 2100 or 2400 mm. Actual size needs to be determined through the design process.
- (4) Locate Gr-2 Sign Pattern Template in MSL.
- (5) Is this the right example for this sign? Yes.
- (6) Is this a ground-mounted or overhead sign? Ground-mounted.
- (7) Is this a freeway or non-freeway? Non-freeway.
- (8) Review and draw upon the sign design rules for non-freeway, ground-mounted signs.
- (9) Finalize the sign message including any abbreviations.

- (10) Is this a diagrammatic sign? No.
- (11) Determine font, letter size, and case from Sign Pattern Template. The font is Series D, the letter size is 200 mm, and the text is all upper case.
- (12) Type out all text in Series D in sign design program.
- (13) Determine arrows, crowns, symbols to be used (type and size) from the SPT and the Sign Parts Library in MSL. The crown is an MC-2 crown and the arrow is an A200-300.
- (14) Determine colours to be used (from SPT if available, or sign class).
- (15) Insert horizontal spacing and justification between text blocks and symbols, arrows, etc. The specified MC-2 crown is 432 mm high and 552 mm wide (from Sign Parts Library), with a numeral text size of 250 mm. The height of the largest letter (H) is 200 mm. The word 'EAST' is 606 mm wide and the word 'BROCKVILLE' is 1466 mm wide. The minimum top text line length (401 EAST) is 1358 mm (552 + 200 + 606). The minimum bottom text line length (BROCKVILLE) is 1466 mm. The bottom line is to be centred under the top line, hence the combined text block width (both lines) will be 1466 mm. The minimum space between the combined text block and the arrow is 200 mm. The arrow width is 374 mm. The minimum margin spacing on the left, between the left edge of the text block and the left edge of the sign is 200 mm plus the border width. The minimum margin spacing on the right, between the arrow and the right edge of the sign is also 200 mm plus the border width. If the sign size can be kept below 1200 mm x 2400 mm, it will be a plywood sign, and the

edge border width will be 25 mm. If the sign size is larger than this, in either dimension, it will be an aluminum extrusion sign, and the edge border width will be 50 mm.

- (16) Determine the minimum width of the sign, which is the length of the longest line including text, symbols, spaces, margins, and borders. The minimum width (excluding borders) is  $200 + 1466 + 200 + 374 + 200 = 2440$  mm. On a plywood sign, with 25 mm borders, the total minimum width would be  $2440 + 25 + 25 = 2490$  mm. This is wider than the largest plywood size of 2400. Now the question becomes: can the sign be compressed within the rules (10% compression), and still fit on a 2400 mm plywood sign (a compression of 90 mm), or is it necessary to use an aluminum extrusion sign?

When the sign is compressed horizontally, the compression applies principally to the text and should not exceed 10%. The software compression tool is used to execute the compression, either to fit a given space or by a given percentage. A 6.1% compression applied to the word BROCKVILLE (1466 mm) would reduce it by 90 mm for a width of 1376 mm. The top line (1358 mm) would not need to be compressed. A plywood sign could be used for this sign (based so far on horizontal dimensions only). As a check, the total width is  $25 + 200 + 1376 + 200 + 374 + 200 + 25 = 2400$  mm.

The decision might also be made not to compress the sign horizontally, but to use an aluminum extrusion sign. For aluminum extrusion signs, the border width is 50 mm, hence the total minimum sign width would be  $2490 + 50 + 50 = 2590$  mm. The next larger aluminum extrusion sign size is 9 feet or 2743 mm. To fit on this wider sign, the horizontal spaces on the sign (margins and

space from text block to arrow) are adjusted upwards proportionately, in this case by  $(2743 - 2590)/3 = 153/3 = 51$  mm. When an aluminum extrusion sign is used, it is necessary to develop the sign design dimensions so that it exactly fits the Imperial dimensions of the sign.

- (17) Insert vertical spacing between lines and symbols, etc. Check the SPT. The minimum spacing between the lines of text should be 0.5 to 0.75H (H is the largest letter size), which is a minimum of 100 mm. The spacing between the bottom of the crown and the lower line of text should be approximately 0.5H or 100 mm.
- (18) Determine the minimum height of the sign, considering the height of all elements, with reference to Step 17. Considering the lines of text first, the minimum vertical dimension should be  $133 + 200 + 100 + 200 + 133 = 766$  mm. Considering the crown and the lower line of text, the minimum vertical dimension should be  $50 + 432 + 100 + 200 + 133 = 915$  mm. This is slightly more than the 900 mm shown on the SPT. From the sign design rules, for a two-line sign, a vertical compression of up to 75 mm is acceptable, which is more than sufficient to fit the sign on a plywood blank. The bottom margin and the interline spacing are reduced by 8 and 7 mm respectively, so the overall minimum vertical dimensions will be  $50 + 432 + 93 + 200 + 125 = 900$  mm.
- (19) Add the borders to the sign design, 25 mm wide and squared corners, as specified in Table 2.12.
- (20) Check to see that the sign design appears visually balanced. If it is not, make minor readjustments. If it is satisfactory, move to the next step.

- (21) Check whether the sign width violates any physical width constraints. It does not. Location data indicated there were no space constraints.
- (22) This is not an overhead sign, hence maximum sign area and sign height constraints do not apply.
- (23) Use adapted image file for this sign, use this as cut image and export for scaling up in cutting or printing software.

**Example 4**

**Figure 2.22 – Customized Standard Sign  
ADVANCE TURN-OFF RIGHT TURN (Gf-22)**



**Location data:** Posted speed is 100 km/h; freeway (two lanes each direction); overhead sign; good vertical and horizontal alignment.

Follow the steps outlined below:

- (1) Is a bilingual or French language sign required? No; the exit panel will say EXIT, not EXIT/SORTIE.
- (2) Identify class of sign: Directional guide sign, a customized standard sign.
- (3) Required sign is Gf-22; nominal size is 2100 mm (7 feet) x variable. Actual size needs to be determined through the design process.
- (4) Locate Gf-22 Sign Pattern Template in MSL.

- (5) Is this the right example for this sign? Yes.
- (6) Is this a ground-mounted or overhead sign? Overhead.
- (7) Is this a freeway or non-freeway? Freeway.
- (8) Review and draw upon the sign design rules for freeway overhead signs.
- (9) Finalize the sign message including any abbreviations.
- (10) Is this a diagrammatic sign? No.
- (11) Determine font, letter size, and case from Sign Pattern Template. The font is Series E(m), the text is mixed upper/lower case, and the letter size is 410/300 mm.
- (12) Type out all text in Series E(m) in sign design program.
- (13) Determine arrows, crowns, symbols to be used (type and size) from the SPT and the Sign Parts Library in the MSL. There are no crowns, and the arrows/EXIT panel combination is taken from the SPL.
- (14) Determine colours to be used (from SPT if available, or sign class).
- (15) Insert horizontal spacing and justification between text blocks and symbols, arrows, etc. The height of the largest letter (H) is 410 mm. The word 'Kingsmount' is 3820 mm wide and the word 'Park' is 1430 mm wide. The word 'Road' on the second line is also 1430 mm wide. The minimum top text line length (Kingsmount Park) is 5660 mm (3820 + 410 + 1430). The minimum bottom text line length (Road) is 1430 mm. The bottom line is to be centred under the top line, hence the combined text block width (both lines) will be 5660 mm. The minimum space between the combined text block and the left side of the either/or arrow is 820 mm. The width of the block of the two arrows and the EXIT panel is 3121 mm. The minimum margin spacing on the left, between the left edge of the text block and the left edge of the sign is 410 mm plus the border width of 50 mm = 460 mm (aluminum extrusion). The minimum margin spacing on the right, between the right edge of the EXIT panel and the right edge of the sign is 292 mm. Note that the margin space between the right edge of the EXIT panel and the right edge of the sign is here not governed by the largest letter height, but by the dimension given for these arrow blocks in the SPL.
- (16) Determine the minimum width of the sign, which is the length of the longest line including text, symbols, spaces, margins, and borders. The minimum width (including borders) is  $50 + 410 + 5660 + 820 + 3121 + 292 = 10353$  mm. This is 33.97 feet. This fits almost perfectly on a 34 foot aluminum extrusion sign; a minor amount of expansion, 0.03 feet or 9 mm, would be necessary. If we apply an expansion of 9 mm, the left margin space may be increased from 50 to 59 mm.
- (17) Insert vertical spacing between lines and symbols, etc. Check the SPT. The minimum spacing between the lines of text should be 0.5 to 0.75H, which is a minimum of 205 mm. The spacing within the block of arrows and EXIT panel is given in the SPL.
- (18) Determine the minimum height of the sign, considering the height of all elements, with reference to Step 17. Considering the lines of text first, the minimum vertical dimension should be  $273 + 410 + 306 + 410 + 273 = 1672$  mm. The minimum vertical dimension

of the block of arrows and EXIT panel itself is 1651 mm (from SPL). The SPL shows the top margin from the top of the highest arrow to the top edge of the sign, to be 175 mm, and the bottom margin from the bottom of the EXIT panel to the bottom edge of the sign to be 300 mm. Considering the block of arrows and EXIT panel, the minimum vertical dimension should be  $175 + 1651 + 300 = 2126$  mm. This is slightly less than the 7 feet shown on the SPT (shown as 2100 mm, but actually 2134 mm). The top margin (above the arrow block) is increased by 3 mm to 178 mm and the bottom margin (below the arrow block) is increased by 5 mm to 305 mm. The overall minimum vertical dimensions will be  $178 + 1651 + 305 = 2134$  mm.

The vertical spacing of the lines of text now needs to be readjusted, to make up the 2134 mm height. The text font size remains the same, and the three minimum spaces of 273, 306, and 273 mm are each increased by  $(2134-1672)/3 = 154$  mm, so that these spaces become 427, 460, and 427 mm.

- (19) Add the borders to the sign design, 50 mm wide and square or rounded corners, as specified in Table 2.14.
- (20) Check to see that the sign design appears visually balanced. If it is not, make minor readjustments. If it is satisfactory, move to the next step.
- (21) Check whether the sign width violates any physical width constraints. It does not. A 34 foot wide sign can be installed over a two-lane roadway with shoulders. Location data indicated there were no space constraints.

- (22) Since this is an overhead sign, check to see whether maximum sign area and height are exceeded. Sign height is 7 feet, which is less than the maximum of 9 feet. Sign area is  $7 \times 34 = 238$  square feet, which is less than the maximum of 450 square feet (42 square metres). This is satisfactory.
- (23) Use adapted image file for this sign, use this as cut image and export for scaling up in cutting or printing software.

**Example 5**

**Figure 2.23 – Customized Standard Sign  
ADVANCE DESTINATION Tab (Gd-6A)**



**Location data:** Posted speed is 80 km/h; two-lane rural road (one lane each direction); ground-mounted sign; good vertical and horizontal alignment.

Follow the steps outlined below:

- (1) Is a bilingual or French language sign required? No.
- (2) Identify class of sign: Directional guide sign, a customized standard sign.
- (3) Required sign is Gd-6A; nominal size is 1200 mm (for three lines) x variable, ranging from 1500 mm to 1800 mm to 2100 mm to 2400 mm. Actual size needs to be determined through the design process.

- (4) Locate Gd-6A Sign Pattern Template in MSL.
- (5) Is this the right example for this sign? Yes.
- (6) Is this a ground-mounted or overhead sign?  
Ground-mounted.
- (7) Is this a freeway or non-freeway? Non-freeway.
- (8) Review and draw upon the sign design rules for non-freeway ground-mounted signs.
- (9) Finalize the sign message including any abbreviations.
- (10) Is this a diagrammatic sign? No.
- (11) Determine font, letter size, and case from Sign Pattern Template. The font is Series D, the text is all upper case, and the letter size is 150 mm.
- (12) Type out all text in Series D in sign design program.
- (13) Determine arrows, crowns, symbols to be used (type and size) from the SPT and the Sign Parts Library in MSL. There are no crowns, the advance left arrow is A125-180-80, and the advance channelized right turn arrow is A125-80-80.
- (14) Determine colours to be used (from SPT if available, or sign class).
- (15) Insert horizontal spacing and justification between text blocks and symbols, arrows, etc. The height of the largest letter is 150 mm. The word 'Orchards' is 995 mm wide and the words 'Caledon East', including a space between the words of 150 mm, are 1432 mm wide. The space between the arrow and the adjacent text is 150 mm in each line. Each line (text plus arrow) is to be centred horizontally on the sign. The minimum margin spacing on the left, between the left edge of the sign and the arrow (top line) or first word (bottom line) is 150 mm plus the border width of 25 mm = 175 mm (plywood blank). The minimum margin spacing on the right, between the right edge of the sign and the adjacent text (top line) or arrow (bottom line) is 150 mm plus the border width of 25 mm = 175 mm. The width of the advance left turn arrow (A125-180-80) is 270 mm and the width of the advance channelized right turn arrow (A125-80-80) is 130 mm.
- (16) Determine the minimum width of the sign, which is the length of the longest line including text, symbols, spaces, margins, and borders. The minimum width of the line with "Caledon East" (including borders) is  $25 + 150 + 1432 + 150 + 130 + 150 + 25 = 2062$  mm. The next size up is 2100 mm. If the two margin spaces are each increased by 13 mm and the space between the word "East" and the arrow is increased by 12 mm, the total width will be  $25 + 163 + 1432 + 162 + 130 + 163 + 25 = 2100$  mm. The block of text and arrow in the top line of Orchards is  $270 + 150 + 995 = 1415$  mm, and is centred within the 2100 mm sign width.
- (17) Insert vertical spacing between lines and symbols, etc. Check the SPT. If there were no internal borders between lines, the minimum spacing between the lines of text should be 0.5 to 0.75H, which is a minimum of 75 mm. However, this sign has internal borders between lines, and hence the minimum spacing between the text and the adjacent internal border should be 0.67H or 100 mm, including the 20 mm internal border. The minimum spacing between the text and the adjacent edge of the sign should also be

0.67H or 100 mm, including the 25 mm outer border. The minimum clear vertical spacing between the vertical extremities of the arrows and the adjacent borders should be equal to the width of the outer border (in this case, 25 mm). This means that the minimum vertical spacing between the vertical extremity of the arrow and the adjacent border (including border width) should be 45 mm for internal borders and 50 mm for external borders.

- (18) Determine the minimum height of the sign, considering the height of all elements, with reference to Step 17. Considering the lines of text first, the minimum vertical dimension should be  $100 + 150 + 80 + 20 + 80 + 150 + 100 = 680$  mm. The next larger standard sign size is 900 mm. Increase each of the two outer spaces by 50 mm each, and each of the two inner spaces by 60 mm, so that the spacing becomes  $150 + 150 + 140 + 20 + 140 + 150 + 150 = 900$  mm. The sign is therefore 900 mm x 2100 mm, and the sign blank (from the sign blank table, Table 5.1 in Section 5 or in the MSL) is B-39.
- (19) Add the borders to the sign design, 25 mm wide and squared corners, as specified in Table 2.12.
- (20) Check to see that the sign design appears visually balanced. If it is not, make minor readjustments. If it is satisfactory, move to the next step.
- (21) Check whether the sign width violates any physical width constraints. It does not.
- (22) This is not an overhead sign, hence maximum sign area and sign height constraints do not apply.

- (23) Use adapted image file for this sign, use this as cut image and export for scaling up in cutting or printing software.

**Example 6**

**Figure 2.24 – Diagrammatic Sign  
(No Sign Number)**



**Location data:** Posted speed is 100 km/h; rural freeway (QEW) (three lanes each direction); overhead sign; good vertical and horizontal alignment. Sign to depict diagrammatically a three-lane roadway splitting into two two-lane roadways, with an either/or lane.

Follow the steps outlined below:

- (1) Is a bilingual or French language sign required? No.
- (2) Identify class of sign: Diagrammatic directional guide sign, a customized standard sign.
- (3) Is required sign available from another source? No.
- (4) Locate Diagrammatic Sign Pattern Template (example) in MSL.
- (5) Is this the right example for this sign? Yes, but each diagrammatic sign needs to be custom designed.
- (6) Is this a ground-mounted or overhead sign? Overhead.
- (7) Is this a freeway or non-freeway? Freeway.

- (8) Review and draw upon the sign design rules for freeway overhead signs and for diagrammatic signs.
- (9) Finalize the sign message including any abbreviations.
- (10) Choose arrow configuration design from SPL, if it exists. If there is no identical arrow in the SPL, either create a new one or adapt one of the arrow configurations in the SPL, using the software drawing tools.
- (11) Arrange sign elements spatially for visual clarity.
- (12) Determine font, letter size, and case from Sign Pattern Template. The font is Series E(m), the text is mixed upper/lower case, and the letter size is 410/300 mm.
- (13) Type out all text in Series E(m) in sign design program.
- (14) Determine crowns to be used (type and size) from the SPT and the Sign Parts Library in MSL. From the general guidelines, design the sign using an MC-5 crown, to start with.
- (15) Determine colours to be used (from SPT if available, or sign class)
- (16) Insert horizontal spacing and justification between text blocks, crowns and arrows. The height of the largest letter (H) is 410 mm. The two MC-5 crowns are each 1067 mm high and 1372 mm wide. The words "Bridge to U.S.A." (longest line to the left of the arrows) are 5061 mm wide. The words "Niagara Falls" (longest line to the right of the arrows) are 3937 mm wide. These dimensions include a spacing between words of H or 410 mm. The space between the arrow and the adjacent text (or crown if applicable) is also at least 410 mm at the closest point, on each side of the arrow. Each line (text or crown) is to be centred horizontally on the sign, within the space defined by the minimum spacing from the arrow. The minimum margin spacing on the left, between the left edge of the sign and the word "Bridge" is 410 mm plus the border width of 50 mm = 460 mm (aluminum extrusion). The minimum margin spacing on the right, between the right edge of the sign and the word "Falls" is 410 mm plus the border width of 50 mm = 460 mm. The text lines on either side of the arrow should not encroach closer to the arrow horizontally than the edge of the arrow tip. If the spacing of "H" brings the text closer than this, then the edge of the arrow becomes the governing factor in the horizontal spacing between text and arrow.
- (17) Determine the minimum width of the sign, which is the length of the longest line including text, crowns, arrows, spaces, margins, and borders. The minimum width (including borders) is  $50 + 410 + 5061 + 2530$  (arrow width)  $+ 3937 + 410 + 50 = 12448$  mm. This is 40.83 feet. The next size up is 42.00 feet, or 12802 mm, an increase of 354 mm from the minimum width. This additional space should be divided into four equal parts, each 88.5 mm wide, and used to create additional space around text blocks. To simplify the numbers, a spacing of 89 mm on either end and 88 mm between text and arrows could also be used. The width dimensions then become  $50 + (410 + 89) + 5061 (+ 88) + 2530 + 3937(+88) + (410 + 89) + 50 = 12802$  mm. Taking the left text block as a unit, and the right text block as a unit, each of these units should be centred within its somewhat increased available space. The centre of the left text block is then  $50 + 410 + 89 + (0.5) * 5061 = 3079.5$  mm from the left edge of the sign. The centre of

the diagrammatic arrow is  $50 + 410 + 89 + 5061 + 88 + (0.5) * 2530 = 6963$  mm from the left edge of the sign. Similarly, the centre of the right text block is  $50 + 410 + 89 + (0.5) * 3937 = 2517.5$  mm from the right edge of the sign.

- (18) Check whether the sign width violates any physical width constraints. It does not. The 42 foot sign will fit satisfactorily over three roadway lanes with shoulders.
- (19) Insert vertical spacing between lines and symbols, etc. Check the SPT. The minimum spacing between the lines of text should be 0.5 to 0.75H, which is a minimum of 210 mm. With upper/lower case text, 0.75H or 315 mm is preferable. The minimum spacing between the lowest line of text and the bottom edge of the sign should also be 0.67H or 270 mm, including the 50 mm outer border. The minimum vertical spacing between the vertical extremity of the arrow and the adjacent border (including border width) should be 0.25H (105 mm) at the top of the sign and 0.5H (210 mm) at the bottom of the sign. However, the standard height for all diagrammatic arrows is 8 feet (2438 mm) on a 9 foot sign, leaving only 1 foot (305 mm) for the two margins and borders, which is slightly less than the 315 mm (105 + 210). The upper margin including border width should therefore be 102 mm and the bottom margin including border width should be 203 mm.
- (20) Determine the minimum height of the sign, considering the height of all elements, with reference to Step 19. Considering the lines of crown and text first, the minimum vertical dimension should be  $100$  (i.e., twice the border width) +  $1067 + 205 + 410 + 315 + 410 + 270 = 2777$  mm. (9.11 feet).

Diagrammatic signs are typically designed at a height of 9 feet (the maximum) in order to have space for well-proportioned diagrammatic arrows.

- (21) This is an overhead sign, check whether maximum sign area and sign height constraints are exceeded. The sign height as designed is 9.11 feet and exceeds the permissible 9 feet by 34 mm. In this instance, interline spacing can be reduced toward the minimum by making the spacing 281 mm rather than 315 mm. This results in a sign height of 2843 mm or 9 feet. This height will also accommodate the diagrammatic arrow as outlined in Step 20.
- (22) Add the borders to the sign design, 50 mm wide and square or rounded corners, as specified in Table 2.14.
- (23) Check to see that the sign design appears visually balanced. If it is not, make minor readjustments. If it is satisfactory, move to the next step.
- (24) Since this is an overhead sign, check to see whether maximum sign area and height are exceeded. Sign height is 9 feet, which equals the maximum of 9 feet. Sign area is  $9 \times 44 = 396$  square feet, which is less than the maximum of 450 square feet (42 square metres). This is satisfactory.
- (25) Use adapted image file for this sign, use this as cut image and export for scaling up in cutting or printing software.

## 3. Sign Materials

Most signs are assembled by applying sheeting to a rigid sign blank. In some cases, signs are screened on reflective sheeting. This section describes the materials from which signs are fabricated and assembled, the specifications commonly used in Ontario to control the production of these materials, and procedures for testing material performance. Section 4 deals with the fabrication of signs, including substrate preparation. Book 3 (Sign Support and Installation), yet to be developed, covers sign posts, structures and hardware.

Sign material technology is continually evolving. Road authorities are generally encouraged to keep abreast of new available materials, which may be used, provided that they have been sufficiently tested to prove they meet or exceed the performance requirements of materials currently in use.

### 3.1 Sign Face Materials

Sign face materials include:

- adhesive sheeting;
- screen printing ink and coatings; and
- computer cuttable transparent or opaque overlay films.

These materials may be used in combination with one another. However, not all inks and sheetings are compatible with each other. Manufacturers' specifications and recommendations should be followed to ensure good sign performance and enforceable warranties.

### 3.1.1 Types of Sign Sheeting

Most signs on Ontario's roadways are faced with retroreflective sheeting. As described in Section 2.9 (Reflectorization and Illumination), retroreflective sheeting refracts light from headlights so that most of it is reflected back to the driver and less is diffused to the periphery of the sign (see Figure 3.1). The coefficient of retroreflectivity (i.e., the R-value) was also defined in Section 2.9 as the proportion of light reflected back to the driver. Many signs use non-reflective black material (acrylic or vinyl) or black ink for all or part of the sign message. While non-reflective coloured sheetings are available, they are rarely used, because a sign needs to be retroreflective to ensure that its shape, colour, and message are retained at night.

Various types of retroreflective sheeting are available today. Table 3.1 defines the types of sheeting in terms of name, structure, typical applications, an approximate brightness index and an approximate cost index. The brightness and cost indices are based on the Type I values, which are assigned an index value of 1. In general, the higher the type number (except within Types VII, VIII and IX), the greater the amount of light reflected back to the driver's eyes. Guaranteed and reported service life, which also vary according to sheeting type, are discussed in Section 3.2.1 (Durability and Service Life) below.

