Tauranga Transport Operations Centre

TTOC-02 Requirements for Traffic Signals Design

Document History and Status

	Revision	Date	Prepared By	Authorised By	Description
Requirements for Traffic Signals Design	Final	May 2014	Haydn Wardley	Haydn Wardley	Final
Document No.TTOC-02	B	March 2016	Haydn Wardley	Haydn Wardley	1.0 added BOP Region; 3.0 added TTOC – 01 for ref.; 4.2 location chambers; 4.3 count dets, TTOC -09 added; 4.7 use of default and alternative phasing;
Document No.TTOC-02	C	August 2017	Haydn Wardley	James Wickham	Sections added. More content to modelling and traffic signal design. Formatting, spelling and grammar changes. Put Modelling into new TTOC-06. Changed name from Traffic Signal Guidelines.
Document No.TTOC-02	D	August 2018	Haydn Wardley	James Wickham	Added more to section 4.1
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1. Introduction

The Tauranga Transport Operations Centre (TTOC) is responsible for all traffic signals operations in the Bay of Plenty region from installation through to maintenance.

This document is designed to assist all interested parties to understand the TTOC functions and the standards that have been adopted to ensure a consistent approach is maintained when designing and installing traffic signals and associated equipment.

1.1 Purpose

The purpose of this document is to give an understanding of the TTOC requirements when undertaking the design, installation or maintenance of traffic signal installations in the TTOC regions.

1.2 Who Should Use This Document?

All consultants, contractors and project managers (we refer to as "**applicant"** in this document) involved in the design, installation and maintenance of traffic signals on behalf of Road Controlling Authorities (RCA) in the Bay of Plenty should use this document. Where for example, an upgrade is being carried out by an RCA the applicant shall be the assigned. In most situations this would be the traffic signal contractor (who would have most technical experience in providing the relevant information required).

The TTOC has prepared this document to assist practitioners when designing traffic signal installations. Although this document has technical and specialist content, the applicant must read it in conjunction with TTOC-01 Requirements for Traffic Signal Works. TTOC-01 contains details on document management and describes processes. The intent is to show what is expected in the application. The applicants should also refer to TTOC-00 Standard Traffic Signal Documents Index.

This guideline has been created to ensure that the designs of all intersections are to the highest standard, with variations being the exception rather than the norm. It is important that the information submitted as part of new or modified traffic signal layouts are standardised as much as possible. This will enable any further changes that may result from changing traffic conditions to be implemented quickly and simply.

The applicant's project team members are expected to have the experience and knowledge required to provide the relevant details, particularly the production of software and, CIS and traffic signal design. The TTOC are not responsible for providing training or resources for designers who are new to the industry as there are suitable courses and consultants who can provide training.

2. Glossary of Terms

AS / NZ	Australian Standard / New Zealand Standard
Active Traffic Management System (**ATMS**)	Technology that provides information to road users by means of Variable Message Signage.
Controller	The equipment (including the housing) that switches power to signal lanterns and controls the duration and sequence of signal displays as defined by the controller personality.
Controller Information Sheets (**CIS**)	A hard copy of the information used to make a Controller Personality that is contained within the PROM.
Controller Personality	The unique program stored in the PROM, which configures the controller to the specific operational design of the intersection.
CCTV	Closed Circuit Television.
DP Number	Distribution Point for telecommunications.
FSL	From Stop Line, measurement used for distance from start of detector loop.
IDC	Infrastructure Development Code
ICP Number	Installation Connection Point Number (for electricity power meter).
Intelligent Transport Systems (**ITS**)	Refers to various systems like SCATS, CCTV, VMS and ATMS systems that provide and add information and communications technology to transport infrastructure.
JUMA, JUSP	Joint Use Mast Arm, Joint Use Service Pole
KJB	Kerbside Junction Box to access services. For example, detector loop feeders.
NZTA	New Zealand Transport Agency.
NGEN	Software product developed by RMS to produce .SFT and .M68 files.
PCMCIA Card	A computer card containing the controller personality information housed in the TSC / AS 2578 compliant controller.
PROM	A computer chip containing the controller personality information housed in the TSC3 compliant controller. In this document PROM refers to either a PROM, a PCMCIA card or similar software storage device.
Road Asset and Maintenance Management (**RAMM**)	An Internet accessible system that stores the Traffic Signal assets. RAMM also records the activity of the Maintenance Contractors by the logging of faults as Dispatches and the updating by the Contractors following completion of the job. Contractors' claims are generated from the RAMM system each month end.
RCA	Road Controlling Authority.
Roads and Marine Services (**RMS**) of New South Wales (**NSW**)	The Authority accepted by Tauranga City Council as the basis for the TTOC standards and for product approval. RMS also develop and own SCATS traffic signal software and other products related to SCATS and their output files.
SAT	Site Acceptance Test, commissioning checklist.

