TRAFFIC SIGNAL DESIGN - TS 100

Contents

TS 100 Version Register

Date-Version	Details of Revision	Authorised By
5 Nov 2014 – Ver 0		
Nov 2017 -- Ver 3	Updated to rationalise Master Specification Parts D20, (redundant D32) and R55	Tony Carbone

1 INTRODUCTION

1.1 GENERAL

This Design Standard specifies the requirements for undertaking the planning, design and documentation of traffic signals to be installed on Department of Planning, Transport and Infrastructure (DPTI) roads.

This standard also provides for the traffic signal performance assessment to demonstrate the traffic signals capability, capacity and signal timing.

The designer shall demonstrate that sufficient capacity and level of service is provided in the signals design to cater for projected traffic demands.

The design requirements, for a specific contract, will be found in the Contract Specific Requirements for Road Design.

In a specific contract there will be hold points. A hold point indicates that approval of DPTI is required before further design processes can proceed. Hold points are indicated herein are for reference only.

DPTI may have traffic data and existing traffic analysis that can support the design of projects or development assessments. Unless this is supplied as part of a specific contract it will need to be formally requested in writing.

Where the DPTI supplied information is deficient it is the designer's responsibility to augment the data to fill gaps and update the data.

1.2 DEFINITIONS

"AIMSUN" means the software product produced by Transport Simulation Systems (TSS).

"DPTI" means the person nominated to approve the Design which in the case of a contract shall be the Principal's nominee

"DPTI Traffic Operations" means the Manager Traffic Operations.

"Designer" means the person responsible for the traffic signals design of the project including the associated transport /traffic modelling requirements, and for DPTI contracts will be the contractor.

"LINSIG" Means the software produced by JCT consultancy

"TCD" means a Traffic Control Device prescribed in the Code of Technical Requirements for the Legal Use of Traffic Control Devices.

""TMC" means the DPTI Traffic Management Centre located at Norwood.

TRANSYT" means the software produced by TRL Software.

"TSOPR" means Traffic Signal Operation Performance Report.

"SIDRA" means the SIDRA Solutions software produced by Akcelik and Associates.

"SCATS®" means the Sydney Coordinated Adaptive Traffic System, property of RMS NSW (refer http://www.scats.com.au).

Note: The DPTI Traffic Operations Section (Norwood Office) is responsible for the operational performance of DPTI traffic signal assets and management of the traffic signal controller personalities.

1.3 REFERENCES

Unless specified otherwise, all design shall be undertaken in accordance with the following:

Road Traffic Act 1961 (SA).

DPTI: Code of Technical Requirements for the Legal Use of Traffic Control Devices.

DPTI: Road Design Standards and Guidelines, available from: http://www.dpti.sa.gov.au/standards.

DPTI: Operational Instruction 14.2 Traffic Signal Faces, available from: http://www.dpti.sa.gov.au/standards/tass

AS 2144: Traffic Signal Lanterns.

AS 2578: Traffic Signal Controllers.

AUSTROADS: Guide to Road Design (GRD).

AUSTROADS: Guide to Traffic Management. (GTM)

AS 1742: Manual of Uniform Traffic Control Devices.

National Heavy Vehicle Register, National Transport Commission Performance Based Standards Scheme Network Classification Guidelines ("NTC Guidelines") July 2007.
https://www.nhvr.gov.au/files/resources/0018-pbsnetwrkclassglines.pdf

DPTI: AIMSUN Model Development Manual.

DPTI: Traffic Modelling Guidelines – SIDRA 7

DPTI: Traffic Modelling Guidelines – TRANSYT 15

The following drawings apply to the design of traffic signals:

S-6841:sheet 1 and 2	Traffic Signal Design Guide, detectors, Signal Groups, Phasing and Post numbering
S-4500 sheets 1 and 2	Detector Loop Layouts
S-4074 sheet 7	Kerb Ramps for Signalised Locations
GD 703	2 Stage PAC with Kerb Extension Tactile Ground Surface Indicators Layout.
GD 704	PAC Standard - No Median
GD 705	PAC Standard Median up to 3m (solid or painted)
GD 706	PAC Standard Dual Carriage Way Raised Median more than 3m

DPTI standard drawings are available from the following web site: http://www.dpti.sa.gov.au/standards.