**Figure 3.1 – Concept of Retroreflectivity Using Glass Bead Technology**

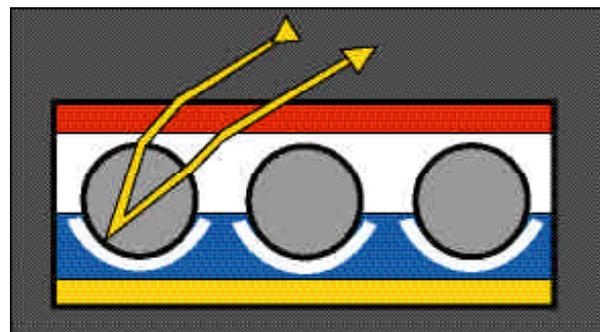


Table 3.1 – Types of Retroreflective Sheeting<sup>1</sup>

ASTM Type	Name	Structure	Brightness Index <sup>2</sup>	Cost Index <sup>3</sup>	Applications	Comments
I	<b>Engineering Grade</b>	<ul style="list-style-type: none"> <li>Enclosed lens glass-bead material</li> <li>Very small glass beads enclosed in a pigmented substrate</li> </ul>	1	1	<ul style="list-style-type: none"> <li>Permanent highway signing, work zone devices, delineators</li> </ul>	
II	<b>Super-Engineering Grade</b>	<ul style="list-style-type: none"> <li>Enclosed lens glass-bead material</li> </ul>	2	<2	<ul style="list-style-type: none"> <li>Permanent highway signing, work zone devices, delineators</li> </ul>	
III	<b>High Intensity Grade</b>	<ul style="list-style-type: none"> <li>Encapsulated glass-bead material</li> <li>Outer transparent pigmented layer and inner reflective layer faced with glass beads connected by honeycomb lattice</li> </ul>	4	2	<ul style="list-style-type: none"> <li>Permanent highway signing, work zone devices, delineators</li> </ul>	
IV	<b>High Intensity Prismatic</b>	<ul style="list-style-type: none"> <li>Non-metallized micro-prismatic material</li> <li>Multi-layer sheeting</li> <li>Reflective layer made of microscopic cube-corner reflectors</li> </ul>	4	2	<ul style="list-style-type: none"> <li>Permanent highway signing, construction zone devices, delineators</li> </ul>	<ul style="list-style-type: none"> <li>Designed for narrow angle viewing (i.e., long distance)</li> <li>Brightness index decreases to &lt;3 for 30 degree entrance angle</li> </ul>
V	<b>Super-high Intensity</b>	<ul style="list-style-type: none"> <li>Metallized micro-prismatic material</li> </ul>	10	5.5	<ul style="list-style-type: none"> <li>Delineators and raised pavement markers</li> </ul>	
VI	<b>Elastomeric High Intensity</b>	<ul style="list-style-type: none"> <li>Vinyl microprismatic material</li> <li>Sheeting without adhesive</li> </ul>	3.5	6	<ul style="list-style-type: none"> <li>Temporary roll-up signs, warning signs, traffic cone collars, post bands, clothing</li> </ul>	
VII	<b>Super-high Intensity (long-medium distance)</b>	<ul style="list-style-type: none"> <li>Non-metallized high reflectivity micro-prismatic material</li> <li>Distinguished by diamond-shaped lattice separating sheeting layers</li> </ul>	11	5	<ul style="list-style-type: none"> <li>Permanent highway signing, construction zone devices, delineators</li> </ul>	<ul style="list-style-type: none"> <li>Highest retroreflectivity at long and medium road distances</li> <li>Brightness index increases to 19 for 30 degree entrance angle</li> </ul>
VIII	<b>Super-high Intensity (long-medium distance)</b>	<ul style="list-style-type: none"> <li>Non-metallized high reflectivity micro-prismatic material</li> </ul>	10	5	<ul style="list-style-type: none"> <li>Permanent highway signing, construction zone devices, delineators</li> </ul>	<ul style="list-style-type: none"> <li>Highest retroreflectivity at long and medium road distances</li> <li>Blue colour brighter than for Type VII</li> <li>Spec for brown (but not for other Type V or higher)</li> </ul>
IX	<b>Very-high Intensity (short distance)</b>	<ul style="list-style-type: none"> <li>Non-metallized high reflectivity micro-prismatic material</li> <li>Similar to Type VII, with fine grain microprisms</li> </ul>	5.5	5	<ul style="list-style-type: none"> <li>Permanent highway signing, construction zone devices, delineators</li> </ul>	<ul style="list-style-type: none"> <li>Designed for wider observation angles when driver eye is close to sign</li> <li>Brightness index increases to 8 for 0.5 degree observation angle</li> </ul>

<sup>1</sup> Includes data from: ASTM D 4956-01a; FP-96 (*Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects*, FHWA, 1996); <http://members.aol.com/rcmoer/sgnsheet.html>.

<sup>2</sup> Based on ASTM D 4956-01a for white sheeting at entrance angle = -4 degrees and observation angle = 0.2 degrees.

<sup>3</sup> Approximate values.

In the Ontario Traffic Manual, one of four grades of retroreflective sheeting (or equivalent) is typically specified for signs: Type I (engineering grade), Type III or IV (high intensity), or high reflectivity micro-prismatic sheeting. The high reflectivity micro-prismatic sheeting specified in the OTM is fluorescent retroreflective sheeting. Material of Type VII, Type VIII or Type IX meets this description; specifications and manufacturers' recommendations should be checked as to which type is best for a given application. In most cases, sheeting with higher retroreflectivity may be used instead of the minimum sign sheeting specified.

The OTM mandates the use of high intensity sheeting (Type III minimum) or high reflectivity micro-prismatic sheeting (Type VII or higher) for several signs which are critical from a safety standpoint, that is, failure to see or heed these signs at night could have serious consequences. See Book 5 (Regulatory Signs), Book 6 (Warning Signs) and Book 7 (Temporary Conditions). In Ontario, high intensity sheeting is also typically used for the legends of overhead freeway guide signs, and some jurisdictions use high intensity sheeting for both the legends and backgrounds of these types of signs. However, it may make sense to use high intensity sheeting or high reflectivity micro-prismatic sheeting for other applications also, for new signs installed and as part of a regular sign replacement program. In addition to the obvious benefit of improving legibility, high intensity sheeting or high reflectivity micro-prismatic sheeting is also often more cost effective over the life of the sign. See Section 3.2.3 (Benefit/Cost Considerations).

In addition to the types of sheeting described above, fluorescent sheeting is also available. Fluorescence is the emission of light immediately upon exposure to radiation. Fluorescent substances appear to glow vividly when they are irradiated, by ultra-violet radiation, for example. This effect is due to the absorption of short wavelengths of radiation

and their re-emission at longer visible wavelengths. Therefore, fluorescent-coloured sheeting appears brighter and more conspicuous than other types of sheeting by day, and particularly at twilight and under overcast conditions. Fluorescent sheeting has minimal effect on the nighttime performance of signs, when compared to non-fluorescent retroreflective sheeting. Because of its unique properties, fluorescent sheeting may be considered for applications where there is a problem with daytime conspicuity, for example at high conflict or high collision locations. At least one manufacturer supplies high reflectivity micro-prismatic sheeting which is also fluorescent and has a practicable life cycle. Other manufacturers supply fluorescent sheeting, but without the high reflectivity micro-prismatic characteristics.

### 3.1.2 Sheeting Standards and Specifications

R-values associated with several types of retroreflective sheeting are detailed in the ASTM Specification D 4956-01a (or its subsequent revisions). (Note: these R-values are referred to in the ASTM specification and in some other publications as  $R_A$ ). Type I to Type IX (inclusive) sheetings are covered in the ASTM specification. Fluorescent sheeting is not defined in the 2001 version of the specification. In Canada, the CGSB Specification 62-GP-11 (or its subsequent revisions) also specifies retroreflective sheeting. The CGSB specification has not been revised since 1987 and does not cover sign sheetings of Type IV or higher. Note also that the CGSB designations are the reverse of the ASTM designations. That is, ASTM Type I is CGSB Level 2; ASTM Type III is CGSB Level 1.

In the specifications, R-values are provided for different entrance angles and observation angles. The entrance angle is the angle between the headlight beam and the perpendicular to the sign

face (see Figure 3.2). The observation angle is the angle formed by light travelling from the headlight and reflected off the sign back to the driver's eye (see Figure 3.3). Larger entrance and observation angles result in lower R-values.

The **entrance angle** is affected by:

- the horizontal sign offset;
- sign mounting height (vertical offset);
- the distance between the vehicle and the sign;
- the travel lane of the vehicle;

- the curvature of the roadway;
- tilt angle of the sign about its vertical axis (horizontal angling of side-mounted signs); and
- tilt angle of the sign about its horizontal axis (vertical angling of overhead signs).

The **observation angle** is affected by:

- the distance between the vehicle and the sign;
- sign mounting height (vertical offset); and
- the distance between headlight height and driver eye height.

Figure 3.2 – Entrance Angle

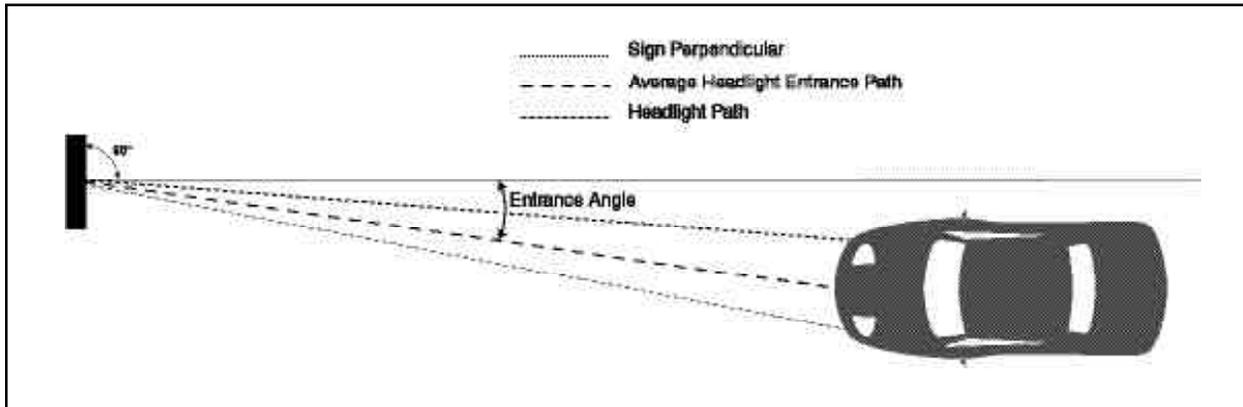
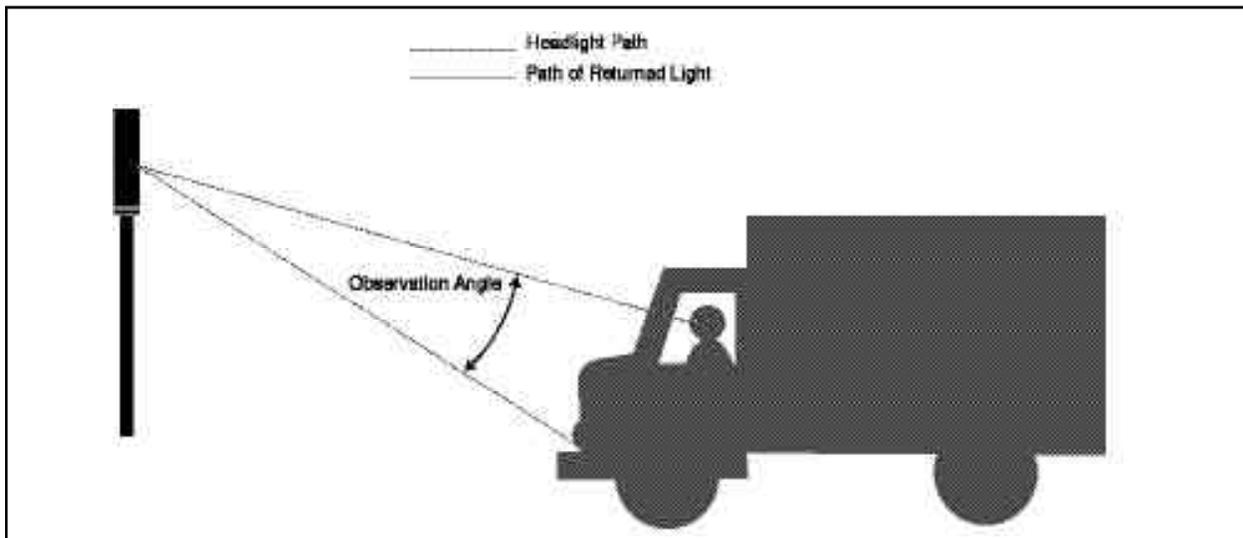


Figure 3.3 – Observation Angle



One difference between the ASTM standard and the CGSB standard is that the CGSB standard sets out a performance level requirement at 50 degrees entrance angle, while the widest entrance angle for which the ASTM standard specifies a performance level is 30 degrees. If signs are to be installed where **entrance** angles are greater than 30 degrees (e.g., if the sign has a very large horizontal mounting offset, or the sign is tilted well away from the perpendicular to the road), the CGSB specification may be used.

The R-values vary according to colour, with darker colours having generally lower R-values. For example, minimum ASTM R-values for new Type I, Type III, Type VII, and Type IX sheeting of various colours, measured at an observation angle of 0.2 degrees and an entrance angle of -4 degrees, are shown in Table 3.2. These R-values should be considered as guidelines only. Typically, new sheeting has much higher values, by on the order of 30%, than the minimum ASTM values indicated in the table.

*Testing Procedures*

ASTM D-4956-01a prescribes performance requirements and corresponding testing procedures for a number of sign sheeting properties, as indicated below. There are supplementary

**Table 3.2 – ASTM R-Values\***  
(candelas/lux-m<sup>2</sup>)

Colour	Type I	Type III	Type VII	Type IX
White	70	250	750	380
Yellow	50	170	560	285
Orange	25	100	280	145
Green	9	45	75	38
Red	14	45	150	76
Blue	4	20	34	17
Brown	1	12	-	-

\* Observation Angle = 0.2 Degrees  
Entrance Angle = -4 Degrees

performance requirements in addition to the mandatory ones. The supplementary requirements apply only when specified by the purchaser in the contract or order. Some of the tests for the various sheeting properties reference other ASTM Standards, primarily specifications, test methods and practices.

**Coefficient of Retroreflection**

For each sheeting type, tables indicate the minimum coefficient of retroreflection required for new sheeting at various:

- Observation angles, including 0.1 degrees, 0.2 degrees, 0.5 degrees and/or 1.0 degrees, depending on the sheeting type. Values for 0.1 degree observation angles are supplementary requirements that apply only when specified by the purchaser in the contract or order;
- Entrance angles, including -4 degrees and +30 degrees; and
- Colours, including white, yellow, orange, green, red, blue and brown. (Specifications for brown sheeting are not included for Types V, VI, VII and IX.)

**Daytime Colour**

Daytime colour specification limits are defined using four pairs of chromaticity coordinates to determine the acceptable colour in terms of the CIE 1931 Standard Colorimetric System.

Minimum and maximum daytime luminance factors for different colours of sheeting are provided in three separate tables:

- For non-prismatic material (Types I, II, III and VI);
- For non-metallized microprismatic material (Types IV, VII, VIII and IX); and
- For metallized microprismatic material (Type V).

**Accelerated Outdoor  
Weathering Requirements**

Sheeting must be weather resistant and show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, and remain within specified limits for shrinkage and expansion, when tested according to the procedure described in the specification.

The minimum coefficient of retroreflectivity required to be retained after the weathering tests is indicated for each sheeting type in terms of percentage of the minimum required new R. The outdoor weathering test time varies by sheeting type and ranges from 6 months to 36 months. Regardless of sign sheeting type, when the colours orange, yellow or white are specified for construction work zone applications, the outdoor weathering test time requirement is 12 months.

**Colourfastness**

After it has been tested for outdoor weathering using the specified tests, retroreflective sheeting must retain its specified daytime colour properties.

**Shrinkage**

The absolute minimum shrinkage allowances are provided, effective after testing for 10 minutes and for 24 hours, according to the specified tests.

**Flexibility**

Sheeting must be sufficiently flexible to show no cracking when tested according to the procedure described in the specification.

**Liner Removal**

If a liner is provided with the sheeting, it must be easily removable after being subjected to the accelerated storage test described in the specification. The liner must be easily removable without soaking in water or other solution, and must not break, tear or remove adhesive from the sheeting upon removal.

**Adhesion**

The specification indicates the bond strength of the adhesive backing of the sheeting, in terms of minimum weight supported for 5 minutes, without the bond peeling for more than a specified maximum distance, when tested according to the procedure described in the specification. The minimum weight that must be supported varies by class of adhesive.

**Impact Resistance**

Sheeting must show no cracking or delamination outside of the actual area of impact when subjected to the impact test described in the specification.

**Specular Gloss**

The specification indicates the minimum required specular gloss value, after testing as indicated in the specification.

**Fungus Resistance (Supplementary Requirement)**

Performance requirements and tests for fungus growth and fungus damage are provided for use in areas where fungus growth on retroreflective sheeting may be a problem.

**Reboundable Sheeting Requirements**

(Supplementary Requirement)

Sheeting must show no cracking or delamination outside the actual area of impact when subjected to the supplementary impact test described in the specification.

**Artificial Accelerated Weathering**

(Supplementary Requirement)

The supplementary test described in the specification may be used for provisional qualification of sheeting before the results from outdoor weathering are available. When they become available, the results from outdoor weathering take precedence over the results from laboratory-accelerated weathering tests.

In addition to performance requirements and test procedures, ASTM D 4956-01a provides information on general requirements (e.g., tolerances for sheets and rolls), packaging and package marking, and ordering information a purchaser should provide when using the specification to procure retroreflective sheeting. The specification also defines four classes of adhesive backing. Sheeting adhesives are discussed in Section 4 (Sign Fabrication).

### 3.1.3 Screen Printing Ink and Coatings

For frequently used sign patterns, e.g., STOP signs, it is feasible to screen coloured ink onto reflective sheeting. Users should follow manufacturers' specifications and recommendations for both sheeting materials and inks to ensure good performance and compatibility between the two types of material and to ensure enforceable warranties.

Positive screening is used for signs with legends that are darker than their backgrounds, e.g., most warning signs. The legends of these signs are applied directly onto the coloured sign face with opaque black ink. Negative screening is used for signs with legends that are lighter than their backgrounds, e.g., STOP and YIELD signs. For these types of signs, transparent ink in the background colour is applied over the entire sign face, with the exception of the legend. For example, in Ontario, STOP and YIELD signs are typically screened in red transparent ink over high intensity white sheeting, allowing the retroreflective sheeting to act through the ink. Where transparent inks are used in screening, the ink should have the same guaranteed life cycle as the retroreflective sheeting (see Section 3.2.1 for information on guaranteed life cycles of retroreflective sheeting).

Clear-coatings are often applied to screened signs for protection. Advances have been made in the development of coatings which better protect signs such as STOP signs from degradation due to ultra-violet radiation. Graffiti-resistant inks and coatings are also available. These coatings are solvent resistant and enable graffiti to be easily wiped off the sign face. They may also feature non-stick surfaces to facilitate sticker removal.

As described in Section 4 (Sign Fabrication), direct-applied retroreflective sheeting copy is also often used in sign manufacture.

## 3.2 Sign Sheeting Performance

Sign sheeting performance is critical to the overall performance of a sign, as the sheeting typically degrades before the substrate and the other sign components. Knowledge of how sheeting degrades and of realistic expected life cycles for sign sheeting materials can assist a practitioner in making cost-effective decisions on which sheeting to use for different applications.

### 3.2.1 Durability and Service Life

The durability of a sign sheeting depends on how long and how well it is able to withstand exposure to natural and man-made elements, primarily ultra-violet (UV) radiation from sunlight, but also, wind, rain, ice, pollution and extreme temperatures. The type of sheeting failure is related to the structure of the sheeting. Single layer sheeting, such as Type I or Type II, usually fails by gradually losing retroreflective intensity. Exposure to ultra-violet rays through sunlight, as well as heat and pollution causes the pigmented material to fade. This type of UV fading is also particularly damaging to transparent inks, such as those used to screen STOP and YIELD signs. Signs with a southern exposure degrade the fastest. Multi-layer sheeting,

such as Type III and Type IV, fails structurally. The outer coloured layer delaminates and falls off, exposing the silver reflective layer beneath to the elements, and decreasing the contrast required for legibility.

Different types of sign sheeting have different lengths of service life (see Table 3.3). For several reasons, it is difficult to directly compare the service life of different sheeting types. Manufacturers guarantee a type of sheeting for a given number of years, by specifying the percentage of the R-values required by the ASTM specifications for new sheeting that will still be in place at the end of the guarantee period. The percentages, however, vary from 50% to 80% by sheeting type. The absolute R-value requirements for different sheeting types are also different.

These differences result in a wide variation among the absolute R-values required at the end of the guarantee period. With higher sheeting types, the percentage of the new R-value that is guaranteed to the end of the life cycle is generally higher. For example, with Type I sheeting, 50% of its new R-value is guaranteed at the end of 7 years (R at

end of life cycle = 35 for white sheeting at observation angle = 0.2 degrees and entrance angle = -4 degrees), while with Type III sheeting, 80% of its new R-value is guaranteed at the end of 10 years (R at end of life cycle = 200 for the same angles). With Type VII sheeting, 70% of its new R-value is guaranteed at the end of 10 years (R at end of life cycle = 525 for the same angles). There is a fifteen-fold difference between the Type VII and the Type I guaranteed end-of-life R-values in this example.

As Table 3.3 shows, the reported service life of retroreflective sheeting, observed through actual experience, may be somewhat longer than covered by the guarantee. A further consideration is that sign manufacturers produce sheeting that may far exceed the ASTM specification for a given type of sheeting, but market it as meeting that specification because test procedures for the lower type are already in place. Setting up new or additional testing procedures may not be cost-effective. Also, some products fall between the standards for two consecutive types of sheeting and therefore are brighter than the next lowest specification available.

**Table 3.3 – Sign Sheeting Service Life**

Type	Service Life		Guaranteed End-of-Life R-Value	
	Guaranteed [years]	Reported [years]	% of New R	Absolute R* [candelas/lux-m <sup>2</sup> ]
I	7	7	50%	35
II	10	15	50%	70
III	10	17-20	80%	200
IV	10	unknown	80%	200
VII	10	13	70%	525
VIII	10	unknown	70%	490
IX	10	10+	70%	266

\* White Sheeting  
 Observation Angle = 0.2 Degrees  
 Entrance Angle = -4 Degrees

### 3.2.2 Benefit/Cost Considerations

If higher intensity sheeting has longer service life, it may prove to be economically advantageous to use, even if it is initially more expensive. Using higher intensity sheeting generally increases nighttime legibility and conspicuity. (In some situations, e.g., Type IV sheeting, the legibility and conspicuity benefits only apply for specific observation and entrance angles.)

In limited situations, increasing sign brightness can be traded off against increasing sign size. When there is a choice of increasing font size or increasing reflectivity to achieve nighttime legibility, increasing sign size is preferred since it improves daytime and nighttime visibility. Where increasing font size is not feasible (e.g., due to placement constraints, sign size structural limits, cost considerations, etc.), material reflectivity can be increased until an equivalent legibility is obtained.

The analyses of benefit/cost assume that a higher reflectivity value over the life of the sign is necessary and valuable. This may not always be the case. For example, although in a crowded urban environment increased sign reflectivity may increase conspicuity, with real benefit, in an open rural area with little visual competition, engineering grade sheeting may provide sufficient conspicuity.

To compare life cycle costs of signs made of various sheeting types, annual costs provide a true comparison. While the Equivalent Uniform Annual Cost (EUAC), amortized using a discount rate over a fixed number of years provides more accurate values, a useful comparison can be made by simply calculating average annual cost as follows:

$$\text{Average Annual Cost} = \frac{\text{Total Cost}}{\text{Service Life}}$$

Since the above approximation of EUAC does not incorporate a discount rate for amortization, it is slightly biased in favour of the sign with the longer service life (i.e., the cost savings for a sign with a longer service life are slightly greater than if a non-zero discount rate were applied).

In the above equation, total cost is taken to be all life cycle costs for materials and labour associated with a new sign installation or an overlay of an extruded sign. (Extruded signs can be overlaid rather than replaced in entirety when the sheeting degrades.) Total cost includes the following items:

- **Materials** – Sheeting, substrates/blanks, supports, bracing, hardware;
- **Labour** – Fabrication, installation, dismantling, inspection, maintenance;
- **Salvage Value (Negative Cost)** – Aluminum, other recyclable materials.

The values used for service life in the equation should make some allowance for the reported life of the sign, to render a realistic estimate. Averaging the guaranteed sheeting service life and the reported service life would be an acceptable approach. Actual experience with sheeting service life within the jurisdiction should be reflected in the values used.

Once the average annual cost is obtained for the signs constructed with the sheeting types being compared, cost savings can be calculated by the following formula:

$$\text{Cost Savings} = \frac{\text{HAAC} - \text{LAAC}}{\text{HAAC}} \times 100\%$$

where: HAAC = Higher Average Annual Cost  
LAAC = Lower Average Annual Cost

A benefit/cost analysis of sign sheeting should take into account the following practical considerations:

- The analysis does not apply to temporary sheeting, which may be used for short periods only, or reinstalled several times.
- If signs are destroyed before reaching the end of their service life, e.g., through vandalism, knocked down by trucks, damaged by weather, etc., the savings resulting from a longer sheeting service life cannot be fully realized. Assuming that a random distribution of old and new signs are destroyed each year, the annual cost savings resulting from using a sign with a longer service life is decreased by about 1% to 3%, per percentage of total signs annually destroyed. For example, if 2% of all signs in a jurisdiction were annually destroyed, the annual cost savings associated with a sign with a longer life would be decreased by 2% to 6%.
- Some high performance sheeting is more fragile and requires more care in fabrication, handling and storage. For example, specialized tools (hot knife) are required for cutting Type VII sheeting. Some agencies may not be equipped to provide this level of control.
- It may not be efficient to inventory and fabricate signs from many different sheeting types to optimally accommodate various signing scenarios. A more practical approach would be to select a few sheeting types to handle overall jurisdictional requirements.