.SFT / .M68	File formats for traffic signal software (TRAFF)
Sydney Coordinated Adaptive Traffic System (**SCATS**)	A fully adaptive area wide control system for traffic signals that is linked to the traffic signal controllers running TRAFF software via telecommunication lines.
TRAFF	Traffic signal base software inside traffic controllers on site running the signals.
TCC	Tauranga City Council
Tauranga Transport Operations Centre (**TTOC**)	Organisation tasked with managing the traffic signals and the ITS systems for local roads and State Highways Bay of Plenty by monitoring SCATS and CCTV.
Vehicle Activated Sign (**VAS**)	VAS is a generic term for a type of road traffic sign that displays a message conditional upon the presence or speed of a road vehicle.
Variable Message Sign (**VMS**)	An electronic traffic sign often used to display a message or picture. The sign display is changeable and dynamic.
Win Traff	A software programme used to check the controller information by testing the software of the controller personality.

3. Technical Criteria

The design of the traffic signals must be carried out in accordance with the standards and guidelines listed below and their revised / subsequent replacements:

- TTOC-00 Standard Traffic Signal Documents Index.
- TTOC-01 Requirements for Traffic Signal Works.
- TTOC-02 Requirements for Traffic Signal Design.
- TTOC-03 Regional Special Conditions to the National Specifications.
- TTOC-04 National Traffic Signal Specification.
- TTOC-06 Traffic Signals Modelling Guidelines.
- AUSTROADS Traffic Management Guides.
- Road Traffic Standards (RTS) 14.
- NZTA Pedestrian Planning and Design Guidelines.
- NZS1158 Public Lighting Standards.

The specification of traffic signals equipment shall comply with the current version of TTOC-03 Regional Special Conditions to the National Specifications or, a written agreement with the TTOC for the use of specific components shall be obtained.

The contractor is responsible for ensuring that all equipment that is installed meets the minimum standards. If there is any doubt, the contractor shall be required to provide evidence that the product meets the TTOC requirements.

3.1 Reference Material

Detailed below are recommended documents to assist in the processes required.

- NSW Roads & Maritime Services, Traffic Signal Design.
- Australian Road Research Board (ARRB), Traffic Signals: Capacity and Timing Analysis.
- Signals National User Group (SNUG).

4. Traffic Signal Report Documentation

Prior to an applicant submitting a traffic signal report to the TTOC, it is expected that the applicant liaise with the TTOC and produce a Traffic Signal Feasibility Report prior to the Traffic Signal Detailed Design[1].

Any deviations from the TTOC's Requirements and the reasons for the deviations must be summarised in a separate section in the report.

All documents to be supplied in electronic format, including original files from various software applications. For example; AutoCAD dwg. This is to ensure that the plans are clear and concise for reviewers, safety auditors and contractors.

4.1 Traffic Signal Feasibility Report

A brief traffic signal report with diagrams and maps that includes the following information:

- Site Location Plan.
- A brief description of the reason for proposing the installation of traffic signals.
- Intersection concept drawing/sketch showing proposed site including poles, lanterns, controller, accesses, bus stops and parking, vehicle and cycle lanes, with widths.
- Proposed and existing site layout detailing:
    - Road and Footpath widths dimensioned
    - Boundary, driveways, building lines and verandahs
    - Traffic signal equipment including phasing
    - Existing services, including manhole covers, boundary boxes, bus shelters etc.
    - Trees, garden plots, berms etc.
- Risk Identification and assessment of existing services.
- Assessment of Network Operation Plan, road hierarchy, speed and usage including over-dimensioned vehicles.
- Assessment and map showing user desire lines and facilities that generate traffic and pedestrian movements. For example, Hospitals, Schools and associated safe routes, event venues/clubs, elderly housing areas etc. This data is to be included in the modelling, as is information about the expected use of the network surrounding the proposed site.
- List user hierarchy in priority order, time and day. For example:

    AM Peak 07:00 – 09:00

    1. Cycle
    2. Freight
    3. Vehicles
    4. Pedestrians
    5. Buses

- Existing crash data with a brief analysis of causes and commonalities.
- Modelling Report – refer to TTOC-06 Traffic Signal Modelling Guidelines.