The following documents give considerable guidance on traffic modelling including the use of micro- simulation models:

a) Transport for New South Wales, Roads and Marine Services, "Traffic Modelling Guidelines"
b) AUSTROADS Incorporated, Austroads Research Report, AP – R286/06, New South Wales. http://www.austroads.com.au
c) The Microsimulation Hub provided by ARRB Group Ltd should also be consulted for the latest AUSTROADS Technical Notes and other micro-simulation information http://www.microsimulationhub.com
d) Dowling Associates, Inc., Cambridge Systematics. Incorporated (2003) Volume III – Guidelines for Applying Traffic Micro simulation Modelling Software: Federal Highway Administration, California. http://ops.fhwa.dot.gov/trafficanalysistools/tat_vol3/vol3_guidelines.pdf

2 TRAFFIC SIGNAL OPERATIONAL PERFORMANCE

2.1 General

Traffic signal performance analysis shall be undertaken, including:

a) capacity analysis to inform the design and operational requirements of traffic signals,
b) traffic modelling using current and specified future design flows, and
c) assessment of the traffic impacts of alternative traffic management arrangements to be used during construction of the project

The following design and operational requirements shall be provided:

d) lane, phasing and coordination requirements at traffic signals that ensures the safe and efficient operation of road network for the current and future design flows, as specified
e) traffic signals integration within DPTI's current systems used to monitor and control traffic signal operation, and
f) the needs of all road users (e.g. buses, heavy vehicles, freight, cycles, and pedestrians) are taken into account

2.2 Traffic Modelling Requirements

The designer shall be responsible for transport and traffic models developed for the purpose of assessing the traffic signals design including any systems or road geometry considerations.

For some projects DPTI will select software applications to be used by the designer for traffic modelling. Any specific software application required to be used will be listed in the **Contract Specific Requirements**.

To ensure that the modelling is fit for purpose the designer shall submit a "model scoping proposal" for approval before commencing modelling, which will include all aspects of the modelling requirements. The submission of the traffic model scoping document shall be a **HOLD POINT.**

The model scoping proposal document shall outline shall include the modelling applications proposed to be used, and their intended purpose in determining the optimal design of the traffic signals, e.g. use of TRANSYT to provide signal offsets.

The designer shall in all cases provide a calibrated and validated base case model using existing traffic volumes. Base Case models shall reflect current circumstances. The submission of the report on the base case assessment shall be a **HOLD POINT.**

Provision by DPTI of a previous traffic model does not remove the designer from the responsibility of updating, augmenting, calibrating and validating models

For the evaluation of future options an interim model may be required, derived from the base case model, which will include optimised signals and committed changes to the road network in the immediate vicinity of the project.

Proposed options shall be derived from the validated base case model using projected traffic design volumes and the scenarios specified in the contract specific requirements or as otherwise approved by DPTI. The scenarios to be tested will be fully documented in the model scoping document to clarify the detailed modelling requirements.

Where specific intersections are required to be included in the scope of models these intersections will be listed in the **Contract Specific Requirements.** Specified intersections are required to be included in the scoping proposals of the models.

Where new intersections are developed as part of the project design the designer is responsible for ensuring these are included in the models.

The designer is responsible for the comprehensive nature of the network models, including modelling uncontrolled intersections, to ensure that the effect of the project on the network can be adequately demonstrated.

The designer shall consider the modelling effects of intersections that operate on common and different cycle lengths owing to the SCATS® signal configuration. The implications of different cycle lengths shall be included in the model scoping proposals.

For consistency and to avoid confusion in model interpretation the traffic signal groups, traffic signal phases and detector numbers shall be labelled in models to conform to DPTI conventions used in drawing S-6841. Existing intersections models should however use the same labels as the existing personality.

Traffic signal controlled intersections shall use the TS number series in models to identify intersections.

2.3 DPTI supplied information

Where DPTI has a specific contract or agreement information may be supplied to the designer including:

a. Nominating the model application software to be used,
b. traffic volumes for base case and future year projections,

c. traffic flow characteristics e.g. saturation flows,
d. traffic control operational data including signal phasing and timing (in the form of SCATS® summaries),
e. lists of intersections to be included in the models,
f. existing model structures including native data files

Where the DPTI supplies current traffic volumes and projected traffic design volumes as part of a specific contract, these are required to be used in models by the designer.