### 3.3 Sign Substrates

Sign substrates are the materials from which sign blanks are fabricated, and to which retroreflective sheeting is then applied. This section describes commonly used substrate materials and specifications controlling their production.

Depending on the material, substrates need to be levelled, smoothed, cut to standard blank size, stamped to form radius corners and holes for sign mounting, deburred if screen-printed, weather-proofed and/or surface-treated to improve adhesion. These processes are discussed in Section 4.1 (Substrate Preparation).

#### 3.3.1 Substrate Materials

The materials described below are most commonly used as sign substrates. The advantages and disadvantages of each type of substrate should be considered for the specific signing application.

##### *Aluminum*

Aluminum is the most frequently used substrate for small signs. In Ontario, aluminum is typically used for signs 600 mm x 600 mm or smaller. Aluminum is lightweight, has a long life and will not rust. It is usually more expensive than steel or plywood, although depending on price fluctuations, aluminum may at times be more cost effective than galvanized steel, especially given the fact that aluminum can be recycled. Being lightweight, aluminum is susceptible to bending from strong winds or vandalism, and may require cross-bracing; hence it is more typically used for the smaller signs.

##### *Steel*

Steel substrates can be coated in different ways, including the following:

- **Galvanized Steel** – Zinc-coated;
- **Galvannealed Steel** – Zinc-iron alloy-coated by a hot-dip process;
- **Galvalume Steel** – 55% aluminum-zinc alloy-coated by a hot-dip process.

Steel substrate coating requirements are described in the specifications for steel signs (see Section 3.3.2). The coatings are applied to protect the steel from rust, therefore the substrates are susceptible to rusting if their coating becomes damaged. Steel is heavier and usually more rigid than aluminum. In Ontario, galvanized steel is typically used for signs that are larger than 600 mm x 600 mm, but smaller than side-mounted guide signs and overhead guide signs.

#### *Plywood*

Plywood is a medium strength substrate which usually does not require cross-bracing. It is the least expensive of the commonly used substrates. It is very porous and susceptible to weathering and cracking if not sealed. Plywood must have its edges filled, and edges, back and front sealed. Some sheeting manufacturers specify that both faces of the medium density overlay plywood (MDOP) substrate must be faceprimed and topcoated with a compatible paint. Primer and finish materials produced by the same manufacturer and formulated as companion products should be used to ensure good adhesion. Conventional high quality exterior paints formulated for wood should be used. When damaged, however, plywood is easy to repair. Plywood is typically used for temporary replacement signs (e.g., while a damaged permanent sign is being repaired or replaced) and for temporary conditions signing. Other typical uses for plywood in Ontario include many freeway warning signs, and, in general, signs larger than 900 x 900 mm and smaller than 1200 x 2400 mm. In some cases, plywood is used for signs as large as 2400 x 2400 mm.

Non-compliance with manufacturers' recommendations and guidelines may result in premature failure.

#### *Extruded Aluminum*

Extruded aluminum signs are different from the flat aluminum signs described above in that they are composed of panels with their sides bent backward into U-shaped extrusions. Panels can then be fastened together along the length of their extrusions to create a large sign surface. Consequently, extruded aluminum panels are most often used for large side-mounted guide signs and overhead guide signs. The panels are available in several widths, usually 150 mm (6") and 300 mm (12"), and profiles and typically incorporate clips for fastening the panel assembly to sign posts.

Extruded aluminum panels are fastened together by either bolting through holes in the extrusions, or snapping using pre-fabricated snap-together panels.

Extruded aluminum panels provide a more rigid sign surface without the requirement for bracing. It is easier to repair than sheet aluminum. A sign face on an extruded aluminum sign can easily be replaced using an aluminum overlay, which is a thin sheet (typically 1 mm (0.040") thick) of aluminum riveted to an existing sign or sign blank. With aluminum overlays, the entire sign does not need to be replaced when the sign sheeting degrades.

Combinations of flat sheet aluminum and reinforcing extrusions are sometimes also used for large guide signs. For example, extruded flanges can be spot-welded to sheet aluminum to form U-shaped panels, which are then fastened together like extruded aluminum panels. This type of substrate, known as Extrusheet, offers the advantages of fewer panels, a larger seamless sign face and the strength of conventional extruded aluminum panels. Increment panels are another type of reinforced flat sheet aluminum sign. These signs are constructed from vertical aluminum panels connected with splice plates and reinforced with additional extruded aluminum. Increment signs are labour-intensive and are the most expensive of the extruded aluminum signs.

### *Other Substrate Materials*

Other newer substrate materials include fibreglass, plastic and combined fibreglass-plastic. The durability of these materials has not yet been fully tested, however the experiences of some jurisdictions with field applications have shown fibreglass and plastics to be a feasible alternative to aluminum as a substrate for flat sheet signs in some applications. Fibreglass/plastic substrates are lightweight and inexpensive. Another advantage is that the substrate material itself can be coloured, eliminating the need to paint the back of the sign. The primary disadvantage of these types of materials is their fragility. They are susceptible to fracture from high winds and impacts and may require cross-bracing, although newer versions of the substrate are being designed to withstand higher impacts. Some types also become brittle in extreme cold temperatures, an important consideration given Ontario's climate conditions. Fibreglass/plastic requires more care in handling than aluminum. Other drawbacks are that sheeting does not adhere well to these substrates and that plastic is subject to premature warping. Due to plasticizer migration, adhesion problems may not be immediately apparent.

New technologies for substrates continue to be developed. For example, recycled materials, such as recycled plastic and rubber, have been developed as sign substrate materials, but have not yet been thoroughly tested. The use of emerging substrate technologies is encouraged, provided that they are sufficiently tested prior to adoption and that they are able to meet the standards required of conventional signing materials, such as rigidity, service life, durability, strength, ability to adhere to sheeting and compatibility with existing sign support hardware. Standards and specifications for substrates (see Section 3.3.2) detail the requirements currently in place for conventional substrates.

### **3.3.2 Standards and Specifications**

In Ontario, the Ontario Provincial Standard Specifications (OPSSs) are the primary specifications for sign substrate materials. OPSS 2001 (June 1995 or subsequent revisions) deals with material specifications for metal substrates, and OPSS 2002 (December 1990 or subsequent revisions) deals with material specifications for plywood substrates. The content of these specifications is described below.

The OPSS specifications make reference to U.S. specifications or standards, and there exist other U.S. specifications/standards for substrate materials that are not mentioned in the OPSS specifications. Table 3.4 lists the standards/specifications that apply to sign substrates in Ontario, and other U.S. standards/specifications.

The OPSS specification for metal substrates provides information on materials and thicknesses for aluminum and steel sign blanks, and allowable size tolerances. In addition, information is provided on: production, including substrate preparation (see Section 4 (Sign Fabrication)) and packaging and delivery; quality assurance; and owner purchase of material by purchase order.

Regarding materials for aluminum sign blanks, OPSS 2001 refers to ASTM B 209M (alloy 6061-T6) for signs larger than 450 mm x 450 mm. This ASTM specification covers the production of aluminum and allows flat sheet, coiled sheet, and plate, in various alloys, tempers and finishes. Signs 450 mm x 450 mm or smaller must be fabricated from utility sheet or coil.

OPSS 2001 specifies that steel sign blanks can be fabricated from galvanized, galvalume or zinc-coated steel made from sheets or coils. For galvanized (zinc-coated) and galvanized (zinc-iron alloy-coated) steel, OPSS 2001 refers to ASTM A 653/A 653M (regular type coating designation

**Table 3.4 – Standards and Specifications for Sign Substrate Materials\***

<b>Substrate Material Specifications</b>	<b>Ontario Standards/ Specifications</b>	<b>Referenced in Ontario Standards/Specifications</b>	<b>Other U.S. Standards/Specifications</b>
Aluminum	OPSS 2001	ASTM B 209M (alloy 6061-T6)	FHWA FP-96 ASTM B 209M (alloy 5052-H38 and alloy 5052-H52) ASTM B 221M (alloy 60 63-T6) ASTM B 449
Steel	OPSS 2001	ASTM A 653/A653 M (regular type coating designation Z275) ASTM A 792/A 792 M (coating designation AZ180)	FHWA FP-96 ASTM A 525M
Plywood	OPSS 2002		FHWA FP-96 NIST PS 1-83
Plastic			FHWA FP-96
Fibreglass Reinforced Plastic			FHWA FP-96 ASTM D 638M ASTM D 790M ASTM D 695M ASTM D 732 ASTM D 3841 ASTM D 696 ASTM D 635

\* OPSS 2001 (June 1995) Material Specification for Metal Sign Blanks.

**Table 3.5 – OPSS-Specified Substrate Thickness\***

<b>Material</b>	<b>Condition</b>	<b>Thickness [mm]</b>
Aluminum**	Temporary panels	2.0
	Permanent panels 750 mm x 750 mm or smaller	2.0
	Permanent panels larger than 750 mm x 750 mm	3.0
Steel	Coated steel	1.6
Plywood (Overlaid)	Temporary conditions signs 1200 mm x 1200 mm or smaller	11.0
	Permanent STOP signs	11.0
	Temporary conditions signs	12.5
	Permanent signs	19.0

\* OPSS 2002 (Dec. 1990) Material Specification for Standard 120 cm x 240 cm Overlaid Plywood Sign Blanks.

\*\* The 2.0 mm (0.081 inch) thickness is recommended for superior performance of smaller aluminum signs, in accordance with ASTM B 209M (alloy 5052 H-38), although some road authorities use utility grade aluminum (1.6 mm (0.064 inch) thickness, in accordance with ASTM B 209M (alloy 5052 H-52) for such signs.

Z275). This ASTM specification covers products in a number of designations, types, grades and classes, pertaining to chemical composition and typical mechanical properties of the steel sheet, which are designed to be compatible with different application requirements. For galvalume steel, OPSS refers to ASTM A 792/A 792M (coating designation AZ180). This ASTM specification covers the production of 55% aluminum-zinc alloy-coated steel sheet in coils and cut lengths, in a number of designations, types and grades which are designed to be compatible with differing application requirements.

Metal substrate thicknesses specified in OPSS 2001 are shown in Table 3.5, along with plywood substrate thicknesses specified in OPSS 2002. The following size tolerances are specified for metal substrates:

- Blanks shall not deviate more than 3 mm from the specified size in any dimension except thickness;
- Blanks shall not deviate more than 0.1 mm from the specified thickness.

OPSS 2002 incorporates CSA and US standards. The specification covers substrate materials, overlays, production including substrate preparation (see Section 4 (Sign Fabrication)) and authority purchase of material by purchase order. According to OPSS 2002, medium density 60/60 overlaid all-fir filled plywood must be used. The overlay must be Medium Density Crown Forest #360 or Weldwood #448. Specified thicknesses for plywood substrate are shown in Table 3.5.

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## 4. Sign Fabrication

This section describes sign fabrication techniques for a variety of sign substrate and sheeting materials. Nothing in this section is intended to supersede specific recommendations from suppliers, who often provide technical support in the form of technical bulletins, training, visits, and instruction manuals. Becoming well acquainted with a supplier's recommendations, techniques and precautions, and following them, will help ensure a better product and eliminate waste.

Procedures for sign fabrication are illustrated in Flowchart B which consists of Flowcharts B.1 through B.9 (see Section 4.6). Flowchart B.1 is an overview flowchart.

Sign fabrication requires the use of various chemicals, paints, inks and solvents that are regulated through the **Workplace Hazardous Materials Information System (WHMIS)**. Each specific product identified under WHMIS must have a current **Material Safety Data Sheet (MSDS)** which describes the composition of the product. It also gives details on the safe handling and storage of the product as well as personal protective safety equipment that is required when using the product, and other protective devices such as fume hoods and breathing apparatus. Handling, storage and use of each specific product must conform to these regulations. All safety precautions must be followed, including those recommended by manufacturers for the operation of sheeting applicators or other equipment.

This section addresses:

- Substrate preparation, testing and storage;
- Background sheeting application;
- Sign assembly (extruded aluminum panels);
- Legend preparation and application; and
- Storage of signs.

## 4.1 Substrate Preparation, Testing and Storage

Metal blanks (aluminum or steel) are typically used for signs up to 900 mm x 900 mm in size.

Plywood is typically used for signs larger than 900 mm x 900 mm, up to 1200 mm x 2400 mm, and is sometimes used for signs up to 2400 mm x 2400 mm. Above these sizes, extruded aluminum panels, bolted or snapped together, are used for sign fabrication.

Plywood is also often used for signs (any size) which are temporary in nature, such as Temporary Conditions signs, and interim signing as replacement of an existing or damaged sign or sign structure.

### 4.1.1 Aluminum

Procedures for metal sign blank preparation are illustrated in Flowchart B.2.

Treated aluminum blanks have been degreased, etched and have a coating applied, so they are ready to accept various types of retroreflective sheeting or vinyl sheeting immediately or at a future date.

Untreated aluminum blanks require preparation before they are ready to accept any sheeting.

If the blanks have been treated according to current OPSS 2001, prior to acquisition from the supplier, very little preparation is required other than wiping the surface with a tack cloth to remove dust just prior to applying the background sheeting.

When using untreated blanks, etching and degreasing are required. This procedure should be performed after sign blank radii and holes have been punched. Specifically designed dip tanks are available for each process using commercially

available solutions, such as chromic acid or chromium sulphate conversion coatings. Blanks should be rinsed thoroughly using high-pressure spray with cold water and left to dry. The sheeting should be applied immediately.

Small production volumes of untreated blanks may also be prepared by scrubbing the surface using an abrasive cleaner and a scouring pad, then rinsing clean with cold water, and drying immediately. In this case the sheeting should also be applied immediately.

Solvent wiping of treated blanks should only be necessary if blanks become contaminated. (i.e., greasy fingers or other contaminants).

### 4.1.2 Steel

Procedures for metal sign blank preparation are illustrated in Flowchart B.2.

Treated steel blanks are fabricated from galvanized or galvalume steel and have been degreased and coated according to the coating designation as stated in OPSS 2001. They are then ready to accept various types of retroreflective sheeting or vinyl sheeting immediately or at a future date.

Untreated galvanized steel blanks may be covered with a thin layer of oil that must be removed before sheeting can be applied.

If the blanks have been treated according to current OPSS 2001, prior to acquisition from the supplier, very little preparation is required other than wiping the surface with a tack cloth to remove dust just prior to applying the background sheeting.

When using untreated blanks, etching and degreasing are required. This procedure should be performed after sign blank radii and holes have been punched. Specifically designed dip tanks are

available for each process using commercially available solutions, such as chromic acid or chromium sulphate conversion coatings. Blanks should be rinsed thoroughly using high-pressure spray with cold water and left to dry. The sheeting should be applied immediately.

Small production volumes of untreated blanks may also be prepared by scrubbing the surface using an abrasive cleaner and a scouring pad, then rinsing clean with cold water, and drying immediately. In this case, the sheeting should be applied immediately.

If the sheeting is not applied immediately, the blanks should be treated with a vinyl pre-treatment or equivalent so they will be ready to accept various types of retroreflective sheeting or vinyl sheeting at a future date.

Generally speaking, the use of pre-treated blanks is preferable. They are readily available from various suppliers. Pre-treated blanks eliminate the need to purchase, handle and store various chemicals and solvents that require regulated procedures as set out in WHMIS and the need to keep up to date records of current MSDSs.

#### **4.1.3 Plywood**

Procedures for plywood sign blank preparation are illustrated in Flowchart B.3.

Plywood sign blanks must be at least medium density overlay (MDO) plywood, as specified in OPSS 2002 or equivalent.

Plywood substrates require several preparation steps before sheeting can be applied, to ensure durability and longevity.

Surfaces must be smooth, impermeable and weather proof. All voids on the edges must be filled with an exterior wood filler, such as plastic wood, or an exterior waterproof caulking with 10 to 20 year durability, then sanded and coated with an acceptable edge seal coating.

Substrate back and edges must be sealed or primed. If substrate back and edges are to be painted, ensure that the surface is clean and dust free, and apply an exterior primer coat followed by a suitable exterior quality paint. Scuff sanding with a fine grit sandpaper may be required to ensure a suitable bonding surface. Remove any sanding residue with a tack cloth.

Sheeting manufacturers' recommended practice or requirements to prime and paint the front face of the sign should be followed.

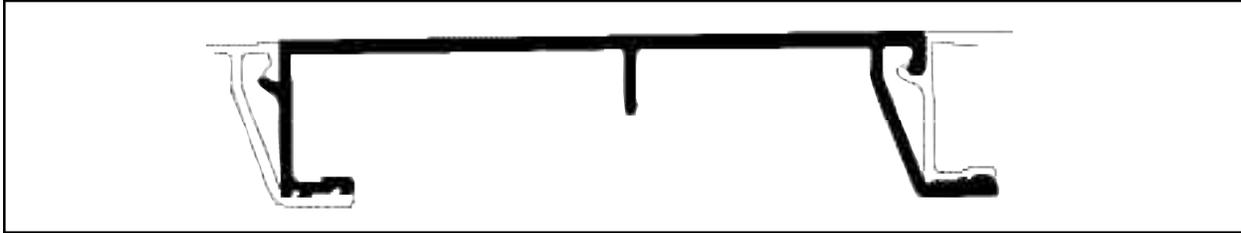
Colour tinting the primer coat the same as the finish paint coat will assist in obtaining good coverage and colour continuity of the finished product. Either good quality latex or oil base paints may be used. An advantage of latex paint is the easier water clean up without the use of solvents. Oil base paints require degassing during application, longer drying time, and solvents for clean up that must meet regulated handling and storage criteria. Also oil base paints tend to be more odour invasive.

#### **4.1.4 Extruded Aluminum Panels and Aluminum Overlay Sheets**

Procedures for extruded aluminum panel preparation are illustrated in Flowchart B.4; procedures for aluminum overlay preparation are illustrated in Flowchart B.5.

Extruded aluminum panels and overlay sheets are commercially available in various widths, lengths and profiles to suit requirements. The most

**Figure 4.1 – Snap-together Extruded Panel (cross-section)**



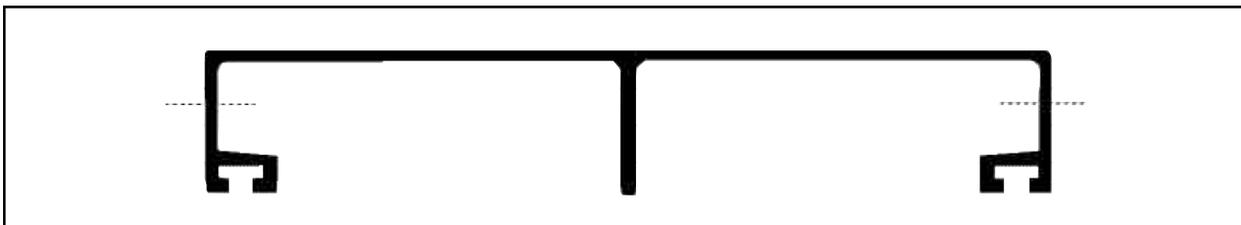
Source: Extrudex Aluminum

common extruded aluminum panels are ‘snap together’ and ‘bolt-together’ profiles. Figure 4.1 shows a cross-section of a snap-together extruded panel. Figure 4.2 shows a cross-section of a bolt-together extruded panel. Aluminum overlay sheets are used to repair or replace part or all of an extruded aluminum sign message without necessarily having to repair or replace the complete sign. Note that a damaged sign may not always be suitable for overlay sheets. Overlay sheets should be attached to a flat surface, and are usually used for maintenance refurbishing of an existing sign for a change of message.

Before sign sheeting can be applied, the panels or overlay sheets must be prepared to conform to manufacturers’ specifications for both substrate preparation and sheeting application.

Extruded aluminum panels and overlay sheets should first be cut to the appropriate size and deburred. The aluminum surface must be degreased and etched prior to having the sheeting applied, by either immersing the panels or overlay sheets in a dip tank or washing and scuffing the surface by hand. Specially designed dip tanks, used to degrease and etch the extruded panels or overlay sheets, contain cleaning and etching solutions such as chromic acid or chromium sulphate. Manufacturers’ instructions on time, temperature, and concentration are to be followed. Panels or overlay sheets must then be rinsed thoroughly using high-pressure spray with cold water and left to dry.

**Figure 4.2 – Bolt-together Extruded Panel (cross-section)**



Source: Alcan Extrusions

When an extruded sign must be built in two or more pieces, the sign design detail and the message to be displayed should be examined. Select a combination of panels that will result in a vertical joint that is not intersected by any sign legend (text, graphics, markers or logos).

Longer panels or overlay sheets not fitting a dip tank may be prepared by scrubbing the surface with an abrasive cleaner and scouring pad and rinsing thoroughly with cold water. Manufacturers' recommendations should be followed.

If the panels or overlay sheets have not been etched, the surface of the panel or sheet may have to be scuff sanded prior to applying the sheeting, to smooth any rough areas that may be present due to oxidization or corrosion while in storage or minor damage occurring during shipping or handling. This may be done by hand or using a belt or oscillating sander with emery cloth or equivalent sandpaper designed for aluminum.

The panels or overlay sheets should be wiped with a tack cloth to remove dust just prior to applying the background sheeting.

#### 4.1.5 Other Substrate Technologies

##### *Plastic/Fibreglass*

Plastics and fibreglass-reinforced laminates vary as to type and composition. While some are suitable for use as sign substrates, others are not. Check sheeting manufacturers' recommendations. It should be noted that any plastic or fibreglass reinforced laminate used as a sign substrate must meet or exceed the requirements set out in the OPSS specifications for aluminum or steel substrates. Preparation of plastic or fibreglass blanks should follow manufacturers' recommendations. Testing is recommended before adoption of such materials as a standard, to ensure

that the materials meet functional requirements over a reasonable life cycle, including rigidity, life expectancy, and sheeting adherence to the substrate.

##### *Recycled Materials*

Recycled materials are also coming into use as sign substrates for some applications. Check sheeting manufacturers' recommendations. These materials must also meet or exceed the requirements set out in the OPSS specifications for aluminum or steel substrates. Testing is recommended before adoption of such materials as a standard, to ensure that the materials meet functional requirements over a reasonable life cycle, including rigidity, life expectancy, and sheeting adherence to the substrate.

#### 4.1.6 Random Testing

Random testing of all metal or plastic/fibreglass substrates should be conducted to ensure proper surface conditions. They should be checked visually and should include a water break test if contamination is suspected. The water break test for oil or wax contamination simply involves pouring water onto the surface of the blank. The water should not bead, but should flow out to form a smooth uniform layer on the surface. Plywood blanks should be visually inspected to ensure quality and conformance to specifications.

#### 4.1.7 Storage of Substrates

All substrates should be stored appropriately to avoid damage and/or contamination. When storing and stacking material, avoid stacking heavy material too high. This will prevent damage such as bending of certain types of material due to excessive weight. Place wooden supports that are wide enough to

leave space between the lifts of material to allow easy access for a forklift truck or other lifting device. This will also prevent possible damage of the material caused by this equipment when material has to be moved.

If possible, the material should be stored indoors where it can be kept dry. If storage of the material is outside, substrates such as plywood, treated aluminum or treated metal blanks should be covered and kept dry.

## 4.2 Background Sheeting Application

Procedures for background sheeting application are illustrated in Flowchart B.6.

For proper application of sheeting, users should follow the recommendations of sign sheeting manufacturers and of manufacturers of sign sheeting applicators. This may also be necessary to maintain warranty provisions.

For better sign quality and colour uniformity, sign sheeting from two different rolls should not be used on the same sign blank or sign without first checking for colour/brightness variability, at least under daylight conditions, and preferably under both daylight and nighttime conditions. This issue arises only with large signs.

### 4.2.1 Pressure Sensitive Sheeting

Pressure sensitive sheeting is generally applied using a mechanical squeeze roll applicator (Figure 4.3) or a hand squeeze roll applicator (Figure 4.4).