[1] As detailed in TTOC-01

- Movements Data. Examples of periods and types to be considered are:
    - AM Peak turn counts (07:00 – 09:00) for cars, heavies, cycles and pedestrians.
    - Inter Peak turn counts (11:00 – 13:00) for cars, heavies, cycles and pedestrians.
    - PM Peak turn counts (15:00 – 18:00) for cars, heavies, cycles and pedestrians.
    - School Travel turn counts for cars, heavies, cycles and pedestrians.
    - Approach design speeds (posted and 85 percentile).

4.2 Traffic Signal Detailed Design

If a Traffic Signal Feasibility Report has been prepared, the detailed design scope can be defined clearly with the majority of risks and modelling assessments already identified. However, some of the requirements have been expanded with an emphasis on more detail.

All drawing plans submitted in electronic format, to show as a minimum:

- Legend corresponding to the symbols and hardware depicted on the drawing.
- North Point.
- Title Block.
- Revisions with comments on changes.
- Drawing type (i.e. construction, information, draft).

Detailed Design requirements in addition to the Traffic Signal Feasibility Report are to include the following drawings and documents:

- Cover Sheet and Site Location Plan.
- Existing Survey and Services.
- Proposed Construction and Set out.
- Proposed Signal and Phasing Layout
- GPS co-ordinate location of poles and traffic signal cabinet(s).
- Proposed Ducting and Cable Diagram.
- Tactile Pavers and Pedestrian Layout.
- Proposed Road Marking and Signage.
- Vehicular Tracking Plan.
- Proposed Street Lighting.
- Standard Details (optional).
- Controller Information Sheet (CIS).

The detailed design should include detailed information for the proposed locations of poles, chambers, signs, lighting columns in relation each other and be drawn to scale.

Particular attention to detailing tactile pavers, pram crossings and pole locations, especially mast arms, should be made.

Further modelling work may be necessary during the detailed design process. The requirements are the same as detailed in the Traffic Signal Feasibility Report section, above.

4.3 Cover Sheet and Site Location Plan

This sheet will have the name of the project, a locality plan showing the location of the intersection, a brief and a drawing register.

4.4 Existing Survey and Services

This sheet is to show the location of all services plotted from the various service authorities services plans. In addition, the information collected by the topographical survey such as existing kerbs, driveways, trees, berms, local facilities such as manholes, valves, poles, streetlights and road marking and signs, must be shown.

We understand the accuracy of underground services plans can be minimal but it is expected that the designer has taken the steps to allow for inspections and trail holes to be investigated before the detailed design is approved.

4.5 Proposed Construction and Set Out

This sheet will show the extent of all new physical works to be undertaken such as kerb relocation, new islands, pole and chamber locations, pram crossings showing top and bottom of let-downs, tactile and directional pavers and, where services are being relocated to if applicable.

4.6 Proposed Signal and Phasing Layout

This sheet will show the proposed kerbs and road marking, the location and, the type of all signal hardware.

The plans shall be scaled appropriately to size of paper. Ideally, A1 size and include the following details:

- Lane configuration and assignment (arrows).
- Lane widths / carriageway widths (include cycle ways and advance cycle boxes where applicable).
- Detectors numbered (advance / queue loops to show distance from vehicle stop line).
- Signal Groups diagram, labelled and numbered.
- Signal phasing diagram, phase sequences and default sequence.
- Operation features e.g. ‘Rest in A’; ‘Z- allows filter’.
- Controller position and door opening.
- Poles with number and type (i.e. 5m outreach mast arm pole, JUMA, JUSP, CCTV).
- GPS co-ordinate location of all poles and the controller cabinet(s).
- External Inputs (include type i.e. Detectors - Infrared, Doppler radar, Video, Thermal.).
- Aspects showing visor and type, and louvers (if used).
- Street Names.
- Property Boundaries.
- Kerb Lines.
- Vehicle Crossings.

4.7 Proposed Ducting and Cabling Diagram

A Ducting and Cabling Diagram shall be scaled appropriately to size of paper and include the following details:

- Kerb Lines.
- Access Chambers and Label.
- Kerbside Junction Boxes (KJB) and Tobies.
- Signal controller cabinet.
- Duct Lines, specifying the size and number of ducts.
- Poles and pole numbering.
- Detectors and detector numbering (including external inputs, overhead detection etc.).
- Cable runs.