Although DPTI may provide information, in support of a contract, which is used in traffic models to determine the traffic signals design, the designer is responsible for ensuring that this information is complete, appropriate for use, fit for purpose, and up to date; and for the collection of any additional data required to support the development of the model.

Where DPTI has developed a model, which may assist the designer in developing a model or models, it may be provided as part of a Contract. Where a model is supplied by DPTI It remains the designer's responsibility to update, augment, calibrate and validate the models

2.4 Traffic Signal Operation Performance Report (TSOPR) –reporting requirements

A report describing all aspects of traffic signal operational performance shall be provided at the following stages of design, unless otherwise required in the **Contract Specific Requirements**:

Model scoping document	To include a full outline of the modelling requirement. To be approved before modelling and/or design commences
Pre-Design	Base Case Calibrated and Validated model report
Notional 30% design stage:	the TSOPR shall be completed including calibration and validation of the base case and assessment of all the options/scenarios
Notional 70% design stage:	the TSOPR will be reviewed to account for design changes since the 30% design stage
Final design stage:	the TSOPR will be reviewed to account for design changes since the 70% design stage

At each design stage, the TSOPR shall be accompanied by the respective model files, and data used to develop the model analysis, from which the conclusions are drawn and recommendations made.

The report shall include:

a) an executive summary including all recommendations;
b) a description of the intersections projected performance, which shall list outcomes using the specified design traffic flows,
c) an outline of the traffic modelling methodologies adopted for the analysis of intersection and network performance including reasons for model selection and statement of compliance with and any DPTI specified parameters (and reasons for and list of deviations from these);
d) a description of the existing traffic conditions including the signalised intersection performance at the intersections within close proximity that may influence the operation of the intersections which are included in the project;
e) a summary of the assessment of the existing (base case) and forecast AM peak hour, PM peak hour, and any other specified design hour,
f) a description of any assumptions used in the models,
g) degree of saturation, LOS and 95th percentile queue lengths for individual traffic movements;
h) reporting on calibration and validation of models;
i) history of design changes with supporting reasons from 30% Nominal Design through to the Final Design;
j) discussion of alternative schemes considered;

k) Any variations from the requirements of this design standard or any specified requirement,
l) reasons for the recommendations,
m) intersection layout plans, traffic signal phasing, phase sequences and time settings,
n) offset parameters for linking to adjacent traffic signal sites

2.5 Operational Analysis

2.5.1 General

The traffic signals analysis shall include:

a) the base model, fully calibrated and validated to reflect the existing traffic conditions, which is constructed from existing intersection geometry and operational parameters,
b) The projected model options, using the calibrated and validated base case including the projected scenario criteria,
c) an assessment of the impacts on intersection and network performance of proposed traffic management strategies where these are to be adopted during the construction phase of a project,
d) analysis shall be included for all traffic signal arrangements, for major construction staging,
e) for existing sites, comparison of the current intersection performance with proposed options

The SCATS® Summaries provided by DPTI shall be used to calibrate and validate base case traffic models.

2.5.2 Intersection Analysis

There are several performance measures of intersection analysis that shall be achieved for all model applications. Those listed below shall apply unless alternative measures are prescribed in the **Contract Specific Requirements**

Measure	New Signals	Temporary Signals
Degree of Saturation for each signal site	≤ 0.9	≤ 1.0
Level of Service (LOS) (use Standard left)	"D" or better	"E" or better

- No intersection movement shall have a degree of saturation greater than 0.90.
- The 95th percentile queue lengths for each intersection lane shall not exceed the storage length of the lane. The storage length does not include the additional deceleration length of the turning bay.
- For continuous lanes, the 95th percentile queue length shall not extend to any adjacent signalised intersection, pedestrian crossing, level crossing, or upstream lane merge, diverge or weaving manoeuvre.
- For closely-spaced intersections, consideration shall be given to the expected lane utilisation distribution as a result of upstream and downstream turning movements.

The designer shall ensure the lane distribution (utilisation) of traffic on approaches is representative of the existing or projected scenario. Justification for lane distributions in the models shall be provided in the TSOPR.

For base case models use the average cycle length of the SCATS® linked group to which the intersection belongs. This cycle length should be found in the SCATS® summaries.

Where signal coordination is to be achieved all intersections in the same SCATS® linking groups shall all use the same cycle length.