**Figure 4.3 – Mechanical Squeeze Roll Applicator**



Source: City of Guelph

**Figure 4.4 – Hand Squeeze Roll Applicator**



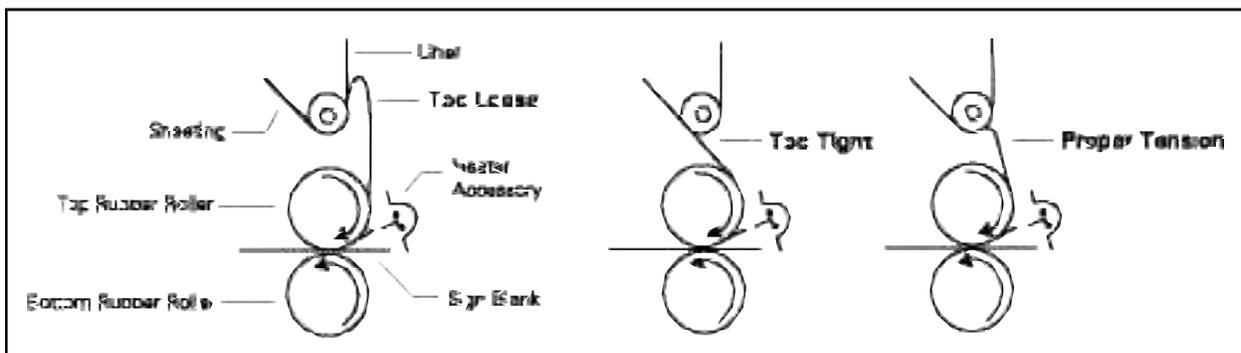
Source: Arges Training & Consulting and City of Toronto Sign Shop

#### *Mechanical Applicators*

Mechanical applicators are well suited to high volume production with both flat substrates (metal or plywood sign blanks) and extruded panels. The following procedures are recommended:

- Using the mechanical applicator, the substrate is fed into the applicator between 2 rollers, an upper roller and a lower roller. These rollers are generally made of rubber although the lower roller may be made of metal. (Note that the lower roller may also be segmented to accommodate extruded aluminum panels).
- The sheeting stock and the take up spool for the sheeting liner (backing) are located above and parallel to the rubber rollers. As the substrate is fed between the rotating rubber rollers, the sheeting is fed from above while the liner is removed and spooled onto the take up roll.
- The sheeting being fed from above must have the correct tension. Tension adjustments must be correct for proper application; tension that is too tight may cause the sheeting to stretch or tear or crack, and tension that is too loose may result in the sheeting wandering off line or wrinkling. Figure 4.5 illustrates proper mechanical applicator sheeting tension.
- As the substrate advances through the applicator, the sheeting also advances at the same speed while uniform pressure from the upper and lower rollers adheres the sheeting to the substrate. Pressure contact from the rubber rollers must be correct according to manufacturer's specifications and uniform across the entire width of the substrate to ensure proper adhesion without wrinkles or air bubbles.
- A heating accessory bar should be used to slightly warm the substrate and sheeting just prior to application. It is located a few centimetres from the rubber rollers where the substrate meets the sheeting. (Note that for some sheeting materials, the manufacturer recommends directing the heater towards the substrate but not towards the sheeting.)
- A feed table and exit table are recommended to assist in supporting larger substrates. Ideally, these tables are at least 1200 mm by 2400 mm (4 feet by 8 feet) and some have adjustable legs for height. The top of the table has a series of rollers that span the width and run the entire length of the table. This accommodates feeding and removal of the substrates since they can easily be rolled into position and removed.
- As the substrate is fed in one end of the applicator and exits on the other end, the location to set up the mechanical applicator must provide enough space to accommodate the longest

Figure 4.5 – Mechanical Applicator Sheeting Tension



Source: 3M Company, St. Paul, MN

substrate that will ever be used. (i.e., a 7.2 m (24 foot) aluminum extrusion would require approximately 18 m (60 feet) minimum of total operating length).

- When sheeting is applied to extruded aluminum panels, the lower roller must be segmented to allow for the profile of the panel to pass between the rollers, providing a flat surface for the sheeting to be applied. A special attachment centre guide of small rollers at right angles to the rubber rollers secures both sides of the centre rib of the panel. This ensures that each panel is fed in straight and positioned properly so the entire surface is covered with the sheeting. The exit end of the table should have a series of edge rollers that gradually wrap the sheeting around the edge of the panels.
- When sheeting is applied to flat stock, fence guides on the feed side at right angles to the rubber rollers should be used and adjusted. This ensures that each piece is fed in straight and positioned properly so the entire surface is covered with the sheeting.
- Adjust pressure and check heating accessory temperature. Once the application is set up for either flat stock or extruded panels, the sheeting stock and take-up spool must be set up.
- Position the sheeting stock on the upper feed spool and a used sheeting core on the take up spool. Feed the sheeting under the supply roller. Peel the liner (backing) off and attach it with tape securely onto the take-up spool. Drape the sheeting over the upper rubber roller and trim excess. Be sure to leave enough material that it will cover the lead edge of the substrate.
- Place the first substrate on the feed table and roll up to the upper and lower rubber rollers coming in contact with the sheeting. Start the applicator and feed the substrate in while wiping with a tack cloth. Feed additional panels while wiping with a tack cloth.
- On the exit end of the rollers, trim the excess material from the edges and the ends to separate the substrates. (Note that extruded aluminum panels will only need the ends trimmed, as the edges will be rolled over by the edge roller attachment). Stopping the machine temporarily on the exit side of the rollers will allow for easier separation and trimming of the substrates.
- Remove the sheeted material from the exit table and stack.
- While the applicator is running, continue to monitor the tension of the sheeting and adjust as required.
- When coming to the end of a roll of sheeting, roll the entire material onto the substrate. Once this has been adhered and has extended past the rollers on the exit end, stop the machine and reverse to bring the end edge of the sheeting back to the feed side of the rollers. Install a new stock roll and attach as explained above. Position material and substrate to allow for an overlap joint and continue the operation.

#### *Hand Squeeze Roll Applicators*

Hand squeeze roll applicators are generally used for low to medium production applications. The following procedures are recommended:

- Using a hand roller applicator, the substrate is fed between a lower and upper roller driven by hand crank. The upper roller is either mechanically or pneumatically adjustable to allow proper

adhesion pressure. Crank a substrate between the rollers and adjust pressure so it is uniform across the entire width of the substrate.

- Prior to the application of background sheeting, cut appropriate pieces of sheeting slightly larger than the substrate to be covered.
- There are two common methods of applying background sheeting to the substrate:
  - the first method is called the split liner method, and is generally considered the easier method to apply. Place a piece of sheeting face up on top of the substrate, so that the sheeting covers the entire substrate. Slide the substrate and sheeting between the rollers, to about the midpoint of the substrate length. After carefully lining up the sheeting over the substrate, tighten the rollers. Pull back one half of the sheeting, over the rollers, and peel off the sheeting backing. Then roll the sheeting onto the substrate for that half of the sign, through the rollers, starting at the centre and rolling out to the sign edge. Repeat the process for the other half of the sign. See Figure 4.6.

**Figure 4.6 – Application of Background Sheetting: Hand Squeeze Roll Applicator**



Source: Arges Training & Consulting and City of Toronto Sign Shop

- the second method applies the sheeting from one end of the sign length to the other, and requires more care and experience to achieve a satisfactory result. Position the substrate on the feed end of the rollers and place a piece of sheeting face up on top of it. Be sure the sheeting is positioned to cover the entire substrate. While keeping the sheeting in place, peel back the leading edge of the sheeting approximately 50 mm and trim off the backing. Adhere the 50 mm strip of sheeting to the lead edge of the substrate. Move the substrate forward to butt against the rollers and then crank in this material approximately 25 mm to secure. Drape the remaining sheeting back over the top roller. Take the backing liner near the rollers and while holding it, crank the substrate and sheeting through the rollers.
- Trim the edges and stack.
- Repeat the process. If multiple small size blanks are being covered, the above process may be used or several of the blanks may be placed on a plywood substrate and covered at the same time.

#### *Hand (Squeegee) Application*

Smaller applications may be done by hand, as follows:

- Position the appropriate slightly over-sized piece of sheeting on the blank and secure it with a piece of tape either at one end of the blank (for small blanks) or across the width of the blank, at the centre of the blank (for larger blanks).
- Raise one end of the sheeting and remove about 25 to 50 mm of the backing liner.
- Place the sheeting back on the blank and apply pressure to make it adhere by using a squeegee or a hand roller.

- Remove the tape.
- Raise the remaining piece of the sheeting, if applicable, and remove the backing liner slowly as the sheeting is rolled or squeegeed into place. Care must be taken to ensure proper adhesion with no air bubbles.

### *Splicing*

Splicing of sheeting is generally not recommended, if it can be avoided. When splicing of sheeting is required, horizontal splicing is generally preferred to vertical splicing since, if properly lapped, it will effectively shed moisture. With some sign substrate sizes, sheeting widths, and applicator widths, horizontal splicing may also be easier and more straightforward when applying sheeting to long horizontal sign panels. If horizontal splicing is used, the top piece of sheeting on the sign should overlap the lower piece of sheeting, to avoid moisture accumulation. However, there may be some situations where vertical splicing is necessary.

Colour matching of spliced material is important for daytime and night time appearance, so material with the same batch number should be used whenever possible. Manufacturers' recommendations for colour matching of spliced materials should be followed.

### **4.2.2 Heat Activated Sheeting**

Heat activated sheeting is rarely used anymore and has virtually been replaced by pressure sensitive sheeting.

This material is applied using a vacuum applicator, which removes the air between the sheeting and the substrate and then uses heat lamps to activate the adhesive to the substrate.

## **4.3 Sign Assembly (Extruded Aluminum Panels)**

Procedures for extruded aluminum sign assembly are illustrated in Flowchart B.9.

### **4.3.1 Bolt-together Panels and Snap-together Panels**

In Ontario, extruded aluminum panels are used for large types of signs in most cases, rather than standard flat stock substrates. As these panels are available in different widths and lengths, a sign can be custom built by varying the number of panels used. Assembly of these panels takes place after the background sheeting has been applied. Both the bolt-together and snap-together extruded panels are assembled in virtually the same way; only the connection of the panels to each other differs. In both cases, the 300 mm (one foot) wide or 150 mm (six inch) wide sign panels run horizontally.

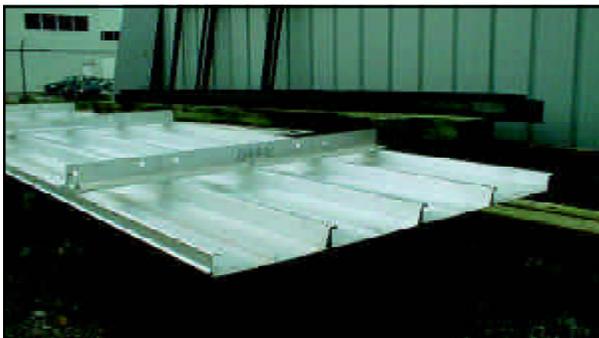
Users of snap-together panels have done so for many years, and continue to do so because of experience and familiarity with this process, citing advantages of faster assembly and lower assembly labour costs. Most sign fabricators use bolt-together panels, and cite the following advantages:

- T-bars or Z-bars used in assembly of the signs are more easily adjustable in the field.
- Signs are more easily assembled, especially longer signs.
- Signs are more easily disassembled and recycled.

Extruded sign assembly may be accomplished through use of the following process:

- The appropriate number of panels is laid face down on a series of saw horses or a flat assembly table, which should be covered with foam padding or carpet or similar material to protect the sheeting on the panels.
- Bolt-together panels are connected horizontally by bolts through a series of slotted holes running the length of the panel edges.
- Snap-together panels are connected horizontally by snapping the panels together by the ribs that are part of the panel design and run the full length of the panel. With the snap together panels the panel edge that is 90 degrees will be the top of the sign.
- Once all the panels are connected using either design, the assembly is completed by installing either aluminium T-bars or Z-bars, bolting them to the panels at right angles to the horizontal. The bars must run the full height of the sign plus 50 mm (2") at the bottom and should have a hole drilled at the top of each bar to facilitate hoisting of the sign. The bars also allow for the mounting of the sign on the sign structure, either by bolts or clamps, and should be drilled accordingly. Figure 4.7 illustrates snap-together extruded panels assembled with T-bars. Figure 4.8

**Figure 4.7 – Snap-together Extruded Panels assembled with T-bars**

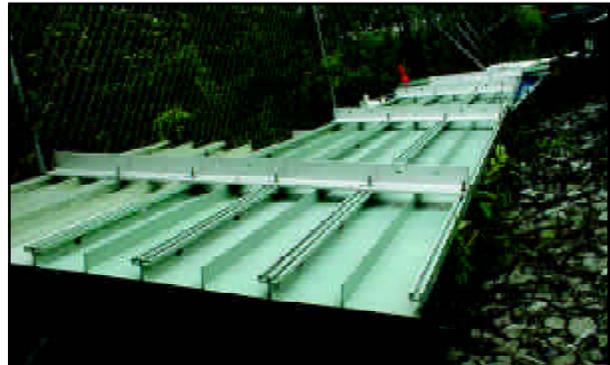


Source: Arges Training & Consulting and Harpar Management Corporation

illustrates bolt-together extruded panels assembled with T-bars. Figure 4.9 illustrates extruded panels assembled with Z-bars, for attachment to a trichord sign structure.

- The T-bars or Z-bars must be cut to length prior to attachment to the sign. It is also advisable to drill the hole in the top of each bar as well as the holes for the mounting brackets prior to attachment to the extruded panels. The positioning of these bars will be dependent on the type of structure on which the sign will be mounted.

**Figure 4.8 – Bolt-together Extruded Panels assembled with T-bars**



Source: Arges Training & Consulting and Harpar Management Corporation

**Figure 4.9 – Extruded Panels assembled with Z-bar, for attachment to Trichord Sign Structure**



Source: MTO

- Measure the spacing of the T-bar or Z-bar along the length of the top and bottom panels.
  - For snap-together panels, place the T-bar or Z-bar in position and hold in place with a clamp or vice grips. Drill and attach the T-bar or Z-bar to the ribs of the extruded panels using 32 mm x 8 mm (1 1/4" x 5/16") stainless steel hex head bolts with stainless steel hex head nuts and stainless steel lock washers. These bars also give the assembled sign panels rigidity and stability.
  - For bolt-together panels, pre-drill the T-bar or Z-bar to accommodate the attachment bolts. Slide the bolts for all bars in the slots and align them across the back of the sign. Place the first bar on the back of the sign, on the bolts, and tighten it down, the top and bottom bolts first, and then the others. Either start with the first bar at one end of the sign and work across, or start with a bar at/near the centre and work outwards. These bars also give the assembled sign panels rigidity and stability.
  - If this extruded sign is a tab, follow the same procedure for either snap-together or bolt-together panels, with the following exception. This particular sign uses a 9.5 mm x 50 mm x 1270 mm (3/8" x 2" x 4'-2") aluminum flat bar to attach the panels and also to attach it to the larger sign. Cut the flat bar to length, and drill and attach it to the extruded tab using the appropriate procedure and bolts for snap-together or bolt-together panels, as described above.
- Note:** If the MTO standard snap-together panels are used, this particular tab sign is built with the 90 degree edge as the bottom of the sign. This tab can be installed in the shop or in the field.
- Once completely assembled, the sign is either flipped over so it is facing up or placed on an easel in preparation for application of the legend.

#### 4.3.2 Aluminum Overlay Sheets

Aluminum overlays are flat stock aluminum sheets used to refurbish existing signs or as a lower cost alternative to a new extruded aluminum sign.

Overlay sheets for this purpose have a thickness of 1 mm (0.040 inches) and come in various widths, usually 900 mm (3 feet), 1200 mm (4 feet) and 1500 mm (5 feet), and lengths, usually 1500 mm (5 feet), 1800 mm (6 feet), 2100 mm (7 feet), 2400 mm (8 feet) and 2700 mm (9 feet).

**Note:** Overlay sheets must be ordered in Imperial measurements as they are used to cover extruded aluminum signs, which are all Imperial measurements. The widths and lengths shown are Imperial; the metric values are nominal equivalents.

Overlay sheets have the background sheeting and legend applied prior to being attached to the existing extruded sign. Overlay sheets may be attached in the field to refurbish an existing sign or in the shop by being attached to a reclaimed extruded aluminum sign. In either case, the sheets are attached to the extruded sign with 3 mm (1/8 inch) aluminum pop rivets and 4.5 mm (11/64 inch) stainless steel truss head bolts. Figure 4.10A shows a sign where small overlay panels have been used to show revised population; Figure 4.10B shows a sign where the complete sign is overlaid to show different messages in summer and winter.

The sheets are held in position while drilled and pop rivets are installed to secure the overlay sheet to the extruded sign. The rivets are installed around the perimeter of the overlay sheet approximately 150 mm apart.

**Note:** A minimum of 2 rivets per extruded panel must be used vertically along the overlay sheet edges to attach the overlay sheet to each extruded panel.)

**Figure 4.10A**  
**Overlay Sheet on Extruded Panel Sign**



Source: Arges Training & Consulting and MTO

**Figure 4.10B**  
**Overlay Sheet on Extruded Panel Sign**



Source: Arges Training & Consulting and MTO

In addition to the rivets, corner bolts are attached in each of the four corners of the overlay sheet using a 4.5 mm (11/64 inch) stainless steel truss head bolt with stainless steel hex nut and stainless steel star lock washer. A 1200 mm (4 feet) wide overlay sheet should also have additional rivets installed through the centre of the sheet vertically from top to bottom. In the field, the sheets must be installed while in vertical position, one sheet at a time,

generally from left to right. Care must be taken to ensure that the first sheet is aligned squarely, as errors will be carried across the entire sign. If the sheets are being installed in the shop on a reclaimed extruded sign, the entire sign should be laid flat on saw horses and all the sheets may then be laid out on top prior to installation.

#### 4.4 Legend Preparation and Application

Legend preparation and application may be accomplished in a variety of ways. Not all methods are described in Book 2. The methods included here are considered to be representative of common industry practice.

##### 4.4.1 Screen Printing

Procedures for legend application (screening) are illustrated in Flowchart B.7. Procedures for construction of a screen frame are illustrated in Flowchart B.7A.

Screen printing is an efficient, cost-effective method of producing large quantities of identical signs. Durable quality signs can be ensured by using the proper inks and appropriate techniques.

Screen printing requires a screen frame consisting of a screen fabric stretched tightly and uniformly and fastened to a rigid metal or wood frame. The type of screen fabric used will depend on the type of ink being used, and the screen mesh size used for a particular type of ink should follow manufacturers' specifications. The screen frame must be large enough to allow a minimum 150 mm (6 inch) wide area between the frame edge and the printing area. A stencil film, as recommended by the sheeting and ink manufacturers, is cut out to the desired sign image and then applied to the

screen mesh. All areas and edges should be sealed with an appropriate filler. The only open mesh areas should be the desired sign message where the ink will pass through.

A screening table must be flat and large enough to support the entire screen frame and have hinges to hold the frame in position. Vacuum screening tables are also available and are designed specifically for this process.

One method for screen printing signs is as follows:

- When preparing to print material, place the screen frame on the table and fasten securely to the hinges.
  - Material to be screened may be either reflective or non-reflective sheeting cut to size, or it may be a blank with the background sheeting applied to it.
  - Position the material beneath the screen.
  - Use tape guides along two adjacent edges of the material to keep subsequent sheets or blanks in proper register. Tape guides work well for screening flat sheets of material. When screening onto a blank, the guides should be almost as thick as the blank and wide enough to support the width of the squeegee being used. This will prevent damage to the screen. Be sure the guides are not higher than the sheeting or the blank as this will affect the printing performance by not allowing the screen to properly contact the material as the squeegee is passed over it. See Figures 4.11 and 4.12.
  - A squeegee is used to deliver the ink across the mesh. The squeegee should be a sharp, medium to hard rubber blade and should be long enough to cover the entire print area plus 50 mm (2 inches) on either side.
- When screening sheets that are not applied to a substrate, the sheets should be held in place using a vacuum table, or a low tack adhesive when a vacuum table is not being used.
  - Off-contact screening gives the best and sharpest print. Placing foam rubber blocks on the frame edges causes the mesh and ink to contact the print area briefly as the squeegee passes.
  - Mix or thin the ink if required, following the manufacturers' specifications and be sure to have enough ink to complete the entire job. Have some clean up solvent ready to wipe up spills or to clean up misprints or leaks in the screen.

Figure 4.11 – Screen Printing Set-up



Source: Arges Training & Consulting and City of Toronto Sign Shop

Figure 4.12 – Screen Printing



Source: Arges Training & Consulting and City of Toronto Sign Shop

- Pour the ink into the frame area at one end or side.
- Place plain unwaxed kraft paper (or similar; the scrap backing paper from the reflective sheeting may also be used) under the frame.
- Flood the screening area by drawing ink lightly across the mesh using the squeegee, not allowing the mesh to contact the material beneath.
- Then draw the squeegee back across the mesh firmly on a slight angle making sure the mesh contacts the material beneath. This causes the ink to pass through the open mesh, making the impression on the material beneath.
- Print two or three different times on the paper to check for print quality. This also allows the screen to become saturated with ink in preparation for the actual printing.
- Once the print quality is satisfactory, and there are no leaks, the final printing can begin. Place a piece of sheeting or blank beneath the frame and repeat the above procedure, beginning with flooding the screen.
- Remove the printed substrate or sheet by lifting the frame just enough to remove the sheeting or blank and place on a drying rack. See Figure 4.13.
- Provide air circulation as recommended by the ink and sheeting manufacturers.

**Figure 4.13 – Drying Racks**



Source: Arges Training & Consulting and City of Toronto Sign Shop

- Place a new piece of material beneath the frame in the register and repeat the process.

#### *Clean-up*

- Upon completion of the job, the excess ink should be removed and placed in a container and the screen should be cleaned immediately with solvents recommended by the manufacturer.
- To clean the screen while it is still attached to the screen table, place several sheets of kraft paper or newspaper beneath the frame. This will be used to soak up the solvent that will pass through the open mesh during the clean up.
- Pour the appropriate solvent into the frame and use rags to wash the screen and remove the ink residue.
- Dry with clean rags, then remove the paper under the frame and dispose of it.

- Repeat the process until the frame is thoroughly cleaned.
- If a washing station is available, remove the frame and rinse clean with the solvent and dry completely.
- Once cleaned and dried, place the screen in a secure area to prevent damage, for future use.
- If this screen was used for a one-time job, after the ink has been removed, the image can be washed out and the screen frame can be dried. This frame should then be placed in a secure area to prevent damage, for future use.

#### **4.4.2 Direct-applied Copy**

Letters, numbers and symbols can be cut using several techniques. Procedures for legend application (direct-applied copy) are illustrated in Flowchart B.8.

##### *Hand-cut Copy or Individually Cut Legend Characters*

Hand-cutting using cardboard templates is one method. This is done by tracing the outline of a letter or symbol (legend) on the liner (backing) side of the sheeting and then cutting this image out using a sharp knife/blade.

- Legend cut individually from templates is placed on the sign surface to produce a specific message. It should be spaced properly to produce a balanced and legible sign message.
- Once the legend is in place, fasten it to the sign with a small piece of masking tape along the bottom to hold it in position so it is ready to apply using transfer tape. Transfer tape is a low tack material that is used to hold sign legend in place

while allowing the removal of the backing liner. Follow manufacturers' recommendations, as the type of transfer tape to be used varies with the type of reflective sheeting material.

- Once the liner has been removed and the sign legend has been secured to the sign face, the transfer tape is easily removed.
- Using a transfer tape slightly larger than the legend to be transferred, squeegee or roll this onto the legend. Pull the transfer tape towards you with the legend, allowing it to hinge along the bottom.
- Remove the backing liner from the legend and move back into position.
- Squeegee or roll the legend to adhere to the sign surface, then remove the transfer tape. Be sure to remove all air bubbles.
- After the message has been cut, weed out the material that is not part of the message. Weeding involves picking off the unwanted material of the sign face such as the background around the legend including certain parts of some letters, i.e., the centre of the letters O, P, R, D etc. Remove this material carefully while not disturbing the desired message. See Figure 4.14.
- Position the legend, including the backing paper, on the sign face or on a cutting table, and roll transfer tape over the material with an overlap of approximately 50 mm (2 inches). See Figure 4.15. Tape the sign legend and transfer tape to the face of the sign. See Figure 4.16. Pull this material back, hinging on the transfer tape, and remove the backing paper. See Figure 4.17.
- Return the sheeting to its proper position and roll or squeegee to adhere the message to the sign face, being careful to remove all air bubbles. See Figure 4.18.
- Remove the transfer tape to leave the desired message on the sign face. See Figures 4.19 and 4.20.

**Note:** In applying legend to overlay sheets, place the overlay sheets on a work table large enough to support the full height of the overlay sheet and to accommodate several sheets side by side. Hold the sheets together with masking tape to prevent relative movement during legend application.