Tactile Pavers and Pedestrian Details

4.7.1 Tactile and directional pavers drawn to show actual proposed location. The design must consider location of services to minimise risk during construction. The relationship between:

- Pole location
- Push button with desired angle shown
- Slip and trip hazards, and
- Pedestrian access ramp and associated slope

is essential detail and the consideration given must be included.

The design should consider accessibility needs of disabled or aged users, such as orientation of the crossing to the target kerb ramp, wayfinding on approach and exit, wheelchair crossings of drains, etc.

The designer must consider relocating services or proposed pedestrian access locations to maintain a practical and operational site. Include additional drawings showing these details. For example:

- Staggered crossing to show fencing positions and method of quick removal for maintenance
- Drainage cross fall details showing within a Median Island, and
- Installation of poles on a staggered arrangement to be located behind the kerb to assist minimising trip hazard, footpath cleaning and drainage.

Specifications for type of tactile paver are defined in TCC IDC. Refer to the Standard Details section in this document. Plastic tactile pavers maybe considered after consultation with the TTOC. Furthermore, in ground pads are not to be used. Alternatives for call cancelling pedestrians can be considered, such as overhead detection. Refer TTOC-04.

4.8 Proposed Road Marking and Signage

This sheet will show the proposed road-marking layout with dimensions including the tie-ins with the existing road marking at the extent of the physical works. Any proposed signage should also be included.

4.9 Vehicle Tracking Plan

This sheet will show the tracking of the largest vehicles deemed appropriate for the site. Of particular note should be the left and right turning vehicles with respect to limit line location and kerb lines.

4.10 Proposed Street Lighting

The street lighting designer shall provide a design that has assessed the proposed traffic signals design in relation to their industry standard documents and appropriate Road Controlling Authority (RCA) Infrastructure Development Code (IDC). The TTOC shall comment on fit for purpose in relation to the proposed users and demographic environment. Examples by way of guide are:

- Suitable lighting to be installed for vehicle's, pedestrian access and crossing the road and also as part of the project site, and
- On the approaches to site, assist with crime prevention and CCTV operations.

The lighting design proposed for the intersection shall be peer reviewed by TCC's nominated consultant.

All overhead traffic signal poles are to have a JUMA spigot fitted to facilitate future street lighting or CCTV equipment if required. A waterproof cap shall be fitted to all spigots not used for lighting or CCTV equipment.

The streetlight is to source its power from the controller cabinet and be controlled by a photocell or ripple control mounted in the controller cabinet. See TTOC-03 and TTOC-04 for specifications relating to power and connections.

4.11 Standard Details

Standard signal sheets will show the details particular to signal installations. TTOC-04 shows some standard details however the designer may propose alternatives. For example:

- Staggered crossing to show fencing positions and the method of quick removal for maintenance.
- Drainage cross fall details (showing within a Median Island).

The applicant must ensure that all works meet the relevant RCA Development Codes and Standards. For example; ducting standards and depths, approved tactile pavers, waste management and drainage. Refer to the appropriate road controlling authority for relevant development code.

4.12 Controller Information Sheet

Controller Software Specification is to be used to develop the Controller Information Sheet (CIS). The newest CIS sheet must show the revisions from the previous version and highlight each change in yellow. Use the document template per TTOC-05 Controller Information Sheet.

The Controller Software Specification specifies the generic layout and operation of the site and includes any special requirements or logic in terms of detector or signal group operation.

These requirements are specific to each site / signal design. Refer to sections that follow for further details. At a glance, the requirements may include information such as:

- Train Operation.
- Pedestrian Protection (See Pedestrian Control section).
- Special Signal Group Overlaps.
- Bus, Tram or Cycle Logic.
- Conditional Phasing.
- Pedestrian Reintroduction.
- Special Time Setting Substitutions, and
- Special Detector Calling Functions.

MSS bits to be considered for all non-loop detectors such as push buttons, pedestrian overhead and underground detectors, Video, Infra-Red, Doppler Radar. This is so the TTOC can monitor the devices and control functions under SCATS variations.

5. Traffic Signal Equipment

This section is referring to considerations during Feasibility and Design stages in relation to location and practical operations rather than equipment performance and specifications where these are defined in documents TTOC–03 and TTOC-04.

5.1 Controller

The controller and its associated cable draw pit located within the road reserve with the back of the controller facing the intersection where practicable, with Door opening to be shown on drawing.