Where there is more than one SCATS® linking grouping, i.e. with different operating cycle lengths, this shall be reflected in the model development. Some model applications will require the development of separate models for each grouping.

For existing double-cycling intersections in network models the designer will need to consider how repeat phases will need to be modelled for the particular modelling application. For proposed double cycling, the network performance effects shall be analysed to ensure that there is no adverse effect on network performance. Where minor intersections are normally operated with double cycling, and are being modelled separately in SIDRA, these may be modelled at half of the SCATS® cycle length.

Intersection layouts shall be designed to provide the most flexible signal operation possible. Split-approach phasing shall be avoided, unless the benefits of increased capacity and reduced delays can be demonstrated for the whole of day operations. Shared lanes shall not be used.

All right turn movements, in new or modified intersections, are to be controlled with right turn arrows, and controlled separately from through movements. Opposed right turns shall be designed to run concurrently to allow diamond right turn operation.

Intergreen times shall ensure that vehicles have sufficient time to safely clear the conflict zones of any vehicle or pedestrian movements that run in the following signal phase.

Intersection phase times need to take into consideration the impact of pedestrian movements, particularly if they require longer phase times than those needed for vehicle traffic. In these cases, the likelihood of the pedestrian phase running needs to be averaged across the peak hour and the phase time fixed to this value.

Use the data available in the SCATS® summaries available from DPTI for configuring the base case models;

Where analysis includes existing signal sites, use the current controller settings for red/yellow and pedestrian times;

For new and proposed upgraded traffic signal sites, the settings for minimum green, red/yellow and pedestrian times shall be calculated using the DPTI phase time setting template.

The saturation flows for existing traffic signal sites shall be consistent with SCATS® MF values. For unmodified approaches of existing intersections the saturation flows shall remain unchanged from the base case models.

For new traffic signals the saturation flows shall reflect those typical of sites in the same environment.

When developing models the designer will calibrate the lane utilisation in base case models. For design options the designer and will consider the effect of lane utilisation and be able report and justify the traffic flow lane distribution.

Where an intersection design is a modification of an existing intersection or a new intersection the phase sequence should assume each phase is serviced in sequence for every cycle of the traffic signals. Phase skipping or undemanded phases are not permitted to be used.in models.

2.5.3 SIDRA Analysis

SIDRA analysis shall be undertaken for all signal controlled intersections. The SIDRA analysis is to consider only the performance of individual intersections and not as a network assessment application. The SIDRA analysis shall confirm that the proposed traffic signal design and operation will satisfy the performance criteria.

In addition to the intersection requirements above the SIDRA analysis shall:

a) use the Site Level of Service Method as per the SIDRA “standard left” template,
b) Calibrate saturation flows in the base model to reflect those experienced in existing traffic conditions. (SCATS® MF data which represents measured saturation flows in passenger car equivalent values are included in the SCATS® summaries),
c) For new intersections, use default values from SIDRA modified to reflect intersection geometry, traffic composition, road environment, and grade; the basic adjusted saturation values produced by SIDRA shall be consistent with measured saturation flow values experienced at adjacent SCATS® sites.
d) where intersections are closely spaced the “Full length lane” “Lane Length” parameter shall be equal to the measured storage space between intersections in order to accurately reflect upstream blocking effects,
e) Incorporate pedestrian and cycle movements in the phasing at all sites, on all approaches, with phase times that reflects existing demands. Use the existing pedestrian demands in scenarios unless a significant change is predicted to future demands
f) Use the “User Given Phase times” in SIDRA to calibrate the base case models.
g) use the “user given cycle time” based on SCATS® summaries for optimising the green splits for future scenarios,
h) include in models downstream merges, the lanes length measured from the intersection to the start of the merge taper, before making manual adjustments to lane distributions,

i) Adjust the heavy vehicle PCU/veh configuration factor, queue space and vehicle length parameters based on current heavy vehicle composition.
j) Models of projected scenarios will assume the same PCU and queue values as existing traffic composition unless this is predicted to change.
k) Use the %age lane utilisation feature in SIDRA to calibrate the traffic flow lane distribution.

2.5.4 Traffic Network Analysis

Traffic modelling techniques shall be used to demonstrate that the traffic signals will be capable of being effectively coordinated with adjacent traffic signal controlled sites. Intersections included in the modelling provisions of the **Contract Specific Requirements** are required to be included in the modelling assessment of the base case and project scenarios.