**Note:** In applying legend to overlay sheets, place the overlay sheets on a work table large enough to support the full height of the overlay sheet and to accommodate several sheets side by side. Hold the sheets together with masking tape to prevent relative movement during legend application.

#### *Computer-cut Copy*

A more current and common method is computer-aided cutting of copy. By use of a computer with the appropriate software, sign legends can be designed and transferred to a plotter/cutter that will cut the legend on reflective or non-reflective sheeting. This process will also cut screen printing film.

- If a sign message is designed on a computer and cut on a plotter/cutter, it can already be spaced properly, and often is cut this way.

Figure 4.14 – Weeding Computer-cut Legend



Figure 4.15  
Transfer Tape Application to Sign Legend



Figure 4.16  
Taping of Legend and Transfer Tape to Sign



Figure 4.17  
Removal of Backing from Sign Legend



Figure 4.18 – Legend Application to Sign Background with Hand Squeegee



Figure 4.19 – Removal of Transfer Tape



Figure 4.20 – Finished Sign



Source: Arges Training & Consulting and Harpar Management Corporation

*Reverse-cut Transparent Film*

An alternative to the use of screen printing or of the typical application of direct-applied copy, particularly where only a few signs are to be made, is the use of reverse-cut transparent film. Consider for example a sign which is to have white legend on a coloured background, such as a STOP sign. Screen printing becomes less attractive as the number of signs decreases. In the typical application of direct-applied copy, the letters are cut from white reflective sheeting and applied over the coloured reflective background. However, this results in use of a considerable amount of both white and coloured reflective material. With reverse-cut transparent film, white reflective sheeting is used for the background, and the legend is reverse cut from a sheet of coloured transparent film (which is less expensive than the reflective sheeting), and applied over the background sheeting. Reverse cut simply means that the cut letters are removed rather than the material that is around them, and the remaining, surrounding coloured material is applied to the white background, allowing the white to show through. The transparent coloured film serves as a colour filter much the same as screening ink, but is often less expensive and quicker. The film is also known as electronic-cutable overlay film. If used, manufacturers' recommendations should be followed.

Figure 4.6 and Figures 4.21 to 4.29 illustrate the process of sign fabrication by this method, and using a hand squeeze roll applicator. The first step, the application of the retroreflective white background sheeting, is shown in Figure 4.6. Figure 4.21 shows the reverse-cut computer cutting of the legend on transparent coloured film. Figure 4.22 shows the weeding of the computer-cut legend. Figure 4.23 shows the application of transfer tape to the reverse-cut transparent sheeting. Figure 4.24 shows the positioning of the transfer tape and transparent sheeting (with backing) on the white background sheeting already applied to the substrate. Figure 4.25 shows the stripping of the

backing from the reverse-cut transparent sheeting, for the first half of the sign. Figure 4.26 shows the same for the second half of the sign. Figure 4.27 shows the application of the transfer tape and reverse-cut transparent sheeting (backing removed) to the white background sheeting on the substrate. Figure 4.28 shows removal of the transfer tape, and Figure 4.29 shows the completed sign.

**Figure 4.21****Computer Cutting of Legend on Transparent Film****Figure 4.22 – Weeding of Computer-cut Legend**

Figure 4.23 – Application of Transfer Tape to Reverse-cut Transparent Sheeting



Figure 4.26 – Stripping of Backing from Reverse-cut Transparent Sheeting (second half)



Figure 4.27 – Application of Transfer Tape and Reverse-cut Transparent Sheeting to Reflective White Background Sheeting on Substrate



Figure 4.24 – Positioning of Transfer Tape and Transparent Sheeting (with backing) on Reflective White Background Sheeting on Substrate



Figure 4.28 – Removal of Transfer Tape



Figure 4.25 – Stripping of Backing from Reverse-cut Transparent Sheeting (first half)



Figure 4.29 – Finished Sign



Source: Arges Training & Consulting and City of Toronto Sign Shop

#### 4.5 Storage of Partially Completed and Completed Signs

Both partially completed sign blanks that are covered with sheeting and completed signs with a sheeting legend should be stored indoors and on their edge in suitable racks. They can also be stored flat, but only in small quantities and for a short period of time, and they should be stacked face to face and back to back. Place a protective paper between the sheeted sign faces to prevent damage.

**Note:** As plywood signs have painted backs, be sure they are dried thoroughly to prevent sticking when they are placed back to back. Depending on the type of blank being stored flat, limit the number of signs per stack and the duration of storage, to prevent damage. As the weight increases the potential for damage increases.

Signs that have a screened legend must be thoroughly dried prior to storage. These should be stored on edge. They may be stored flat if necessary. If they are to be stored flat, they should be stored face to face and back to back. An appropriate type of unwaxed paper should be placed between the faces of the signs to prevent them from sticking together. Again, when storing signs flat, limit the number of signs per stack and duration of storage, to prevent damage. If signs are stacked and stored flat, the crushing may result in a loss of reflectivity, even after relatively short storage periods. Also, the weight of a large number of signs in a stack may result in the signs sticking together. This may result in damage when the signs are separated.

Sheeted aluminum overlay and completed aluminum overlay with legend applied should be stored on edge until ready to install.

Completed extruded aluminum signs should be stored on edge in appropriate racks.

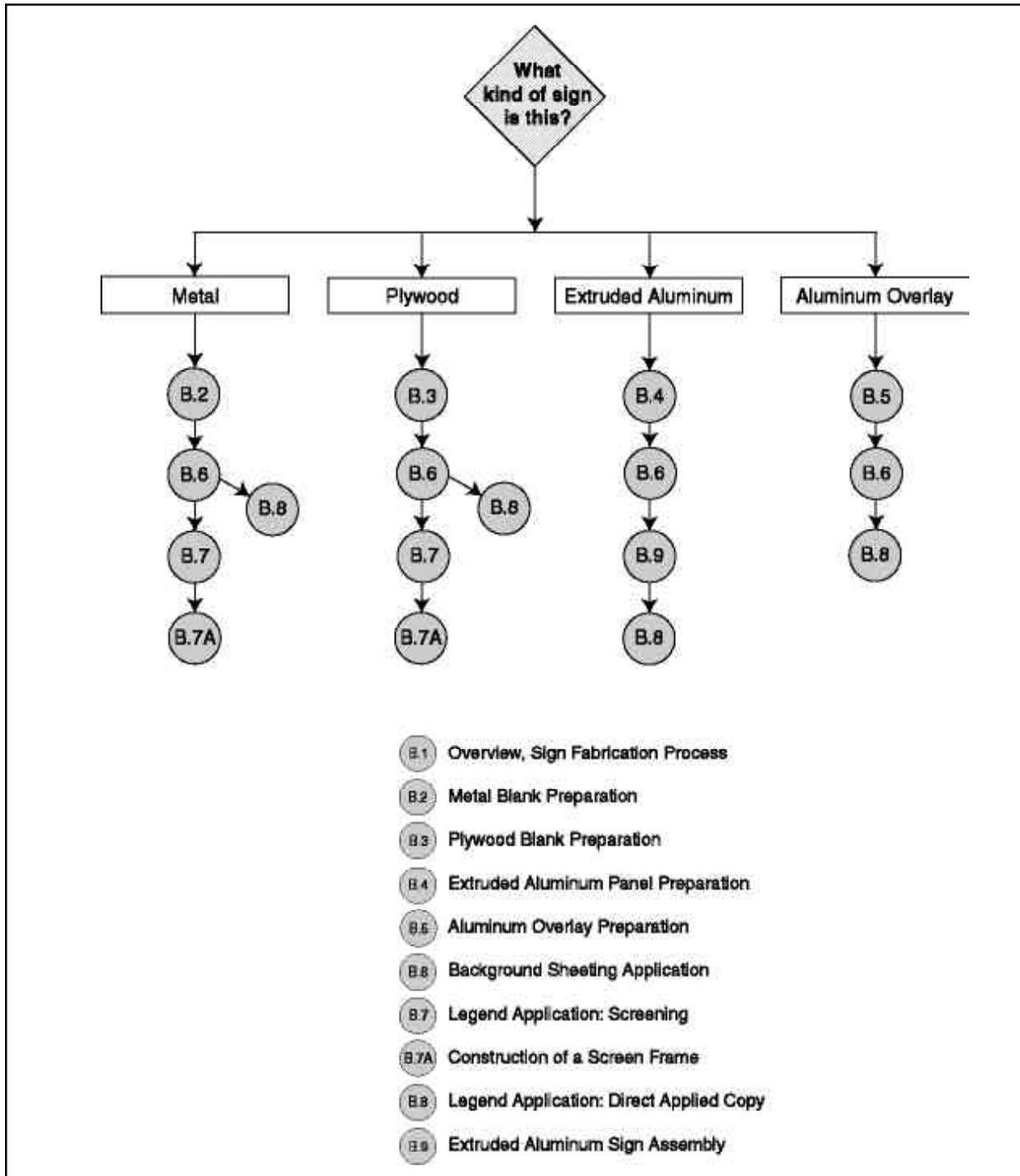
Signs sheeted with Type III, IV, V, VI, VII VIII or IX reflective sheeting should be stacked on edge in appropriate racks. Special care is required if they are to be stacked in a flat position. They should be stacked face to face, then back to back. A special micro foam protection should be placed between the sign faces to prevent damage. Also, limit the number of signs per stack as excessive weight will cause damage by compressing the cells of the Type III, IV, V, VI, VII VIII or IX sheeting. Loss of reflectivity can occur, even after relatively short storage periods.

#### 4.6 Sign Fabrication Process (flowcharts of procedures)

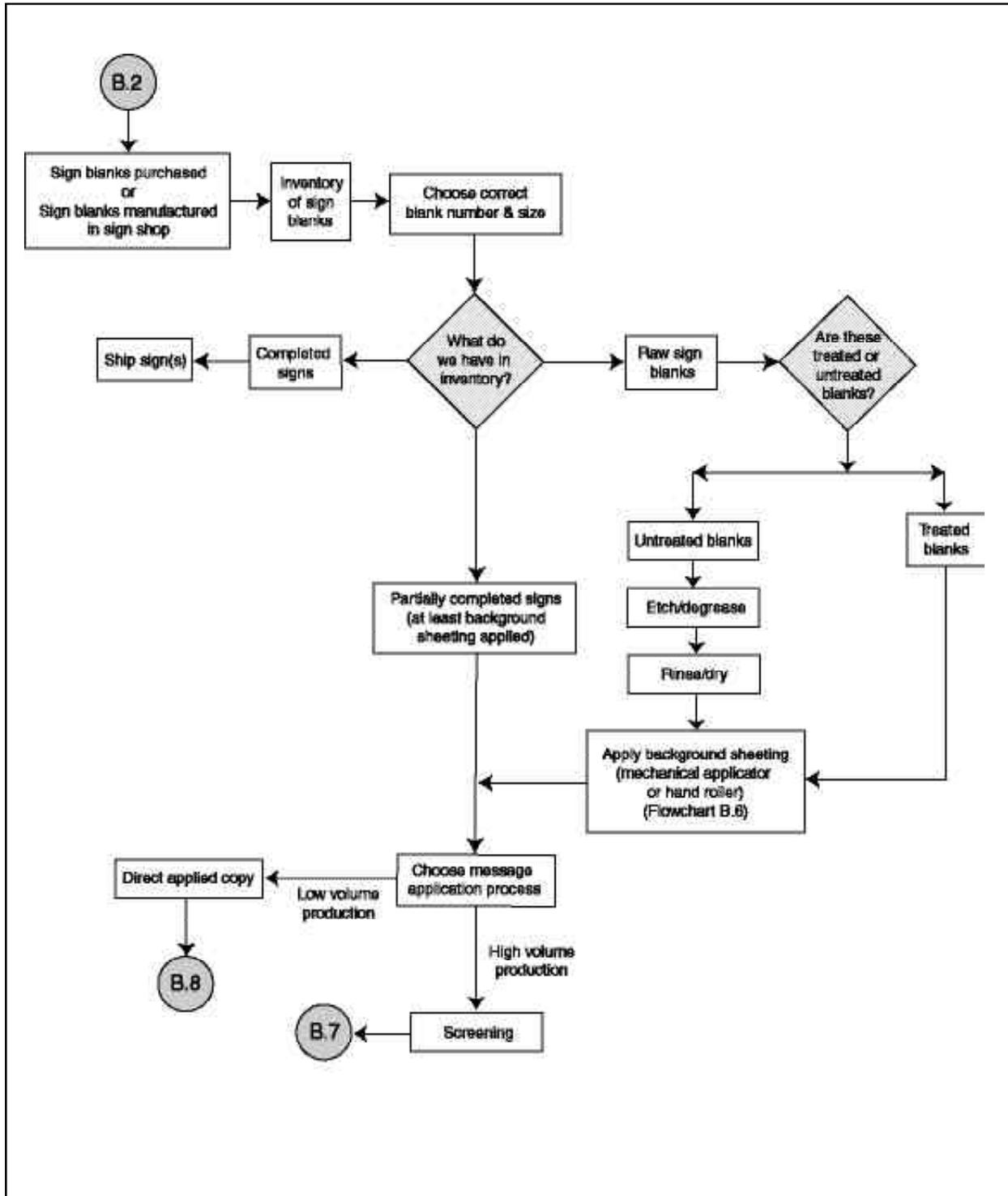
The processes for fabricating signs of various types, as described in Sections 4.1 to 4.5, are illustrated in Flowchart B, a collective term which includes Flowcharts B.1 through B.9.

- B.1 Overview, Sign Fabrication Process
- B.2 Metal Blank Preparation
- B.3 Plywood Blank Preparation
- B.4 Extruded Aluminum Panel Preparation
- B.5 Aluminum Overlay Preparation
- B.6 Background Sheeting Application
- B.7 Legend Application: Screening
- B.7A Construction of a Screen Frame
- B.8 Legend Application: Direct Applied Copy
- B.9 Extruded Aluminum Sign Assembly

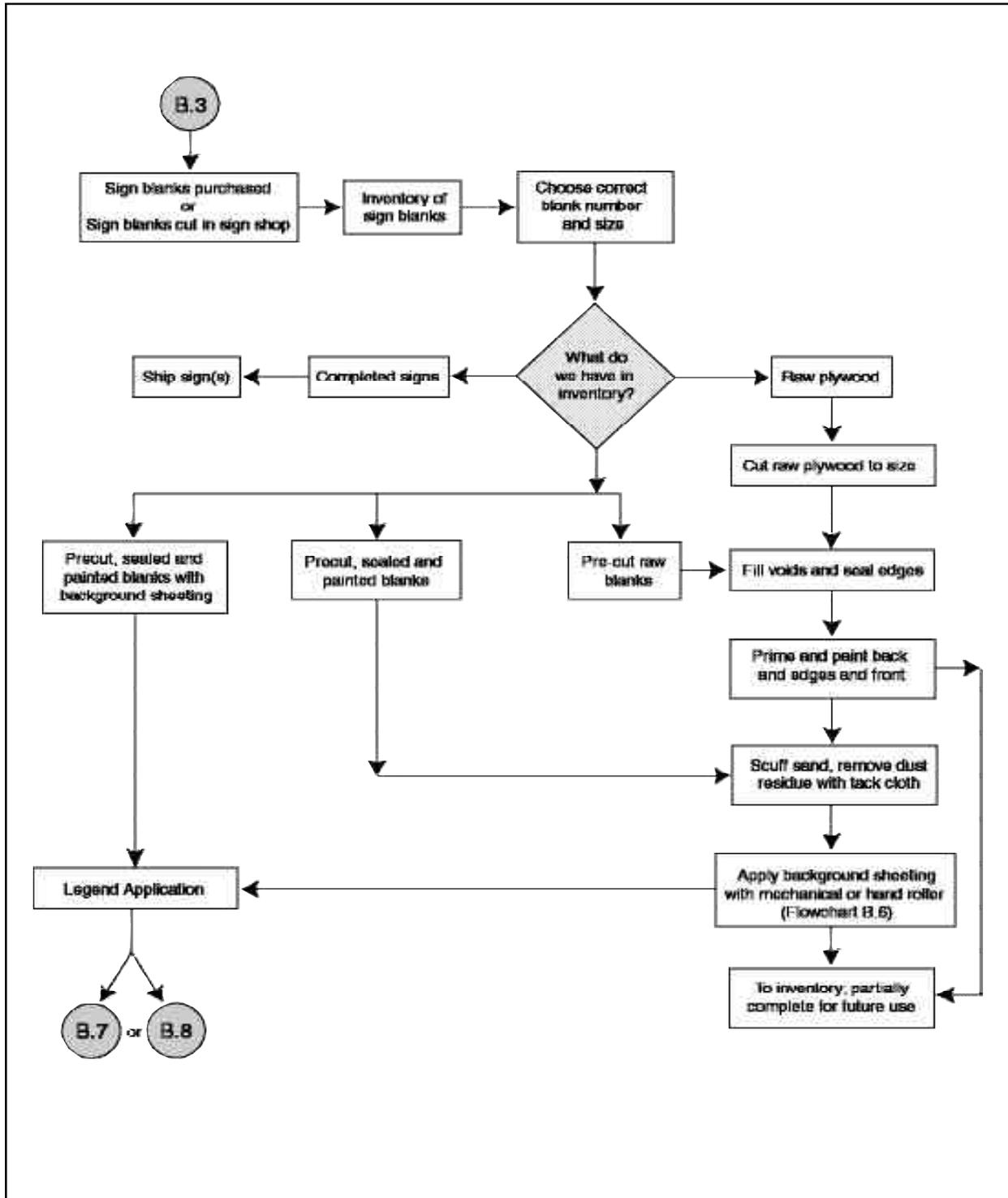
Flowchart B.1 – Overview  
Sign Fabrication Process



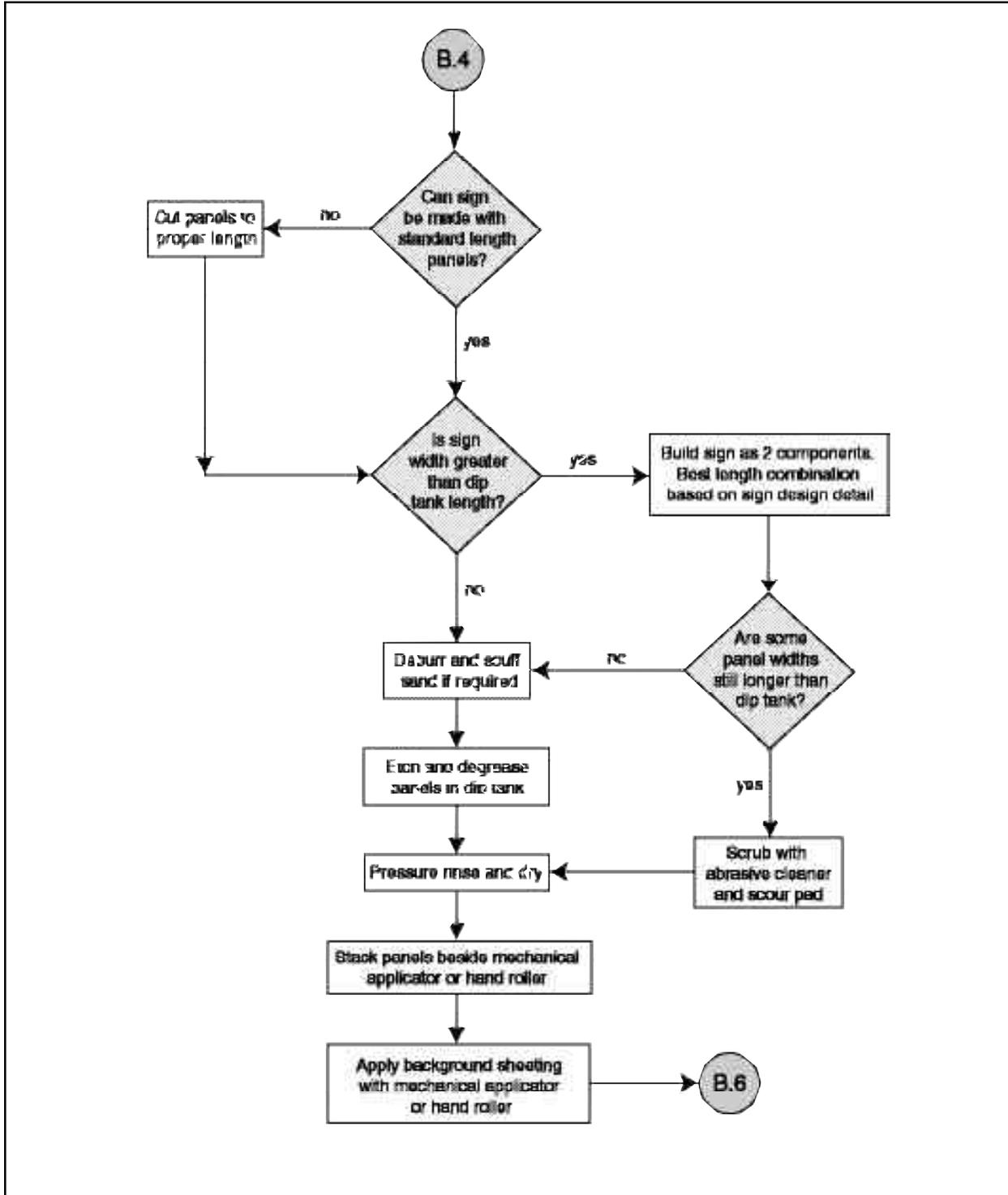
Flowchart B.2 – Metal Blank Preparation



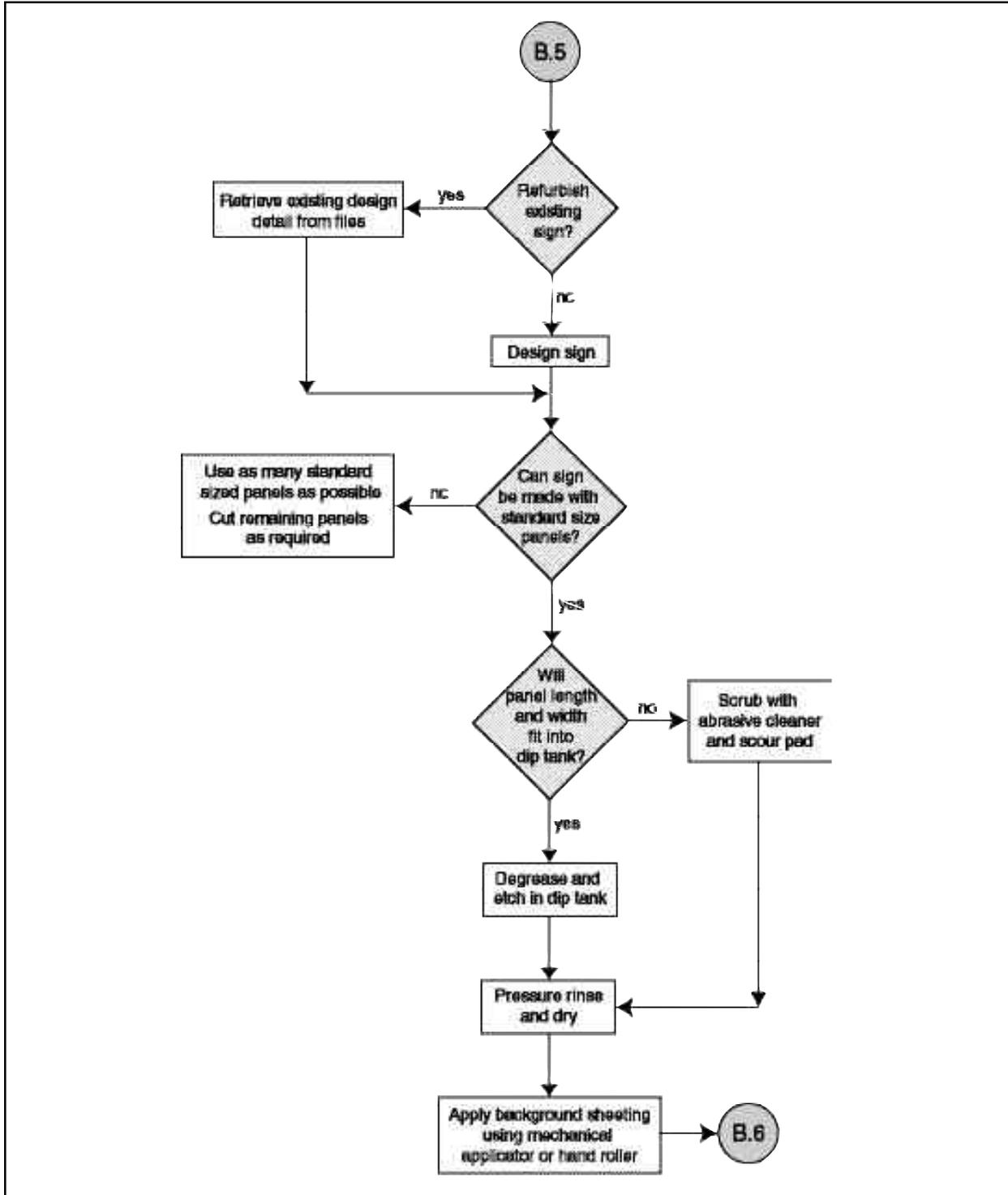
Flowchart B.3 – Plywood Blank Preparation