The controller should be located where it is:

- Close to the power supply and telecommunications.
- On reasonably level ground.
- Accessible to maintenance vehicles and personnel.
- Preferably near a property boundary and away from the edge of road.

The controller should be located where it:

- Can accommodate temporary external portable power supplies.
- Does not interfere with sight distance.
- Does not interfere with pedestrian and shared path facilities.
- Enables maintenance and operation personnel to have a clear view of traffic signals from the controller, if possible.

Where controllers are at risk of minor collision, e.g. with vehicles manoeuvring / parking on verges, protective bollards are to be installed.

5.2 Traffic Signal Post Locations

Traffic signal posts shall generally be located in accordance with AUSTROADS Guide to Traffic Management; however we have detailed the requirements for the TTOC below.

In addition, an absolute minimum clearance of 600mm shall be maintained between any portion of the fittings, lanterns or accessories and the kerb face. Clearances must be increased where there is a probability of:

- Conflict with the 'overhang' of vehicles such as buses, or
- The 'cutting in' of the rear end of long vehicles or trailers, or
- Where the road has a significant camber which may cause high vehicles to 'lean in' towards the posts and attachments.

The requirements of clearances for over dimension vehicles (See NZTA website for routes) shall be met where applicable.

Where the lateral position is less than 1metre clear from the kerb face (e.g. on narrow medians) consideration shall be given to modifying the intersection geometry (e.g. widening the medians).

Where there are more than two (2) posts along a kerb (e.g. opposite the stem of a T-junction) they shall be laterally offset sufficiently to provide clear sight lines to all aspects from all relevant approaches; i.e. the lanterns and visors on one post do not restrict sight lines to lanterns on another.

Traffic signal posts shall be longitudinally located such that pedestrian push buttons are easily reached from the top of pedestrian ramps by all pedestrians including the disabled. Where this cannot be readily achieved, relocate traffic signal post or when not practical then separate pedestrian push button posts (stub posts) shall be provided.

Pole location and their relationship to tactile pavers and pedestrian access ramps must be carefully considered ensuring drainage and practical installation of poles can be achieved.

Where the requirements for clearances for over dimension vehicles apply, but the geometric layout and signal post location cannot be arranged to adequately cater for over dimension vehicles, hinged or removable traffic signal posts are to be used and placed near a termination pit so that the post can easily be removed[2].

5.3 Use of Overhead Signal Faces (Mast Arms)

The use of overhead signal faces (mast arms) should be minimised and shall only be included with prior approval from the TTOC. Where practicable the geometric layout should be modified to avoid the necessity to use mast-arms. As per AUSTROADS Guide to Traffic Management Part 10, mast arms are warranted where the:

- Stopping sight distance to the post-mounted signal face is inadequate, e.g. because of vertical or horizontal alignment, awnings, poles, trees or similar sight obstructions, and
- Roadway is too wide for kerb mounted signal faces to fall within the driver's line of sight.

5.4 Signal Display Location

In general, primary signal posts and signal displays should be located such that they are as close as practicable to the direct line of vision of approaching drivers, ideally at least 1m from the stop line, taking into account the alignment of the approaching lanes.

Secondary and tertiary signals posts and signal displays should be located such that they are as close as practicable to the direct line of vision of drivers when stationary at the stop line and when manoeuvring through the intersection, whilst taking into account the alignment of the individual lanes. For example; a dual secondary signal display may be out of direct line of vision when the driver is stationary at the stop line but may come into direct line of vision when moving forward and waiting to turn.

To assist in the potential conflict of displays the designer may consider use of aspect louvres and/or visors to maintain safe operations.

Multiple signal displays are used to ensure drivers on multilane roads can see at least one signal display for each movement on approach and on departure. This allows for masking of some of the signals by adjacent vehicles and also provides some redundancy in case of lamp failure.

Signal displays shall be arranged generally in accordance with AUSTROADS Guide to Traffic Management Part 10 with the following variations:

- In addition to a primary signal display, all approaches with two (2) or more lanes (with or without a median) shall have:

[2] Mast arms are not removable

    - Dual primary signal display, or
    - Overhead primary signal face.
- At T-junctions the terminating roads should have a dual secondary signal face except where:
    - The right turn is permanently prohibited, or
    - Where it would be significantly out of the driver's direct line of vision[3].
- Where 2 columns of arrows are used a dual secondary signal display shall be provided.
- Split tertiary signals shall not be used.
- Signalised left slip lanes shall have a primary and dual primary signal display located between the projection of the stop line and up to a distance of 3m downstream, consider use of arrows on green display to avoid confusion for Giveway / Stop slip lanes.
- Single-lane signalised left slip lanes shall have at least a secondary signal display located on the median of the cross road.
- Multi-lane signalised left slip lanes shall have a secondary and tertiary signal display, both located in the median of the cross road.
- Where parallel walks / no parallel walks are in place at sites without right turn arrows, there is no requirement for a Dual Far Right Secondary Display.