Also Include in the analysis, traffic signals located outside of the extent of the project which are co-ordinated with the project sites. These sites may not have been included in the **Contract Specific Requirements,** but shall be identified in the traffic model scoping document.

The traffic signal offsets data generated by the models are to be included in the TSOPR.

Those intersections currently linked, via SCATS®, to the intersections affected by the project shall be included in the traffic network models.

New or modified intersections created as part of the project scenario shall be included in the network models.

The network analysis is to determine any adverse impacts of the project on traffic signal operation particularly the effects on the design of upstream queues. Where such impacts are evident, the design shall (as appropriate):

a) develop and assess alternative concepts and select a preferred concept for capacity improvements at the intersections and the interchange ramps;
b) Inform DPTI of other locations that may require improvements. and
c) Identify locations at which temporary capacity improvements may be required to cater for traffic diversions resulting from proposed full or partial road closures
d) Provide traffic signal offsets representing optimised linking of the network.

2.5.5 Network Modelling Software Applications

The network modelling shall be undertaken by a modelling application used by DPTI, which currently includes:

a) AIMSUN
b) LINSIG
c) TRANSYT

Where the traffic modelling is part of a contract or agreement, the network model application selection will be included in the **Contract Specific Requirements**. Where the DPTI does not specify the modelling application/s this shall be proposed by the designer in the modelling scoping proposal and approved by the DPTI before modelling commences. Submission of proposed modelling applications shall be a **HOLD POINT** and will normally be included in the model scoping document.

More than one software applications may be necessary to be used to ensure a thorough assessment of the design.

AIMSUN shall be used for assessing traffic impacts of freeways, transit facilities, level crossings, queue relocation features, and may be used to analyse complex intersections. Freeway impacts includes weaving, merging and diverging behaviour. AIMSUN models shall be in the micro simulation form. AIMSUN models shall be used in conjunction with other, deterministic, modelling software, capable of optimising traffic signals, e.g. LINSIG or TRANSYT.

In creating an AIMSUN model for network analysis, the model/s shall be developed in accordance with the DPTI AIMSUN Model Development Manual.

LINSIG, may be used to analyse the network performance of traffic signal controlled intersections and the at grade elements of interchanges to produce optimised offsets, and phase sequences. Transport for New South Wales, Roads and Marine Services, “Traffic Modelling Guidelines” provides some useful information on processing LINSIG models.

TRANSYT may be used for similar functions to LINSIG. The TRANSYT model shall be developed in accordance with the DPTI "Traffic Modelling Guidelines - TRANSYT 15".

In consideration of the predicted queuing effects, the model analysis using any of the above software applications shall be consistent with the "SIDRA Analysis".

The Traffic network analysis results shall be included in the Traffic Signals Operational Performance Report. The performance measures that shall be reported shall include, but is not limited to the following:

a) Overall network delay time
b) Queue lengths
c) Number of stops per vehicle
d) Average speed
e) Travel time – network average and for key routes
f) Intersection delay
g) Degree of Saturation
h) Level of Service

2.5.6 Traffic Management during Construction

Traffic models are required to be prepared by the designer to analyse the impacts of traffic arrangements and restrictions during the various construction stages. Where a construction stage change involves the provision of traffic signals which require controller programming, these models are to be developed and processed as if they were used to assess a permanent traffic signal installations.

The impacts on intersection and network performance of proposed traffic management strategies to be adopted during construction shall be assessed. Analysis shall include all major construction staging of traffic signal arrangements, including a detailed assessment of the performance of the proposed interim traffic signal operations.

Where specified, provision of a construction stage model shall constitute a **HOLD POINT**.

All traffic signals analysis for construction management shall be fully documented in the TSOPR.

3 DESIGN AND OPERATIONAL REQUIREMENTS

3.1 Turn Movements

All turning paths shall cater for the type and size of the Design Vehicle and Check vehicle. Design vehicle turning paths shall be applied in designing the most effective phasing for the intersections and the physical intersection arrangement to maximise the traffic throughput. The design vehicle requirements is as described below or will be provided for in the **Contract Specific Requirements** and any alternative design vehicle shall be submitted for approved by DPTI .