Flowchart B.4 – Extruded Aluminum Panel Preparation

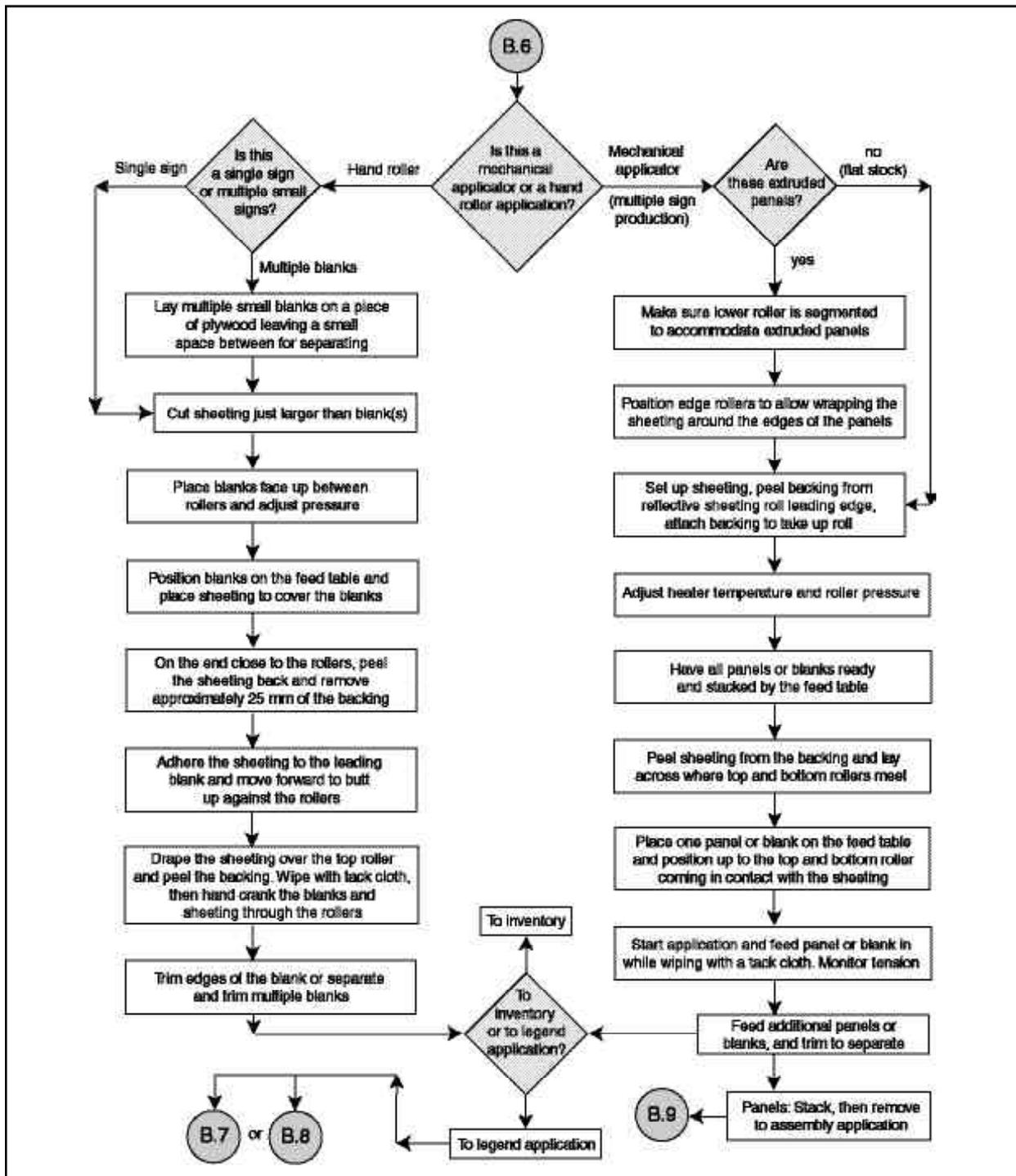


Flowchart B.5 – Aluminum Overlay Preparation

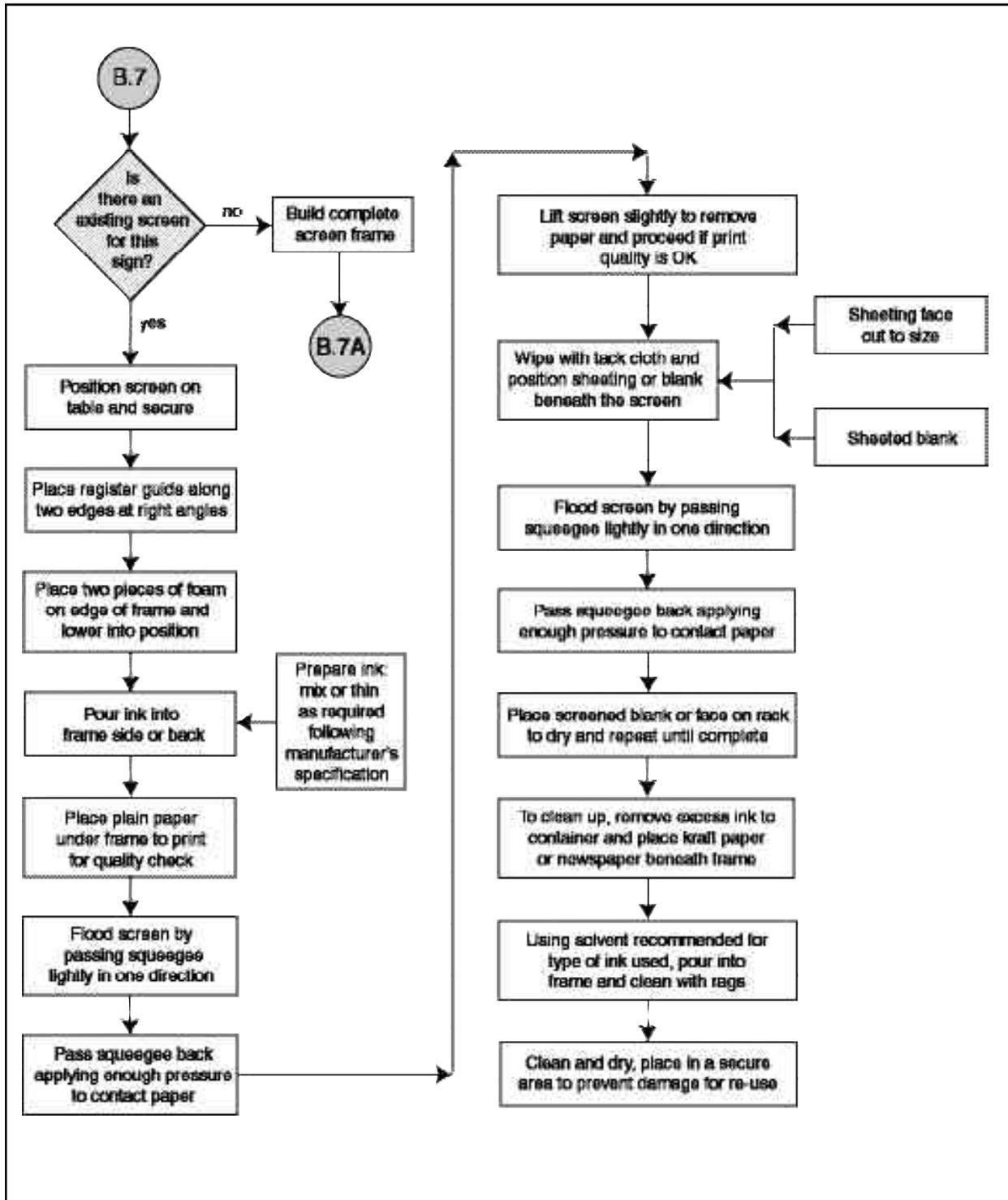


**Flowchart B.6 – Background Sheeting Application**

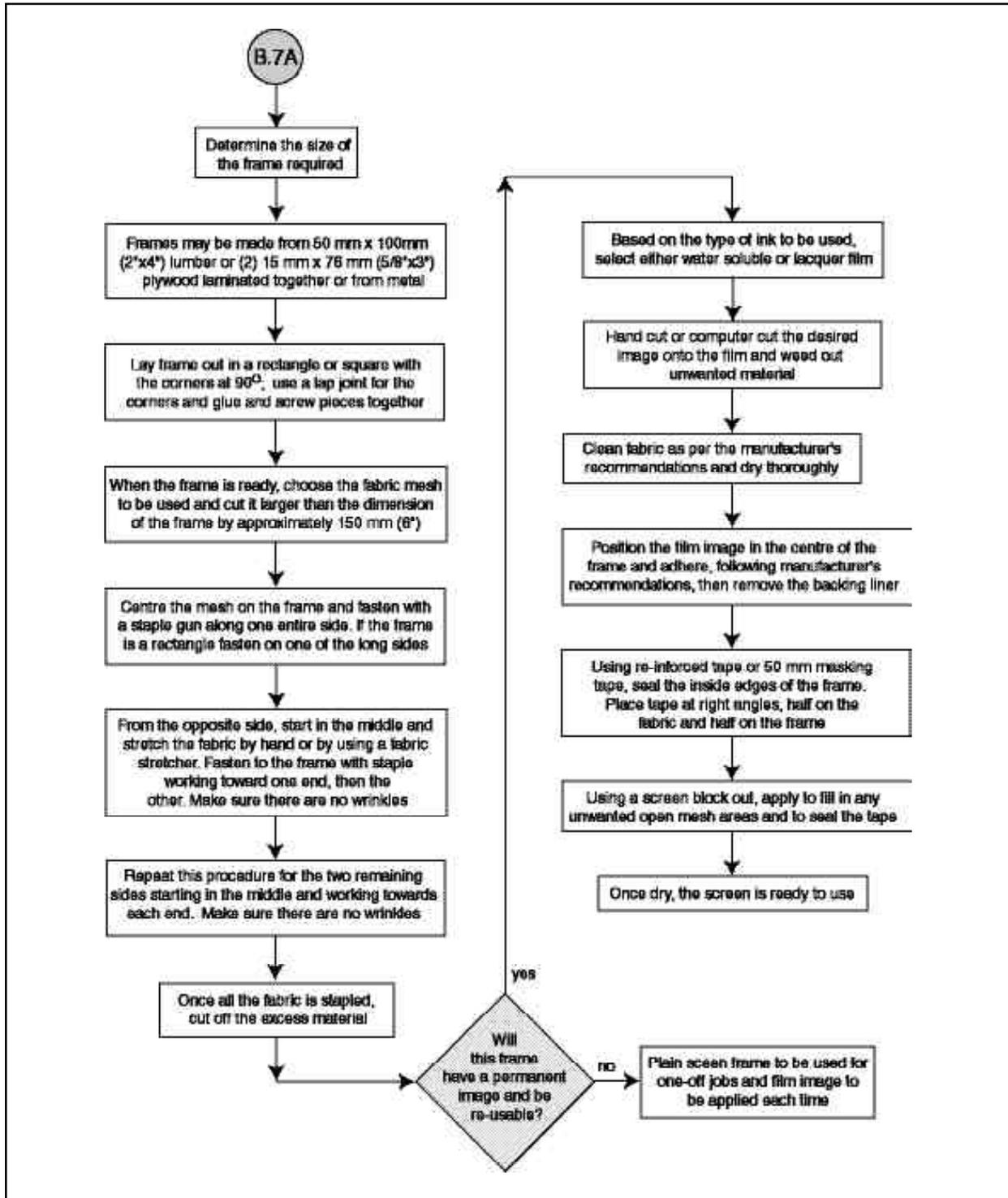
Mechanical Applicator or Hand Roller – Metal or Plywood Blanks or Extruded Aluminum Panels



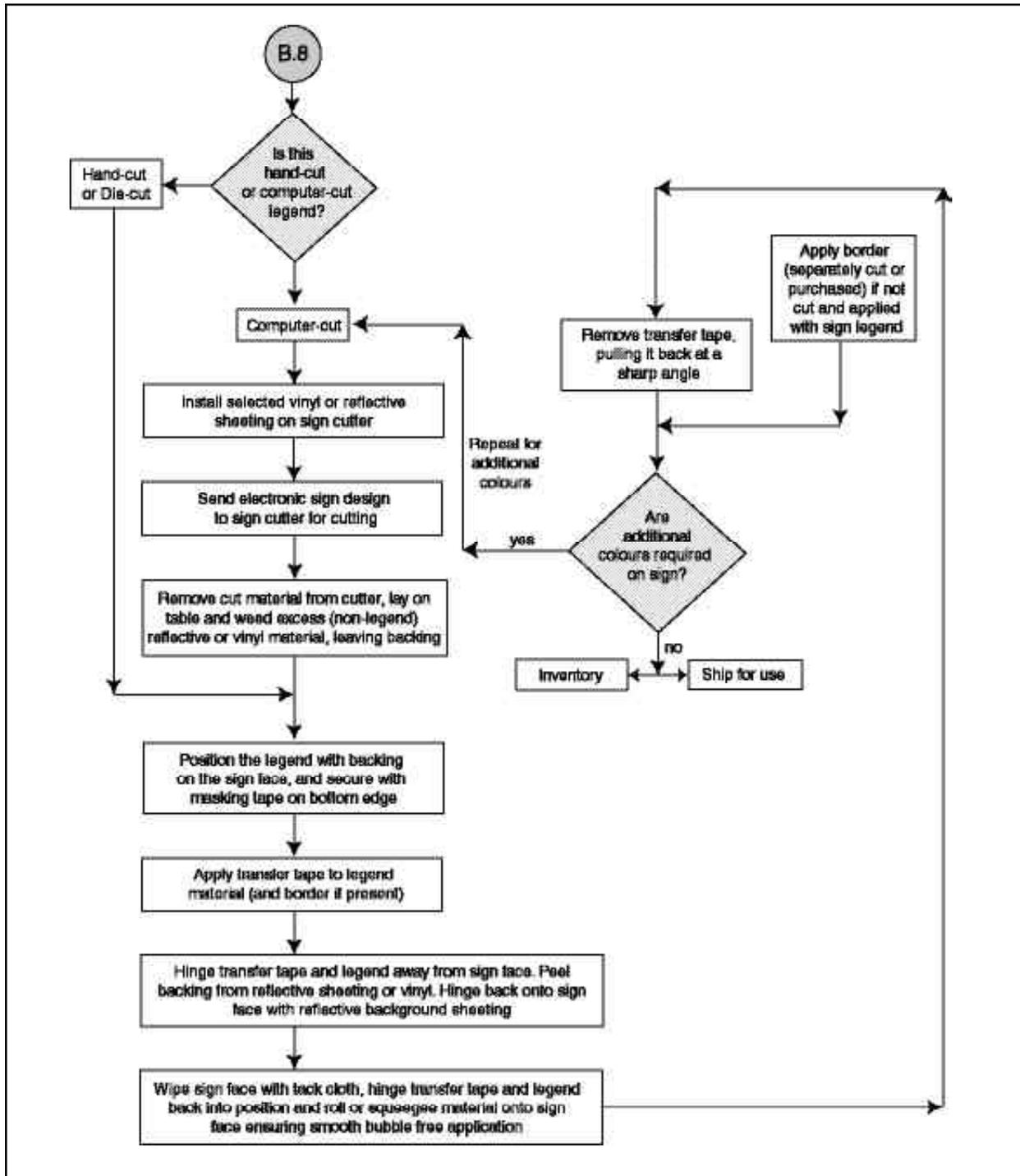
Flowchart B.7– Legend Application: Screening



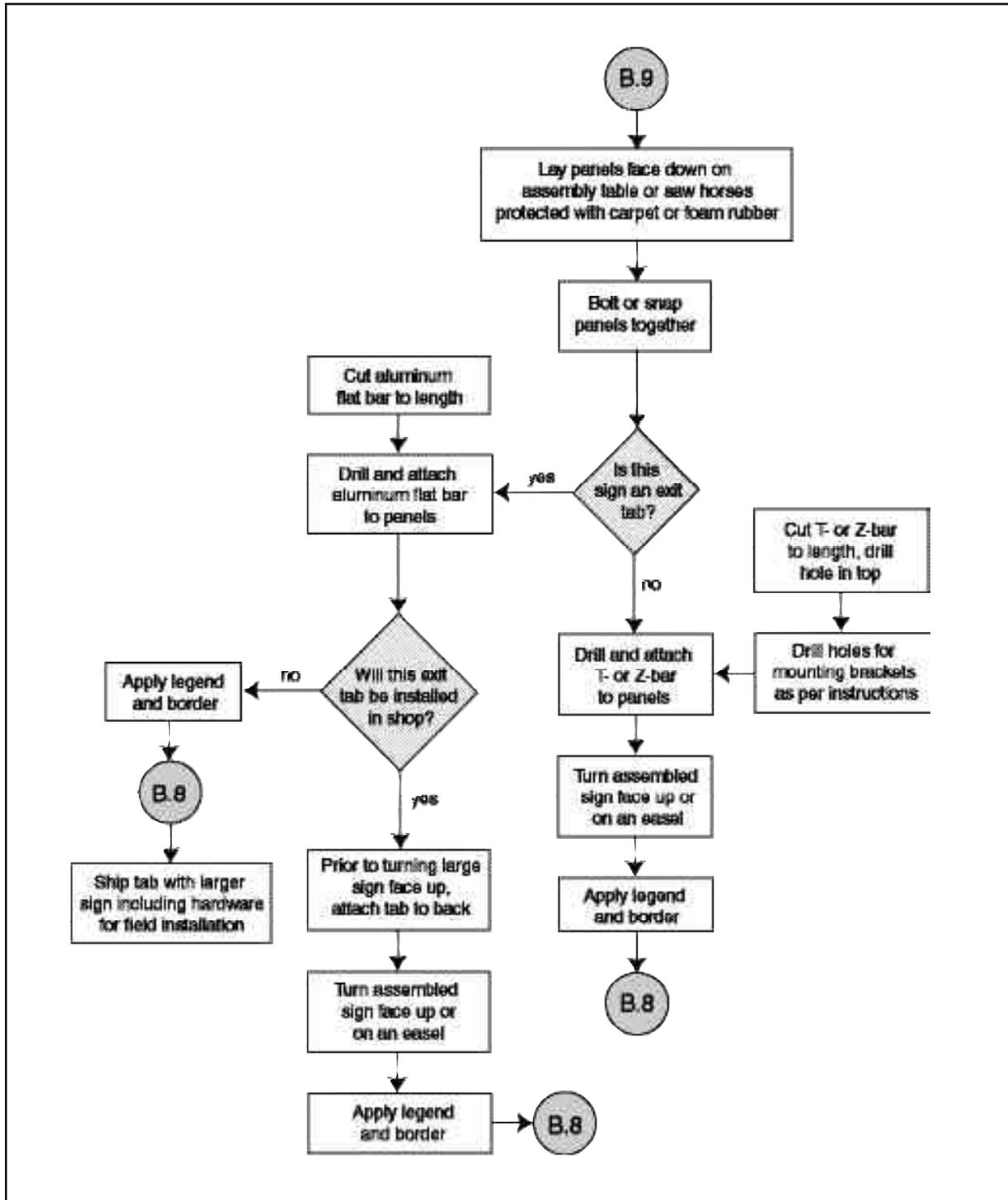
Flowchart B.7A – Construction of a Screen Frame



**Flowchart B.8 – Legend Application: Direct-applied Copy**  
 Metal or Plywood Blanks and Extruded Aluminum Panels



Flowchart B.9 – Extruded Aluminum Sign Assembly



## 5. Master Sign Library

An important part of Book 2 is the electronic Master Sign Library (MSL), packaged on a CD-ROM in the back cover of this Manual. Because of space limitations, a hard-copy paper library of all standard sign pattern templates was not included. The MSL has been created with Adobe® Illustrator® 9.0. As well, the MSL has been created with Adobe® Acrobat®, permitting users to make hard copies of selected sign pattern templates using Adobe Acrobat Reader, even if they do not have Adobe Illustrator. Section 5.1.3 details electronic standards.

### 5.1 Master Sign Library Elements

The Master Sign Library contains the following:

- (1) The sign patterns for all OTM signs, using a standard (common) sign pattern template. See Section 5.1.2 (Sign Pattern Template).
- (2) A Sign Parts Library (SPL), containing various sign parts (e.g., arrows, crowns, shields) used to create customized standard signs (such as directional guide signs) to a standard template, as well as non-standard signs. See Section 5.1.4 (Sign Parts Library).
- (3) A list of all standard MTO sign blanks, along with detailed dimensions and drawings of those standard sign blanks used for metal signs. See Section 5.1.5 (Sign Blanks).

Font sets (all numerals and alphabet characters) are not included in the MSL, as they are copyrighted and must be purchased separately by the user (see Section 5.1.3).

#### 5.1.1 Sign Classes

The organization of the sign patterns in Book 2, including the Master Sign Library, follows the sign classes in Books 5 to 9 of the Ontario Traffic Manual. Although Books 8 and 9, based on the KHGSPM, have not yet been published, most KHGSPM directional and information signs are included in the MSL.

- **Regulatory Signs** (Book 5)
  - Ra Right-of-way Control Signs
  - Rb Road Use Control Signs
  - Rc Miscellaneous Control Signs
- **Warning Signs** (Book 6)
  - Wa Physical Conditions Warning Signs
  - Wb Traffic Regulations Ahead Signs
  - Wc Pedestrian and Intermittent Hazard Signs
- **Temporary Conditions** (Book 7)
  - TC Temporary Conditions Warning Signs
- **Directional and Information Signs** (Book 8)
  - Gd Destination and Assurance Signs
  - Gf Freeway Guide Signs
  - Gh Highway Numbering Change Signs
  - Gl Municipality, County, District Signs on Highways
  - Gor Police, First Aid, Telephone, Picnic, Travel Information Signs
  - Gr Channelizing & Turn-off Signs, Urban Street Name Signs
  - Grr Private Roadway Signs
  - Gs Miscellaneous Guide Signs
  - Mf Hospital, Airport, Bus Terminal, Rail Station, Ferry, Travel Information Markers
  - Mh Route Markers, Direction and Turn-off Markers

- **Tourism and Commercial Signs** (Book 9)
  - T Tourism Attraction Signing (freeways and non-freeways)
  - L Logo signing for motorist services
  - Municipal & Institutional Attraction Signing (not signed from highways)
  - Commercial Signing

### 5.1.2 Sign Pattern Template (SPT)

A standard (common) sign pattern template is used for the signs in the Master Sign Library. The sign pattern template displays the appearance of the sign. Attached to each sign pattern template, for standard regulatory, warning, and temporary conditions signs, are accurately drawn 1/10 scale cut image(s) in Adobe Illustrator 9.0, suitable to be used for the fabrication of the sign. There is a separate cut image for each size of standard sign shown in the OTM. The cut image provided is sufficient to recreate the entire sign. The sign pattern template also contains important information about the sign, including:

- sign name;
- basic sign number, e.g., Ra-1;
- sign numbers for each of the standard sizes given for that sign (this is the basic sign number together with the overall dimensions of the sign). See also Section 1.2 (Sign Numbering System);
- sign blank number;
- dimensions of the various component elements of the sign (e.g., text lines, symbols, markers, arrows);

- the cut image reference for a standard sign of a given size (this reference is the basic sign number together with the overall dimensions of the sign, and is shown beside the cut image to identify it; also shown with the cut image reference is the scale factor of 1:10);
- the sign element (background, border, or legend), colour and minimum reflective sheeting;
- the font series used for word legends; and
- special notes, including a note, for specific regulatory signs, that they must comply with the Highway Traffic Act (HTA) and its Regulations.

For a square, rectangular, octagonal or trapezoidal sign, the vertical dimensions for the sign elements shown on the SPT will add up to the overall vertical dimension of the sign.

For a diamond-shaped warning or temporary conditions sign, the overall dimension of the sign refers to one of the sides of the diamond. However, the vertical dimensions for the sign elements shown on the SPT add up to the diagonal dimension of the diamond-shaped sign, not to the dimension of the side of the sign, even though the side dimension is shown below the line (to indicate the sign size to which those vertical sign element dimensions refer). For example, for a 900 mm x 900 mm diamond-shaped sign, the slightly rounded vertical dimensions of the sign elements will add up to 1230 mm.