To assist in placing signals as close as practicable to the driver's direct line of vision, where medians are more than 6m wide consideration shall be given to mounting the dual secondary signals on the same post as the dual primary signals of the opposing direction, instead of the far right corner

Where the right hand turn lane approach is aligned towards the right and filtering is prohibited, splitting the 6-aspect secondary signal face and mounting the right turn arrows column on the same post as the dual primary signals of the opposing direction, and maintaining the dual secondary on the far right corner shall be considered.

5.5 Chamber Locations and Ducts

A chamber is generally required on each corner of an intersection. An additional chamber is to be installed immediately adjacent to a controller. This allows for easy installation of cables to the controller, provides more space for maintenance contractors to work and keeps cabling within the controller tidier.

Chamber locations should be placed so as not to cause a trip hazard and where practicable outside of any tactile paving. Furthermore, chambers are to be located where minimum traffic management is required. For example, not on the nose of an island. Toby feeder cable boxes to be located where practical at least 1m from the carriageway kerb and ideally at the back of footway. This enhances the protection and safety for maintenance and reduces potential congestion due to traffic management.

All ducting should link back to a chamber location at each road crossing. To minimise carriageway work and disruption to traffic, it is best practice to only cross a main road once (i.e. road having the highest volumes). A minimum of two ducts shall be installed on all road crossings. Cables pull throughs to be installed on all ducts.

[3] Only right-turning vehicles which have to stop part way through their turn, for conflicting traffic or pedestrians, rely on the visibility of a dual secondary signal

5.6 Detectors

All loop positions are to be determined early in the design.

All controlled lanes must have detector loops installed including for example left turn lanes under Give Way control to count vehicles only, if there are sufficient detector inputs available.

Advance loops may be required in some instances to optimise signal operation and enhance safety in high speed environments. If controller capacity allows, detector loops are to be included in uncontrolled slip lanes for traffic counting purposes. Loops on bridge decks or approach slabs should be avoided where practical. Refer TTOC–09.

Where there are a high number of cyclists the type and style of loops shall be clearly shown. Cycle lane design requires special attention and these shall be considered on a site by site basis.

Special care is required to ensure that the placement of the loop is in the correct position within the lane. Failure to confirm positions prior to sealing can mean that another loop may be required to be saw cut into the new seal. All loop locations to be accurately located and included on as-built drawings.

The ideal or preferred methodology of installing loops is to place them under the bedding of the pavement prior to sealing in order to avoid repeatedly cutting in a short period of time.

Consult with the TTOC for details on installation methods.

If the controller cabinet is relocated then the site must be renumbered to comply with the standard convention.

Configure virtual red light running loops in the CIS when there is spare capacity to allow, consult with TTOC as required.

5.6.1 Vehicle Detectors

Detectors are numbered anticlockwise from the controller assuming that a line is drawn from the controller through the centroid of the intersection.

The first circuit is the stop line loops, departure loops and counting loops are numbered first, with the departure loop being numbered after the stop line loop it is associated with.

The second circuit is the dynamic loops, followed by the advance dynamic loops.

The reason detectors are numbered anticlockwise is so that an approach will read numerically correct left to right when viewed on a SCATS System Monitor display.

Where there is a secondary part to the signals such as at interchanges, the first circuit is around the part of the intersection closest to the controller, then around the second part of the intersection. Then back to the first part of the intersection for the second circuit. A line is drawn from the controller through the centroid of the second part of the intersection to give the starting point for each numbering circuit.

If a controller is relocated then the site must be renumbered to comply with the standard.

5.6.2 Detector Card Configurations for AS 2578 VC5/6 Compliant Controllers

When the new AS 2578 and VC5/6 compliant controllers were first introduced each Detector card had 16 Internal Detectors (Vehicles) and 16 External Detectors (Pedestrian). Since then the manufacturers have provided some flexibility to allow combinations to be used. It is important for the designer to understand and number the loops and pedestrian call detectors in the appropriate manner as this impacts directly on the preparation of the software. Furthermore, VC6 controllers have extended the capacity therefore check with the manufacturer on these specifications.

Pedestrian Detectors

Pedestrian detectors are numbered depending upon the card in use. First ascertain the number of detectors available at the controller if it is an existing site or determine the requirement if new. TSC3 Controller Detector cards come in groups of four ranging between 4 and 32.

5.6.3 The AS 2578 Compliant controllers come with a 16, 24 or 32 input Detector card. This consists of vehicle inputs and external inputs. Again, this will depend on the type of controller and the configuration applied.

The pedestrian detectors are numbered from the highest number down as follows and may include more than four pedestrian facilities:

PEDESTRIAN / WALK NUMBER	1 PED	2 PEDS	3 PEDS	4 PEDS	5 PEDS
W1	16	16	16	16	16
W2		15	15	15	15
W3			14	14	14
W4				13	13
W5					12

Table 1: Pedestrian Detector Slot Numbering (16 Detector)

A similar configuration will apply across the top end for 24 and 32 detector cards.

In ground and above ground pedestrian detection systems will need to be configured as a pedestrian input. Using Table 1 as an example, for four pedestrians we use inputs 13-16 and if we were to install above ground pedestrian detection for all the walks the detection would be numbered 11-4 leaving one unused before the pedestrians. MSS bits shall be used and numbered the same as the pedestrian detector number (where possible). Furthermore all non-loop detectors shall have an MSS assigned for each unit for additional SCATS variation options and monitoring options.

5.7 Pole Numbering

Poles are numbered in a clockwise direction from the controller assuming that a line in drawn from the controller to the centroid of the intersection.

Where there is a secondary part to the signals such as at interchanges, the intersection closest to the controller shall be numbered first then the additional part can be numbered in the same format assuming that a line is drawn from the controller to the centroid of the secondary part of the intersection. If a controller is relocated then the site must be renumbered to comply with the standard convention.

5.8 Signal Groups

With AS 2578 and VC5 compliant controllers, the number of signal groups can range from 4 to 32 in modules of four signal groups. The recent changes to VC6 controllers may change some of the content listed below, therefore discussions with the manufacturer is expected during the design phase.

Pedestrian signal groups in a sixteen group controller will be denoted as: W1=16, W2=15, W3=14, & W4=13). If there are only two Pedestrian groups then W1=16 and W2=15.

5.9 Phasing

The phasing diagram must show the following:

- Each phase in a separate box with the phase label inside the box corner A, F, F1, etc.
- Show only the movements that display green in each phase.
- Indicate movements by an arrow pointing in the direction that traffic will travel.
- Signal groups shown in a circle at the point of the movement arrow for vehicles and beside.
- Pedestrian movements.
- Any Special Flags inside the phase box Z, Z+, etc.
- Indicate if filter turn movements are permitted.
- Label phasing to lanterns.
- Default and Alternative phasing to be shown. Alternative phasing must show split phasing for each approach to assist in maintenance and operations.
- An all red phase to be added to all plans for operational requirements, no detector or input to be assigned to call/demand. Shall be operated only by SCATS Dwell.

The phase sequence must be shown on the plan adjacent to the phasing diagram.

In general, all traffic signals shall be consistent with the standard RMS configuration. Standard phasing configurations are detailed below. Where standard phasing configurations are not appropriate due to the site or traffic flow conditions, the phasing should be designed to:

- Minimise the number of phases
- Minimise cycle time
- Run as many compatible movements as possible in each phase
- Restrict each phase to non-conflicting movements
- Allow each movement to run in as many phases as possible (preferably allowing as many as possible to overlap from the previous phase or into the following phase), and
- Comply as closely as possible with the standard RMS configuration. Examples of a range of standard arrangements are found on the following pages of this document.

The phasing design should consider the use of filter right turn movements. The phasing design should provide the most flexible operation that will accommodate changes in traffic conditions without the need to reprogram the controller personality. This may result in a phasing sequence in which not all phases are used initially. An example of this is the inclusion of repeat right turn phases.

The phasing sequence (i.e. the order in which each phase runs) should be designed to provide the optimum coordinated flow along a corridor. This may change at different times of the day.

Filtering Right Turn Movements

At most intersections right turning traffic that has opposing movements will be provided for by installing a separate signal display, giving the right turning motorist a protected turn at some time in the phasing sequence. However, under strict criteria filter turn movements may be permitted in order to improve intersection efficiency.

5.9.1 Whilst the provision of filter turns may improve efficiency, it reduces the potential safety as conflicting movements may now occur. The phasing design must consider a balance between safety and efficiency. When considering allowing filtering, safety must be given a higher weighting in the decision process.