In Book 2, the term “Standard Signs” is used to refer to those signs in the Master Sign Library for which the cut images may simply be used as is or with very minor change (e.g., speed limit sign numeral 90 instead of 50 as shown). Most regulatory, warning, and temporary conditions signs (Books 5, 6, and 7 respectively) are standard signs.

The term "Customized Standard Sign" is used to refer to those signs which are in the Master Sign Library (shown on a sign template), but which need to be adjusted to accommodate the specific local sign message. Most customized standard signs are directional guide signs and need to be designed according to the sign design rules and sign design process outlined in Sections 2.14 and 2.15. Sign templates are provided in the MSL, as illustrative examples only, for directional guide signs and for tourism and commercial signs (Books 8 and 9 respectively). The images shown for these signs cannot simply be used as cut images to create a sign. On most large directional guide signs, a standard border width is used over a specific range of sign sizes, so that even if the size of the sign is changed, the border width remains the same.

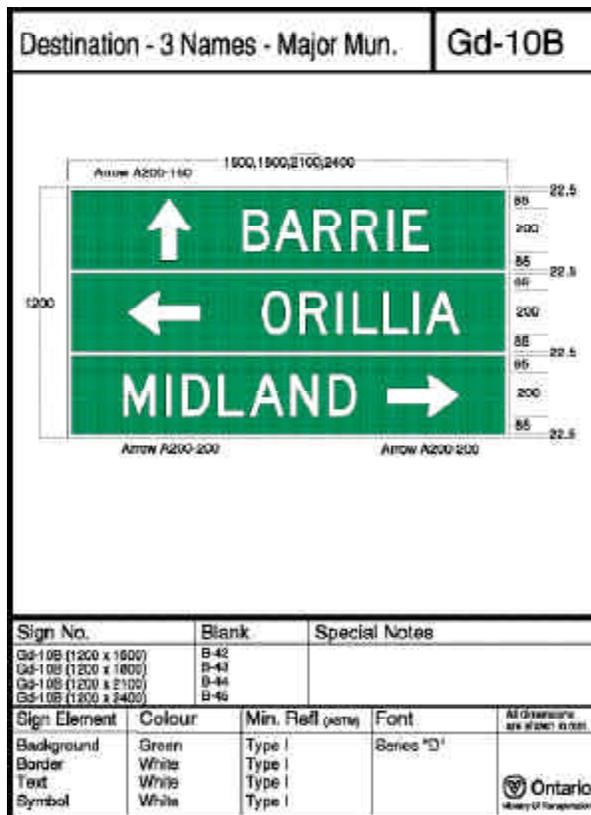
Some signs will have a standard height and a variable width, depending on the message. Other signs will have both variable height and variable width. The sign template for these signs shows similar information as is listed above, but the pattern will have to be adjusted, depending on number of lines, length of words, and use of various parts from the Sign Parts Library. See Section 5.1.4 (Sign Parts Library). That is, the sign pattern provides a starting point, but the sign must be customized and properly designed for the particular situation.

The term "Non-standard Sign" is used to refer to signs which are not included in the MSL, and which need to be designed by the user. Some examples of these are special warning signs. Note

Figure 5.1 – Sign Pattern Template for Rb-1



Figure 5.2 – Sign Pattern Template for Gd-10B



however, that non-standard signs still need to follow basic rules of design. These include colour and shape coding consistent with the type of sign (regulatory, warning, temporary conditions, directional, information, or tourism and commercial), and use of the Sign Parts Library (as appropriate) and the principles and rules for sign design and layout.

Examples of sign pattern templates are shown in Figures 5.1 and 5.2.

### 5.1.3 Electronic Standards

#### *Adobe® Illustrator®*

All standard sign patterns and all parts of the Sign Parts Library were created using Adobe Illustrator 9.0 (.ai format) at a scale of 1/10. Illustrator is widely used in the sign fabrication industry, and is therefore considered to meet the needs of most users. Any user with Adobe Illustrator 9.0 or higher will be able to open and use the MSL .ai files. Users with older versions of Adobe Illustrator can buy an upgrade at a modest cost. Many sign-cutting software packages, used with sign-cutting machines, readily accept Adobe Illustrator files.

#### *Adobe® Acrobat®*

All drawings in the MSL have also been created with Adobe Acrobat (.pdf format). Acrobat Reader is available free of charge from Adobe at [www.adobe.com](http://www.adobe.com).

#### *Fonts*

Fonts are not included in the MSL CD-ROM, as they are copyright protected and must be purchased from a font supplier.

The fonts in the Illustrator files have been converted to outlines, therefore it is not necessary to install fonts except when creating customized standard signs (directional and information guide signs, tourism and commercial signs, and some temporary conditions contract identification signs) and signs with variable numerals (e.g., maximum speed signs, distances, height clearances, maximum loads).

The FHWA fonts used by the Ministry of Transportation Ontario (MTO) for standard signs and directional guide signs are FHWA 2001 Canadian Edition Series C, D, E, and E(m), and less often, Series B or Series F. FHWA Series E(m) is the generally preferred font for freeway signs. Other less frequently used fonts are Helvetica Medium, Helvetica Bold Condensed, Century Bold and Century Condensed Bold. See Section 2.5.1 for details on font use.

For the customized design of the larger directional guide signs, a standard library of necessary fonts, particularly those developed by the U.S. Federal Highways Administration (FHWA), is strongly recommended.

These FHWA fonts are commercially available, in some cases from the manufacturers of sign-cutting machines, and otherwise from Digital Graphics Inc., tel: (905) 846-8667. Table 2.9 (Sources for Traffic Sign Fonts) provides contact information for obtaining fonts used in sign design. Adobe Illustrator has a number of fonts available, some of which may be suitable for traffic sign design, and some of which are not.

### 5.1.4 Sign Parts Library

The Master Sign Library also contains the Sign Parts Library, necessary for the design of customized standard signs, especially the directional guide signs, and custom signs. The

contents of the Sign Parts Library need to be used together with the rules for sign design and layout, which are outlined in Section 2.14, and define how the sign parts are to be used in sign design.

The Sign Parts Library contains the following:

- Arrows
  - Types of arrows
  - Dimensions
  - Patterns
- Crowns, Shields
- Symbols

### 5.1.5 Sign Blanks

MTO has developed a catalogue of standard sign blanks. The detailed drawings of standard sign blanks for metal signs in the Master Sign Library show the dimensions of the sign as well as the location of the mounting holes. In some cases, a given sign blank may be used with more than one substrate material. Table 5.1 lists the MTO standard sign blanks included in the Master Sign Library.

Table 5.1 – MTO Standard Sign Blanks

MTO Blank #	Size (mm x mm)	Material*	Comment	MTO Blank #	Size (mm x mm)	Material*	Comment
B-6a	100 x 350	Aluminum		B-11	450 x 450	Metal	
B-6b	100 x 375	Aluminum		B-11a	450 x 450	Aluminum	STOP/SLOW Paddle
B-6c	125 x 125	Metal		B-12	450 x 750	Steel	
B-6d	250 x 250	Aluminum		B-13	450 x 900	Steel	
B-6e	300 x 300	Metal		B-15	450 x 600	Metal	
B-6f	150 x 300	Metal		B-17	610 x 610	Metal	For Portable signs (size now obsolescent)
B-6g	150 x 200	Aluminum		B-18	600 x 600	Metal	
B-6h	250 x 450	Aluminum		B-20	600 x 900	Steel	
B-6i	130 x 200	Metal		B-20a	600 x 1050	Plywood	
B-6j	150 x 450	Metal		B-20b	600 x 1200	Steel	
B-6k	150 x 600	Metal		B-21	457 x 727	Metal	Shield
B-6l	175 x 375	Metal		B-22	750 x 900	Steel	
B-6m	230 x 250	Metal		B-23	750 x 750	Steel	Octagon
B-7	300 x 450	Metal		B-23a	750 x 750	Steel	
B-7a	300 x 750	Metal		B-23b	600 x 600	Steel	Octagon
B-8	300 x 900	Metal		B-23c	900 x 900	Steel	Circle
B-8a	300 x 900	Plywood		B-24	800 x 800	Steel	Pentagon
B-8b	300 x 1200	Plywood		B-24a	600 x 600	Plywood	Pentagon
B-8c	300 x 1500	Plywood		B-25	200 x 450	Metal	
B-8d	450 x 1200	Plywood		B-25a	200 x 600	Steel	
B-8e	450 x 1500	Plywood		B-25b	300 x 600	Steel	
B-8f	450 x 1800	Plywood		B-25c	225 x 450	Steel	
B-8g	450 x 900	Plywood		B-26	900 x 900	Steel	Triangle (YIELD)
B-9	200 x 900	Plastic		B-26a	750 x 750	Steel	Triangle (YIELD)
B-9a	200 x 900	Metal	Mileage Marker	B-27	900 x 900	Steel	
B-9b	200 x 750	Metal		B-28a	900 x 1050	Metal	
B-10	450 x 450	Metal	County/Secondary; Detour Marker	B-28b	900 x 1050	Plywood	

Table 5.1 – MTO Standard Sign Blanks (cont'd)

MTO Blank #	Size (mm x mm)	Material*	Comment	MTO Blank #	Size (mm x mm)	Material*	Comment
B-28c	900 x 1350	Plywood		B-38	900 x 1800	Plywood	
B-29	900 x 1200	Plywood		B-39	900 x 2100	Plywood	
B-30	1200 x 1200	Plywood		B-40	750 x 900	Plywood	Plaque
B-31a	200 x 1200	Plywood		B-40a	750 x 1500	Plywood	Plaque
B-31b	200 x 1500	Plywood		B-40b	900 x 900	Plywood	Plaque
B-31c	400 x 1500	Plywood		B-40c	900 x 1500	Plywood	Plaque
B-31d	200 x 900	Plywood		B-42	1200 x 1500	Plywood	
B-31e	200 x 1800	Plywood		B-43	1200 x 1800	Plywood	
B-31f	200 x 2100	Plywood		B-44	1200 x 2100	Plywood	
B-31g	200 x 2400	Plywood		B-45	1200 x 2400	Plywood	
B-32	250 x 1200	Plywood		B-48b	300 x 1800	Plywood	
B-32a	250 x 1500	Plywood		B-48c	300 x 2100	Plywood	
B-32b	250 x 2100	Plywood		B-49	450 x 2100	Plywood	
B-33	600 x 1500	Plywood		B-50	450 x 2400	Plywood	
B-34	600 x 1800	Plywood		B-52	600 x 750	Metal	
B-34a	600 x 2100	Plywood		B-54	900 x 2400	Plywood	
B-34b	600 x 2400	Plywood		B-55	1500 x 2400	Plywood	
B-35	750 x 1500	Plywood		B-57	600 x 1200	Plywood	
B-35a	750 x 1200	Plywood		B-59	450 x 900	Aluminum	
B-35b	750 x 1050	Plywood		B-60	200 x 600	Aluminum	Mileage marker; replaced by B-09a
B-35c	750 x 2100	Plywood		B-61	1200 x 1200	Plywood	Octagon
B-35d	750 x 2400	Plywood		B-63	800 x 1800	Plywood	
B-36	750 x 1800	Plywood		B-63a	1800 x 1800	Plywood	
B-36a	750 x 900	Plywood		B-64	300 x 2400	Plywood	
B-37	900 x 1500	Plywood					
B-37a	900 x 900	Plywood					

\* Where stated as "Metal," the material may be either Steel or Aluminum.

### 5.1.6 CD-ROM Contents

The CD-ROM, included as part of Book 2, is organized as follows:

1. **Read Me** (Book 2, Section 5)
2. **Adobe® Acrobat® Reader**  
(Available at [www.adobe.com](http://www.adobe.com))
3. **Master Sign Library**  
(Adobe® Illustrator® (.ai) files)
  - 3.1 **Sign Blanks** (dimensions & drawings of metal sign blanks)
    - Sign Blank List
    - Sign Blank Patterns
  - 3.2 **Sign Parts Library**
    - Arrows
    - Crowns, Shields
    - Symbols
  - 3.3 **Sign Patterns**
    - 3.3.1 **Book 5 – Regulatory Signs**
      - Ra Signs (each sign class is organized as shown for Ra signs, with sign pattern templates and associated cut images)
        - Bilingual Signs (separate folder)
        - French Signs (separate folder)
        - English/universal Signs (listed alphanumerically)
      - Rb Signs
      - Rc Signs

### 3.3.2 Book 6 – Warning Signs

- Wa Signs
- Wb Signs
- Wc Signs

### 3.3.3 Book 7 – Temporary Conditions Signs

- TC Signs

### 3.3.4 Book 8 – Directional Guide Signs and Markers

- Gd Signs
- Gf Signs
- Gh Signs
- Gl Signs
- Gor Signs
- Gr Signs
- Grr Signs
- Gs Signs
- Markers

- Mf Markers

- Mh Markers

### 3.3.5 Book 9 – Logo Signs

- L Signs

### 3.3.6 Book 9 – TODS Signs

- T Signs

4. **Master Sign Library**  
(same breakdown as Section 3)  
(Adobe® Acrobat® (.pdf) files)

## 5.2 Use of the Master Sign Library

This section describes the use of the MSL, that is, how to apply the information on the Sign Pattern Templates and the cut images for the purpose of sign design (where applicable) and sign fabrication.

Because of the variety of available sign cutters and associated software, this description must necessarily be somewhat general.

### 5.2.1 Standard Signs

For standard signs (regulatory, warning, and temporary conditions signs), the cut images provided on the Sign Pattern Templates (SPTs) may be used directly for sign fabrication, after scaling up to full size. The cut images are in .ai format at 1/10 scale, and can be scaled up to create full-size signs.

In some cases, such as where a sign legend is of only one colour, on a background of a different colour, the complete sign legend may be cut as an integral unit. Alternately, individual parts of the sign legend may be cut separately, using the appropriate part(s) of the cut image, and assembled on the background sheeting. This alternate approach is also commonly used where the sign has multiple colours. Sign borders (inner borders, or outer borders where there is no inner border) can be cut as part of the complete sign legend, or they can be cut separately and applied to the sign face.

The cut images of all or part of a sign legend, when scaled up to full size, may also be used to create a screen for screen printing of signs. These cut images are sent to the cutter for cutting, and the process is the same, whether a screen is being cut, or vinyl or reflective sheeting is being cut.

The cut images are imported into the sign cutter software, in a manner appropriate to the requirements of that software, and the cutting is done by the cutter automatically.

The signs are fabricated as outlined in Section 4 of Book 2.

### 5.2.2 Customized Standard Signs

For customized standard signs (directional (guide) and information signs, TODS and logo signs), the scale images provided on the SPTs cannot be used directly for sign fabrication. These scale images look like cut images but they are not cut images, because the sign legend has to be customized to fit the specific site sign requirements. The scale images are in .ai format at 1/10 scale, and they are included in the MSL to provide a convenient starting point for design of the sign. (The image shown on the SPT itself is not to scale, but is shown at whatever scale is necessary to fill the available space on the SPT. Hence, it is not a convenient starting point for sign design.)

The sign may be designed either with Adobe Illustrator or with the software for the sign cutter. Depending on the specifics of the sign cutting software, one of these design tools may be more convenient than the other.

Once the customized standard sign has been designed, all or part(s) of the scaled design (the specific sign cut image) may be plotted by the sign cutter to create the parts required to fabricate the sign.

The signs are fabricated as outlined in Section 4 of Book 2.

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## Appendix A • Definitions

### A

#### **Adhesion**

The ability of a sign sheeting to adhere (bond strongly) to the substrate to which it is attached. The specification indicates the bond strength of the adhesive backing of the sheeting, in terms of minimum weight supported for 5 minutes, without the bond peeling for more than a specified maximum distance, when tested according to the procedure described in the specification. The minimum weight that must be supported varies by class of adhesive.

#### **Arrow**

A symbol indicating the direction of movement that a driver may or must make, as the case may be, or the direction of a destination.

#### **ASTM**

American Society for Testing and Materials.

#### **At-grade Intersection**

An intersection of two roadways where there is no vertical separation between the two roadways at their point of intersection.

### B

#### **Bilingual Sign**

A sign which has its message (legend) in both English and French.

#### **Blank Number**

See Sign Blank Number.

#### **Bond**

Adhesive quality of a coating or sheeting to a Substrate.

#### **Brightness**

A term that refers to human perception of Luminance. Whereas luminance is a photometrically measured quantity, brightness describes how intense a light source or lighted surface appears to the human eye.

### C

#### **Candela**

The basic SI unit of luminous intensity.

#### **CGSB**

Canadian General Standards Board.

#### **Colourfastness**

The ability of Sign Sheetting to retain its original colours after testing or after use in the field.

#### **Commercial Sign**

A sign falling into one of the following classes:

- (1) field advertising;
- (2) third-party signs; or
- (3) other commercial signs, on the highway right-of-way, for which a fee may be charged.

#### **Comprehension**

The ability of drivers to understand the meaning of a sign message, including any symbols or abbreviations.

#### **Conspicuity**

The ability of a Traffic Control Device to attract or command attention, given the visual setting in which it is placed.

**Construction and Maintenance Signs**

A group of Regulatory and Warning Signs used for the protection of public traffic and workers in the vicinity of a work area located on or near the roadway.

**Continuous Wide Median**

On a divided highway, a median that has a continuous width of 10 m or more. See also Divided Highway.

**Contrast**

Contrast refers to differences in colour or in brightness which allow a target, such as a sign message or symbol, to be seen against the sign background.

$$\text{Contrast} = \frac{R_L - R_B}{R_B}$$

$$\text{Contrast Ratio} = \frac{R_L}{R_B}$$

Where:  $R_L$  is Reflectance of Legend, and  
 $R_B$  is Reflectance of Background

For light-emitting dynamic message signs, the same relationships apply, except that reflectance is replaced by emitted light intensity for both legend and background.

**Cost-effectiveness**

The relationship between a measure’s benefit over its service life and the total costs it incurs over its service life, often expressed as a ratio.

**Crown**

A particular type of sign symbol, in the shape of a crown, used for King’s Highway numbers, either by itself or as part of a Directional Guide Sign.

**Curve**

A horizontal or vertical deviation in the roadway. A horizontal curve appears as a bend in the roadway, requiring drivers to turn the steering wheel. A vertical curve appears either as a “crest” or a “sag” to provide for a change in gradient on the profile of the roadway.

**Curve Sign**

A Warning Sign used to inform drivers of an upcoming change in roadway alignment. In some cases, a reduction in speed is recommended.

**Customized Standard Sign**

A sign which is in the Master Sign Library, but which needs to be adjusted to accommodate a specific local sign message. Most customized standard signs are Directional Guide Signs and need to be designed according to the sign design rules and sign design process outlined in Book 2, Sections 2.14 and 2.15.

**Cut Image**

The accurate, scaled template of a standard regulatory, warning, or temporary conditions sign that may be used directly for sign manufacture, supplied in the MSL.

**D**

**Daytime Colour**

Daytime Sign Sheeting colour as defined by daytime colour specification limits using four pairs of chromaticity coordinates to determine the acceptable colour in terms of the CIE 1931 Standard Colorimetric System.

**Decision Time**

The time required to make a decision and initiate a manoeuvre, if required, after reading or encountering a Traffic Control Device. Also called perception-reaction time.

**Delineators**

Small, Retroreflective devices erected in a series adjacent to the edge of a travelled portion of the roadway for the purpose of providing positive driver guidance.

**Design Speed**

A speed selected for purposes of design and correlation of those features of a highway, such as curvature, superelevation, and sight distance, upon which the safe operation of vehicles is dependent.

**Detour**

A diversion from the usual travelled roadway; either a crossover from one multi-lane roadway to another (within the highway right-of-way), or a Route Detour.

**Detour Marker**

A sign used to identify a Route Detour for detour route continuity, to assist driver navigation.

**Device (Traffic Control)**

See Traffic Control Device.

**Diagrammatic Sign**

A sign used primarily on freeways, which uses graphics to display the approximate geometry of the interchange or intersection, including lane configuration, along with essential directional information.

**Diamond Grade Material**

A non-metallized, high reflectivity micro-prismatic sign sheeting material (ASTM Type VII, VIII, or IX). The material may be fluorescent or non-fluorescent.

**Directional Guide Sign**

A broad class of signs providing route-finding or operational guidance to road users, including direction to specific destinations.

**Diversion Route**

A route where the driver is required to depart completely from the normal route and is directed to use an alternate route.

**Divided Highway**

A multi-lane highway consisting of roadways for opposing traffic which are separated by an unpaved area or other physical barrier, including a curbed island. See also Continuous Wide Median.

**DOT**

U.S. Department of Transportation.

**Driver**

A person who operates a vehicle on a highway.

**Driver Response**

The driver action taken as a result of reading a traffic sign or encountering another traffic control device.

**E**

**Eighty-fifth (85th) Percentile Speed**

The speed at, or below which, 85% of motorists are travelling.

**Engineering Grade Material**

A retroreflective sign sheeting material meeting ASTM Specification D 4956-01a for Type I material or CGSB Specification 62-GP-11M for Reflectivity Level II material.

**Entrance Angle**

The horizontal angle between the headlight beam and a line perpendicular to the sign. For computation of the entrance angle, the headlight beam is usually considered to emanate from a point midway between the two headlights.

**Expectancy**

Used in traffic engineering to describe a driver's anticipation of upcoming road design and traffic control conditions. Driver expectancy is usually affected by previous experience and the consistency and continuity of traffic control devices encountered.

### **Expressway**

A divided arterial highway for through traffic with full or partial control of access and generally with Grade Separations at major intersections.

## **F**

### **Fabrication**

The construction and/or assembly of a traffic control device and/or its supports. See also Sign Fabrication.

### **FHWA**

U.S. Federal Highway Administration.

### **FHWA Fonts**

A series of fonts used in sign design.

### **Fluorescence**

The emission of light produced by certain substances when excited by an ultraviolet (UV) energy source. This emission ceases when the UV source is removed.

### **Fluorescent Orange and Yellow-Green**

Fluorescent sign sheeting colours designed for high conspicuity in daytime. Fluorescent sign sheeting may be non-reflective (daytime use only) or reflective (daytime and nighttime use).

### **Font**

A set of letters, numbers, and symbols of a unified design and given size, and designated by name.

### **Freeway**

A multi-lane Divided Highway with continuous dividing median, full control of access and interchanges in place of At-grade Intersections, and a posted speed of 90 km/h or greater.

### **French Language (French) Signs**

A sign whose text message is in the French language only.

## **G**

### **Grade Crossing**

A railroad crossing a highway at the same elevation (no vertical separation).

### **Grade Separation**

The vertical separation of two or more intersecting roadways or a roadway and another transportation mode, e.g., railroad, thus permitting traffic on all roads to cross traffic on all other roads without interference.

### **Ground-mounted Sign**

A sign mounted beside the Roadway rather than above it.

### **Guideline**

A recommended practice, method or value for a specific design feature or operating practice.

### **Guide Sign**

A Traffic Sign used to direct traffic along a route towards a destination.

## **H**

### **High Intensity Material**

A retroreflective sign sheeting material meeting ASTM Specification D4956-01a for Type III or IV, or CGSB Specification 62-GP-11M for Reflectivity Level I material.

### **High Occupancy Vehicle (HOV)**

A vehicle that carries a defined minimum number of persons (typically two or three).

### **Highway**

A general term denoting a public way for purposes of vehicular and pedestrian travel, including the entire area within the Right-of-way. This includes King's Highways, regional and county roads, rural roads, municipal roads, and streets.

### **Highway Traffic Act (HTA)**

The Ontario Highway Traffic Act.

### **Horizontal Sign Offset**

The horizontal distance between the edge of the pavement and the nearer edge of a ground-mounted traffic sign.

### **HOV**

High Occupancy Vehicle.

### **HTA**

Highway Traffic Act (Ontario).

### **Human Factors**

The consideration of human physical, perceptual and mental limitations in engineering design, so as to optimize the relationship between people and things. The objective is to reduce error and increase user comfort.

## **I**

### **Information Load**

The amount of information presented to a driver by a Sign or other Traffic Control Device, which is a factor in determining the amount of time drivers require to read, comprehend, and act upon the message.

### **Interchange**

A system of interconnecting roadways in conjunction with one or more grade separations, providing for the interchange of traffic between two or more roadways on different levels.

### **Interdictory Symbol**

An annular (circular) red band with a diagonal red stroke at 45 degrees, or as close to 45 degrees as practical, signifying that whatever is depicted within the symbol is prohibited.

### **Interline Spacing**

The vertical space between the bottom of one message line on a sign and the top of the message line beneath it. Also called line spacing or 'leading' (pronounced 'ledding').

### **Intersection**

The area embraced by the prolongation of lateral curb lines or, if none, of the rights-of-way of two or more highways that join one another at an angle, whether or not one highway crosses the other.

### **Intersection Approach**

That part of an Intersection Leg used by traffic approaching the intersection.

### **Intersection Channelization**

Raised or painted islands at an intersection that prevent specific movement(s) from being made or provide better definition of large uncontrolled areas of pavement.

### **Intersection Leg**

That part of any one of the roadways radiating from the intersection which is close to the intersection but outside the area of the intersection proper.

### **ITE**

Institute of Transportation Engineers.

## **J**

### **Junction**

See Intersection.

### **Jurisdiction**

A legal or other authority with responsibility and control for specific actions within a defined area.

## K

### **KHGSPM**

King's Highway Guide Signing Policy Manual (Ontario).

### **Kilometre (km)**

A measure of distance equal to 1,000 m (0.621 miles).

### **King's Highway**

A highway, including secondary and tertiary roads designated under the Public Transportation and Highway Improvement Act.

### **King's Highway Guide Signing Policy Manual (KHGSPM)**

The Ministry of Transportation Ontario manual for guide signing on provincial highways. It is being superseded by OTM Book 8 (Directional and Information Signs) and Book 9 (Tourism and Commercial Signs).

### **km**

Abbreviation for kilometre.

## L

### **Lane**

A defined width of road intended to accommodate a single line of moving vehicles.

### **Lane Designation Sign**

An Overhead or Ground-mounted Sign, erected at or in advance of an intersection, or over a lane or lanes, to regulate traffic on an approach by assigning certain traffic movements to specific lanes or a reserved lane. These signs should not be confused with Turn Control Signs.

### **Lane Use Sign**

See Lane Designation Sign.

### **Left-turn Lane**

A lane reserved for left-turning vehicles and so designated by Pavement Markings and/or Lane Destination Signs.

### **Legal Authority**

The authority provided by legislation and regulations, to a jurisdiction or enforcement body for the actions it takes.

### **Legend**

The complete message on a sign, which may include text, symbols, arrows, markers, shields, crowns, and diagrams.

### **Legibility**

Sign legibility is governed by the distance at which the sign becomes legible and the duration for which it remains legible. Legibility depends on Font, character, word and Interline Spacing, Contrast ratio, and clarity of symbols.

### **Legibility Distance**

The distance at which a sign can be read by a given driver under prevailing conditions.

### **Legibility Distance, Required**

The distance at which a sign must be legible, based on the travel speed and the sum of Reading Time, Decision (perception-reaction) Time, and Manoeuvre Time.

### **Line Spacing**

See Interline Spacing.

### **Logo Services Signing**

Logo-based signing located on freeways, on approaches to interchanges, for specific food, fuel and accommodation (lodging) services and establishments.

### **Luminance**

Reflective light; the luminous flux in a light ray, emanating from a surface or falling on a surface, in a given direction, per unit of projected area of the surface as viewed from that direction, per unit of solid angle.

## **M**

### **m**

Abbreviation for Metre.

### **Maintenance**

The upkeep of highways, traffic control devices, other transportation facilities, property and/or equipment.

### **Manoeuvre Time**

The time to complete any required manoeuvre before reaching a sign, other traffic control device, or decision point.

### **Marker**

A particular type of sign symbol used for regional, county, or municipal route numbers, either by itself or as part of a Directional Guide Sign.

### **Master Sign Library (MSL)**

The electronic library of all signs in the OTM, including scaled sign pattern templates and cut images for the fabrication of standard signs. The MSL is stored on a CD-ROM as part of Book 2, and is made up of:

- (1) Sign Blank list and patterns;
- (2) Sign Parts Library; and
- (3) Sign Patterns.

### **Material Safety Data Sheet (MSDS)**

A sheet for each specific product identified under the Workplace Hazardous Materials Information System (WHMIS) which describes the composition of the product. It also gives details on the safe handling and storage of the product as well as personal protective safety equipment that is required when using the product, and other protective devices such as fume hoods and breathing apparatus. Handling, storage and use of each specific product must conform to these regulations.

### **Maximum Speed**

The maximum speed drivers are permitted to travel. The maximum speed is imposed by the Highway Traffic Act, or municipal by-laws. See also Normal Posted Regulatory Speed.

### **May**

Indicates a permissive condition. No requirement for design or application is intended. However, mandatory requirements apply to some specific options if and when they are selected.

### **Median**

That portion of a Divided Highway separating the travelled ways for traffic in opposite directions.

### **Median Island**

A zone or physical island constructed in the centre of a roadway to separate opposing directions of traffic.

### **Median Strip**

An expanse of hard surface material separating opposing lanes on a highway. The hard surface is flush or nearly flush with the adjacent lanes.

### **Metre (m)**

A metric unit and the base SI unit of linear measure, equal to about 39.4 inches.

**Ministry**

Unless otherwise specified, the Ministry of Transportation Ontario (MTO). Where so specified, the Ministry means the Ontario Ministry of Labour (MOL).

**MOL**

The Ontario Ministry of Labour.

**Motorist**

See Driver.

**MSDS**

Material Safety Data Sheet.

**MSL**

Master Sign Library

**MTO**

The Ministry of Transportation Ontario.

**Multi-lane Highway**

A roadway with two or more travelled lanes carrying traffic in each direction.

**Must**

Indicates a mandatory condition. Where certain requirements in the design or application of the device are described with the “must” stipulation, it is mandatory that these requirements be met when an installation is made.

**MUTCD**

The Manual of Uniform Traffic Control Devices for Ontario, 1995.

**MUTCDC**

The Manual of Uniform Traffic Control Devices for Canada, 1997, and its subsequent updates.

**MUTCD-US**

The U.S. Manual on Uniform Traffic Control Devices, 2003 Edition.

**N**

**Non-standard Sign**

A sign which is not included in the MSL, and which needs to be designed by the user. Some examples of these are special warning signs. Note however, that non-standard signs still need to follow basic rules of design.

**No Parking**

See Parking and Parking Restriction.

**Normal Posted Regulatory Speed**

The regulatory maximum speed posted on a highway under normal conditions, that is, when no construction zone or work activity is present.

**No Standing**

The prohibition of the halting of a vehicle whether occupied or not, except for the purpose of and while actually engaged in the receiving or discharging of passengers.

**No Stopping**

The prohibition of the halting of a vehicle, even temporarily, whether occupied or not, except where necessary to avoid conflict with other vehicles, or in compliance with the directions of a police officer or Traffic Control Signal.

**O**

**Observation Angle**

The vertical angle formed by light travelling from a vehicle’s headlights and reflected off the sign back to the driver’s eye.

**Occupational Health and Safety Act (OHSA)**

The Ontario Occupational Health and Safety Act and Regulations, of the Ontario Ministry of Labour (MOL).

### **Official Sign**

Any sign approved by the Ministry of Transportation Ontario (MTO).

### **OHSA**

Occupational Health and Safety Act.

### **Older Driver**

A driver aged 55 years or older.

### **Ontario Provincial Standard Specifications (OPSS)**

A compilation of standard specifications for materials and products used in road construction and maintenance, compiled by the Ministry of Transportation Ontario together with other stakeholders.

### **Ontario Traffic Manual (OTM)**

A comprehensive user manual for traffic practitioners, addressing the needs of all Ontario road authorities, superseding the Manual of Uniform Traffic Control Devices (MUTCD) and the MTO King's Highway Guide Signing Policy Manual (KHGSPM). The OTM has been in development since 1997, and is issued as individually bound books.

### **Operating Speed**

The speed at which the majority of vehicles are travelling, typically the 85th Percentile, regardless of the speed limit.

### **OPSS**

Ontario Provincial Standard Specifications.

### **OTM**

Ontario Traffic Manual.

### **Out-of-view Time**

The period of time, when approaching a sign, when the sign is very close, is seen on an angle, and becomes difficult to read. It is assumed in the OTM that the sign is not read for the last 1/2 second, the out-of-view time.

### **Overhead Sign**

A Traffic Sign mounted above the Roadway, usually with 4.5 m to 5.3 m of vertical clearance and preferably mounted over the lane or lanes to which the sign applies.

### **Overpass**

A Grade Separation where the travel way in question passes over the other travel way.

### **Oversize Sign**

A Traffic Sign with greater proportional dimensions than the minimum dimensions specified in the OTM. Such signs are generally required on higher speed highways, or on other highways in special cases.

## **P**

### **Parking**

The stationary storage or leaving of a vehicle unoccupied or unattended.

### **Parking Control Sign**

A sign which identifies the time of day and days of week parking, stopping or standing restrictions are in place on the section of road adjacent to the sign.

### **Parking Restriction**

A limitation which prohibits vehicles from being parked in specific locations, at specific times, or for specific type of vehicle. Most often used to control on-street parking.

### **Parking (and Stopping) Signs**

A Traffic Sign of the regulatory type which informs drivers of the parking and stopping regulations in effect on facilities where such signs are erected.

**Pedestrian Crossover (PXO)**

Any portion of a Roadway, designated by municipal by-law, at an intersection or elsewhere, distinctly indicated for pedestrian crossing, by signs on the highway and lines or other markings on the surface of the roadway, as prescribed by the regulation and the HTA, with associated signs Ra-4, Ra-4t, Ra-10 and Ra-11.

**Pedestrian Crosswalk**

Any portion of the Roadway, at an intersection or elsewhere, distinctly indicated for pedestrian crossing by appropriate pavement markings and/or signs, or by the projections of the lateral lines of the sidewalk on opposite sides of the road.

**Pedestrian Sign**

See School and Pedestrian Signs.

**Perception-reaction Time**

See Decision Time.

**Permissive**

Refers to areas where a driver is permitted to travel.

**Permissive Symbol**

An annular (circular) green band used on a sign to signify that whatever is depicted within the symbol is permitted.

**Positive Guidance**

Provision to road users of the information they need to avoid hazards, when and where they need it, in a form they can best use it. See Book 1c (Positive Guidance Toolkit).

**Posted Advisory Speed**

The maximum advisory speed as indicated by appropriate Warning or Temporary Conditions Signs.

**Posted Speed Zone**

A section of highway upon which the maximum speed is indicated by appropriate Regulatory Signs.

**Prescribed Sign**

A sign prescribed by the Highway Traffic Act (HTA), Section 182 (R.S.O. 1990) and its regulations, providing for the the type of sign and its location on the roadway. The criteria and specifications for application, dimensions, location and orientation are prescribed and illustrated under Regulations 615, 608, 581, 599 (R.R.O. 1990). Signs erected in accordance with the Regulations, and pursuant to the Highway Traffic Act, are enforceable under various provisions of the Act. Enforcement is permitted under the particular section under the authority of which a prescribed sign may be erected to indicate a traffic regulation, or HTA Section 182 (R.S.O. 1990), which requires obedience to prescribed signs.

**Provincial Highway**

Any public highway under the jurisdiction of the Ministry of Transportation Ontario (MTO). See King's Highway.

**Public Roadway**

Any roadway under the jurisdiction of and maintained by a public authority and open to public travel.

**Public Way**

A sidewalk, street, highway, square, or other open space to which the public has access, as of right or by invitation, either express or implied.

**PXO**

Pedestrian Crossover.

**R**

**Railroad Crossing**

A location where one or more railroad tracks cross a public highway, road, street, or a private roadway, and includes sidewalks and pathways at or associated with the crossing.

**Ramp**

An interconnecting Roadway of a traffic Interchange, or any connection between highways at different levels, or between parallel highways, on which vehicles may enter or leave a designated roadway.

**Reading Time**

The time required to read a sign.

**Reflectance**

See Reflectivity.

**Reflectivity**

A measure of the degree to which a surface reflects incident light. A related term, reflectance, is the amount of light reflected back from a sign, relative to the amount of light shining on the sign. See Retroreflectivity, Coefficient of (R).

**ReflectORIZATION**

A method of incorporating light-reflective material on the approach face of a Traffic Sign so that the face will reflect light during the hours of darkness while retaining the same colours as by day.

**Regulation**

A prescribed rule, supported by legislation, such as any regulation made under the HTA or OHSA or municipal by-law. Regulations provide the legal basis for enforcement.

**Regulatory Sign**

A Traffic Sign advising drivers of an action they should or must perform (or not perform) under a given set of circumstances. Disregard of a regulatory sign would usually constitute an offence.

**Reserved Lane**

A street or highway lane reserved for use by specific classes of vehicles, either all day, or during specified periods. These classes may include any or all of buses, carpools, taxis or bicycles.

**Reserved Lane Controls**

All controls, including Traffic Control Devices and physical devices, intended to ensure that a Reserved Lane functions in accordance with its intended purpose.

**Response Time**

The time between the occurrence of an event and the action taken to respond to the event.

**Restrictive**

Refers to areas where, or times when, a driver is not permitted to travel, stop, stand, or park.

**Retroreflective Material**

A type of material applied in either strips or sheets which reflects illumination back to its source.

**Retroreflectivity, Coefficient of (R)**

R indicates the proportion of light reflected back to the driver from a retroreflective sign surface, in candelas per lux per square metre.

**Right-of-way (ROW)**

- (1) Allocation of right of movement to a road user, in preference over other road users;
- (2) The width of the road allowance from the property line on one side to the property line on the opposite side of the roadway.

**Right-of-way Rule**

Although these may vary in specific localities, generally a vehicle approaching an uncontrolled intersection must yield to a vehicle approaching on the leg to its right.

**Right Turn on Red (RTOR)**

A right-turning movement permitted on a red signal indication after coming to a stop and ensuring that a right turn can be made safely. Allowed by the HTA, but subject to site-specific local by-laws.

**Road**

See Highway.

**Road Authority**

The body (Municipal, Provincial or private) that has legal jurisdiction over a roadway.

**Roadway**

The part of the Highway that is improved, designed or ordinarily used for vehicular traffic, but does not include the Shoulder, and, where a highway includes two or more separate roadways, the term “roadway” refers to any one roadway separately and not to all of the roadways collectively.

**Roadway Alignment Sign**

A Warning or Temporary Conditions Sign used to inform drivers of an upcoming change in roadway alignment, including turns and Curves.

**Route Detour**

A detour where a driver is required to depart completely from the normal route and is directed to use an alternate route. The alternative route must be signed using a combination of the appropriate TC-10 directional signs. See OTM Book 7.

**Route Marker**

A Guide Sign bearing a route number which is erected along numbered highways.

**ROW**

Right-of-way.

**RToR**

Right turn on red.

**Rural Area**

An area outside of the limits of any incorporated or unincorporated city, town, village, or any other designated residential or commercial area.

**S**

**Safe Speed**

See Advisory Speed.

**School (and Pedestrian) Signs**

A group of signs, both Regulatory and Warning, used to control vehicles and protect pedestrians wherever students and pedestrians are likely to be present and conflict with vehicles may occur.

**School Zone**

A section of roadway in the vicinity of a school, with a mandatory 40 km/h maximum speed zone, in effect at designated times every school day. The HTA also makes provision for 60 km/h speed zones on King’s Highways.

**Separate Roadway**

A physically separated, access controlled, HOV priority treatment facility, usually located within the median of an urban freeway. Separated roadways can be either reversible or two-way, single or multi-lane facilities.

**Shall**

Means the same as “must”.

**Shared Roadway**

Any roadway upon which a Reserved Lane is not designated and which may be legally used by a variety of vehicle types regardless of whether such facility is specifically designated. This includes bicycles, buses, taxis, and carpools.

### **Shield**

A particular type of sign symbol used for provincial highway numbers, either by itself or as part of a Directional Guide Sign.

### **Should**

Indicates that an action is advised; recommended but not mandatory. 'Should' is meant to suggest good practice but allows that in some situations, for good reasons, the recommended action cannot or need not be followed.

### **Shoulder**

The portion of a Highway between the outer edge of the roadway and the Curb, or point of intersection of the slope lines at the outer edge of the roadway and the fill, ditch, or median slope. Used to accommodate stopped vehicles, for emergency use, and for lateral support.

### **Sidewalk**

That portion of a road, adjacent to the travelled roadway, which has been improved for the use of pedestrians.

### **Sign**

A Traffic Control Device mounted on a fixed or portable support which conveys a specific message by means of symbols or words, and is officially erected for the purpose of regulating, warning, or guiding traffic.

### **Sign Assembly**

Any Traffic Sign mounted and erected alone or in conjunction with any combination of associated Tab Signs.

### **Sign Blank**

The Substrate for a given size of standard sign.

### **Sign Blank List**

The list of standard sign blanks and numbers, included as part of the Master Sign Library.

### **Sign Blank Number**

The number issued to a given size of standard Sign Blank (substrate), for purposes of identification, inventory and fabrication.

### **Sign Blank Pattern**

A scaled, dimensioned pattern suitable for fabrication of standard metal Sign Blanks. Sign blank patterns are included as part of the Master Sign Library.

### **Sign Fabrication**

The process of producing a sign including: substrate fabrication, preparation, extruded panel assembly, application of background sheeting, and application of legend, but excludes sign mounting or installation in the field.

### **Sign Materials**

Those materials used in signs, including substrate, extruded aluminum panels and hardware, background sheeting, and legend (vinyl, retroreflective sheeting, paint, or ink).

### **Sign Parts Library (SPL)**

The library of scaled drawings of sign parts, such as arrows, markers, crowns, shields, and symbols, which may be used in the design of signs. The SPL is included as part of the Master Sign Library.

### **Sign Pattern**

The full-size drawing of an individual sign, showing sufficient detail and dimensional accuracy for sign fabrication.

### **Sign Pattern Template (SPT)**

The base record of reference in the OTM Master Sign Library for sign design. The SPT includes: a sign image, sign numbers, sizes, sign blank numbers, colours, minimum reflectivities, fonts, special notes, and scaled templates (cut images) for the design of Standard Signs.

### **Sign Sheeting**

The Retroreflective Material used on the surface of a Sign to provide good daytime and nighttime visibility.

### **Sign Support**

The physical means of holding a sign in its intended position.

### **Sign Symbol**

A pictogram, depiction, arrow, silhouette or figure, and/or Interdictory or Permissive Symbol, used to simplify or represent a word message on a sign.

### **Specular Gloss**

A measurable characteristic of Retroreflective sheeting which, when subjected to light at specific angles, can result in glare for drivers.

### **Speed Limit**

The maximum vehicular speed allowed within any given posted or unposted Speed Zone.

### **Speed Zone**

A specific section of roadway upon which a maximum speed limit has been imposed. Such zones may be posted or unposted. A construction speed zone must be posted.

### **SPL**

Sign Parts Library.

### **SPT**

Sign Pattern Template.

### **Standard**

A rule, principle, pattern or measure, which practice or theory has shown to be appropriate for a given set of conditions, and applicable, as the case may be, to planning, design, traffic control devices, operations or maintenance.

### **Standard Sign**

A sign in the Master Sign Library for which the cut images may simply be used as is or with very minor change (e.g., speed limit sign numeral 90 instead of 50 as shown). Most regulatory, warning, and temporary conditions signs (Books 5, 6, and 7 respectively) are standard signs.

### **Standard Sign, Customized**

See Customized Standard Sign.

### **Standing**

The halting of a vehicle whether occupied or not. See also No Standing.

### **Statutory Speed Limit**

A maximum speed limit automatically in effect on all roads, unless otherwise signed. The statutory speed limit applies even where no maximum speed limits are signed.

### **Stopping**

The halting of a vehicle, even temporarily, whether occupied or not. See also No Stopping.

### **Stopping Sight Distance**

The distance required by a driver of a vehicle, travelling at a given speed, to bring the vehicle to a stop after an object on the roadway becomes visible. It includes the distance travelled during the Decision Time and the vehicle braking distance.

### **Street**

An urban Highway.

### **Substrate**

The material and surface to which the sign sheeting is applied.

### **Symbol**

See Sign Symbol.

# T

## Tab Sign

A sign smaller than the primary sign with which it is associated, and mounted below it. There are two types of tab signs:

- (1) Supplementary Tab Sign – contains additional, related information;
- (2) Educational Tab Sign – conveys the meaning of symbols during their introductory period.

## TAC

Transportation Association of Canada.

## T-Bar

A metal bar used on the back side of an extruded aluminum sign, at right angles to the length of the sign panels, for purposes of connection, bracing, and structural rigidity.

## TC

Temporary Conditions.

## Temporary Conditions (TC)

Roadway and traffic control conditions related to non-permanent construction, maintenance and utility work on any highway.

## Temporary Conditions Sign

A Regulatory, Warning, or Guide Sign, intended to be used for Temporary Conditions.

## Text

The part of a sign legend consisting of words.

## Time of Operation

The time period for which a traffic system is in operation or during which a prohibition or restriction is in effect.

## TOD

Time of Day.

## TODS

Tourism Oriented Destination Signing.

## Tourism Oriented Destination Signing (TODS)

A program of tourism signing developed for provincial highways with Trailblazing continuity on other roads. Some municipalities have developed municipal tourism signing programs compatible with TODS.

## Tourism Signing

Information signing for tourist-related attractions. Tourism signing includes TODS as well as non-TODS signing for local and municipal attractions.

## Traffic Control Device

Any sign, signal, marking, or device placed upon, over or adjacent to a roadway by a public authority or official having jurisdiction, for the purpose of regulating, warning, guiding or informing road users.

## Traffic Sign

A device (other than Pavement Markings, Delineators and Traffic Control Signals) which may be erected beside or above a roadway for the purpose of regulating, warning or guiding traffic.

## Trailblazer

A small identification sign which provides continuity and assurance for drivers wishing to follow a given route or to reach a given destination.

## Travel Speed

Rate of motion. Ratio of travel distance and travel time.

## Travel Time

The time of travel, including stops and delays except those off the travelled way.

### Turn Control Sign

A Traffic Sign, generally erected at an intersection, indicating by arrows and an Interdictory Symbol the movement or movements traffic on that approach must not take. These signs should not be confused with Lane Designation Signs.

### Turn Prohibition

A regulation prohibiting a straight-through movement or a left or right turn at an intersection.

### Turn Sign

A Warning Sign used to inform drivers of an upcoming change in roadway alignment. See also Curve Sign.

### Two-lane Highway

An undivided two-way facility having one lane for traffic moving in each direction.

### Two-way Left-turn Lane

The centre lane on some three, five or seven lane sections of undivided highway which is designed to facilitate left turns from each direction.

## U

### Uncontrolled Intersection

An intersection which does not have Right-of-way control devices on any of the approaches.

### Underpass

A grade separation where the travel way in question passes under another travel way.

### Undivided Highway

A multi-lane highway with no continuous Median, or with a paved flush dividing strip, or with a Two-way Left-turn Lane.

### Uniformity

Consistency in the design, fabrication and application of traffic control devices and operations.

### Urban Area

An indefinite area of land used primarily for residential, commercial, and/or industrial purposes, usually associated with a given area size, population, and density.

## V

### v

Velocity.

### Vehicle

Includes a motor vehicle, trailer, traction engine, farm tractor, road-building machine, bicycle, and any vehicle drawn, propelled or driven by any kind of power, including muscular power, but does not include a motorized snow vehicle or motorcycle sidecar.

### Vehicle Eligibility

Eligibility of a vehicle to use a reserved lane or parking space, based on meeting defined criteria.

### Vehicle Occupancy

The number of persons, including the driver and passenger(s), in a vehicle at a given time. See also High Occupancy Vehicle (HOV).

### Vertical Sign Offset (Vertical Sign Clearance)

- (1) For ground-mounted signs, the vertical sign offset is the vertical distance between the bottom of the sign face and the elevation of the edge of the nearest traffic lane or of the sidewalk, as the case may be.
- (2) For overhead-mounted signs, the vertical sign clearance is the vertical distance between the bottom of the sign face and the elevation of the highest point of the pavement surface beneath it.

**Volume**

The number of vehicles or pedestrians that pass over a given section of a lane or a roadway or make a particular movement during a specific time period (such as one hour or 24 hours).

**W**

**Warning Sign**

A sign which indicates conditions on or adjacent to a highway or street that are actually or potentially hazardous to traffic operations.

**Warrant**

A criterion or set of criteria by which justification for a given type of Traffic Control Device or other application is determined.

**Weathering Requirements**

Sign material (sign sheeting) specification tests, to verify that sign sheeting is weather resistant and shows no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, and remains within specified limits for shrinkage and expansion, when tested according to the procedure described in the specification.

**WHMIS**

Workplace Hazardous Materials Information System. See Material Safety Data Sheet (MSDS).

**Work Zone**

A section of highway or roadway where highway-related construction, maintenance, or utility work takes place. See Book 7.

**Y**

**Yield**

To cede the right-of-way.

**Z**

**Z-Bar**

A metal bar used on the back side of an extruded aluminum sign, at right angles to the length of the sign panels, for purposes of connection, bracing, and structural rigidity.

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## Appendix B • References

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