The phasing design at adjacent intersections should also be considered to provide consistency along a corridor and preferably throughout the region.

The operation of such movement should be designed and implemented with prior consultations with the TTOC.

Repeat Right Turn Phases

5.9.2 A repeat right turn is where the right turn movement is introduced for a second time within the same phase cycle. Repeat right turns can be provided at any site with a right turn phase. Generally the controller logic will have two phases with exactly the same movements (i.e. for a T-intersection B and D) with one phase only introduced when a special facility signal is activated (normally B using the Z+ flag).

Repeat right turn phasing can only be used under Masterlink or Flexilink control modes (not in isolated mode) and is generally provided at peak times. It is unusual to have a repeat right turn phase operating 24 hours a day.

Repeat right turn phasing is normally used where the single right turn phase does not provide sufficient capacity within a cycle for specific flow periods, or it is necessary for progression within a coordinated system.

A typical use is where a right turn bay is too short to cope with the number of right turning vehicles that can arrive within the cycle which results in the right turn queue extending into and blocking the through traffic lane. This reduces the capacity for the through movement and increases the risk of nose to tail type crashes occurring. The use of the repeat right turn is particularly important, under these circumstances, where there is only one through lane.

Repeat right turn phasing should only be considered under the above mentioned conditions. Generally, where vehicles may queue outside of the through lane (i.e. on a painted median), it is more efficient to provide a longer single right turn phase than two short phases. Installation of queue detection loops to be considered in the design.

5.10 Pedestrian Control

The hierarchy of signalised pedestrian control strategies range from providing full pedestrian protection through to partial protection during the early stages of the crossing movement. They fit broadly into the following range:

1) Exclusive pedestrian phase with full protection and all vehicle traffic stopped. Also known as Barnes Dance. This is only used where pedestrian numbers are high, in CBD.
2) Full protection for the whole Walk and Clearance using red arrow.
3) Partial protection for part of the Walk and Clearance using red arrow and individual push button inputs. Red arrow on a minimum of 6 seconds for one direction and the other direction to be calculated to the last crossing lane using 1.5m per second (this can be reduced on site as required).
4) Full protected staggered or staged pedestrian movements.

The method of control adopted at any specific site is based on location, traffic volumes, pedestrian volumes and type (i.e. age or disability), intersection layout combined with the aim to provide safe, efficient movement for all users. However, when selecting control options, it is important to ensure, whenever possible, that a consistent approach is adopted within any given corridor. This may result in a more conservative approach being adopted at some intersections to maintain uniformity throughout that corridor.

At signalised intersections, near schools, where there is a high pedestrian demand at the same time each day, the signal operation should be adjusted to cater for the reoccurring demand. This will generally be achieved by increasing the Walk' and/or clearance times.

It is preferable to have all pedestrian push button inputs wired and configured in the CIS individually to enhance pedestrian protection.

MSS bits to be used for every push button to enhance the variation options in Scats. (All non-loop detectors shall have an MSS assigned for each unit for additional Scats variation options and monitoring options).

5.11 Cyclists

Cycle lanes are being progressively introduced along some of the main corridors. Cyclists are features managed as part of the 'traffic mix' and there are currently limited special facilities for them at signalised intersections. These facilities are generally in the form of advance boxes or hook turn boxes and do not require special traffic signal control. Where cyclists may be on a side road or one that is not reverted to during phase sequence then detectors may be required to demand the phase for the cyclist.

Cycle detector loops are numbered in sequential order as part of the first circuit of vehicle detectors. Cycle call buttons are external inputs and numbered in descending order after the pedestrian inputs, e.g. W1=32, W2=31, C1=30.

Special care and attention to the detector position, type and detector alarm to be used in the cycle lane and / or cycle box. TTOC have designed different sizes and style for cycle detection, these can be added to the drawings following consultation.

Where cycle boxes are used they shall always be behind the traffic signal primary pole. Consultation with the TTOC is required at an early stage so we can consult the users groups.

5.12 Bus Lanes

Bus priority is becoming more common and requires the allocation of a signal group to each approach using the same convention as above for individual sites. If the bus signal group is demanded then the controller puts in a pre-specified delay to the through movement signal group. Where bus loops are installed these are numbered as part of the first circuit of vehicle detectors in sequential order. Where a separate signal group is provided for bus movements, these are numbered last, after all other vehicle signal groups.