Swept paths for right turns, including double lanes shall ensure a minimum clearance of 2m to opposing right turn swept paths,(i.e. left side of vehicle to left side of vehicle). For new designs assume right turns from opposing directions will be operated simultaneously.

Right turn lanes and left turn lanes shall be designed with turn bays. Turn bays are to be provided with sufficient length to accommodate predicted queues and deceleration to the back of queue from the adjacent lane. Tur bays are considered to be of sufficient length when the storage length will accommodate 95%ile demand. Through lane and short lane queue interaction is not permitted.

The deceleration length of a turn bay is to be provided in addition to the storage length.

Filter right turning movements are not permitted for new signal installations or where the intersection geometry is modified. This is to be reflected in the modelling of intersections and their design.

The design vehicles adopted for double right and left turns shall provide for simultaneous movements of the design vehicle and an 8.8m service vehicle, with the service vehicle using the inner turn lane.

The design of left turns at unsignalised intersections and high entry angle left turn slip lanes may allow the design vehicle to encroach on the second lane of a multi-lane carriageway, where it can be demonstrated that:

(a) The manoeuvre is a legal movement for the Design Vehicle;
(b) Current access conditions are maintained.

Notwithstanding the requirements of the design vehicle and check vehicle, the design should provide accommodation for existing road use, access and routing e.g. use of local roads by19m articulated buses.

3.2 Design Vehicle

The design vehicle, unless otherwise specified in the **Contract Specific Requirements**;

- For Urban Arterial Roads shall comprise a 19m Single unit Articulated Truck, and the check vehicle shall comprise a B-Double (26m) combination.
- For National Highways and Major Rural Roads shall comprise a B-Double (26m) and the check vehicle shall comprise a performance based B-Triple level 3A (36.5m)

The B-Triple as a design vehicle shall be in accordance with the National Transport Council standards. B-Triple PBS L3A specification that is deemed to satisfy level 3 Performance based specification requirements with an overall maximum length of 36.5m.

The Designer shall provide drawings and transport modelling to demonstrate the road design can accommodate the design vehicle and check vehicle. Design and check vehicle templates shall be applied in accordance with GRD Part 4 “Intersections and crossings - General” standard vehicles for design and checking design unless specified otherwise.

The road design shall accommodate the design vehicle within marked lanes. Swept paths shall include a 0.5m clearance to kerbs, pavement edge lines; and centre of pavement lines on two-way roads. The minimum turning radii used in the determination of a design vehicle or checking design vehicle shall be not less than the recommended turning radii in Austroads GRD Part 4 “Intersections and crossings - General” for those specific types of vehicles.

The design of all roads shall allow for the design vehicle, including accommodation of vehicle swept paths, for all through lanes, turning lanes, deceleration lanes and intersections.

The design shall make allowance for over-dimensional / over-mass vehicles as per DPTI Over-Dimensional Route Network as detailed in the DPTI Heavy Vehicle Access Framework.

3.3 Heavy Vehicles and Buses

The design shall clearly show how the effect of heavy vehicles and buses on design flows and signal timings are taken into account. In particular the design shall allow for the yellow and all red clearances for long vehicles required by the NTC Guidelines, Section 2.5 “Signalised Intersections”.

In deterministic models the passenger car equivalent values used to represent Heavy vehicles and buses shall be calculated based on the existing vehicle composition.

The PCU values to use are based on the following equivalents:

AUSTROADS VEHICLE TYPE	AUSTROADS Class	PCU VALUE	Average vehicle length (m)
Short < 5.5m	1	1.0	5
Medium (short + trailer or Ridged) 5.5m – 14.5m	2-5	2.0	12
Long (articulated) 11.5m – 19m	6-9	3.0	19
Medium Combination 17.5m - 36.5m	10-11	4.0	26
Tram		3.5	20

Refer to Austroads GTRD part 4 Table 5.1

For vehicle “queue space” add 2m gap to the average vehicle length.

4 DESIGN REQUIREMENTS

The traffic signal design shall comply with the following:

a) the design shall facilitate compliance with, and be capable of delivering the requirements of R55 “Installation of Traffic Signals”;
b) the design phase arrangement and phase sequences shall be compatible with SCATS® operating requirements;
c) all right turn movements shall be fully controlled and separate right turn lanes provided;
d) the operational performance requirements documented in the TSOPR are achieved;
e) cater for all turn movements of the maximum size Specified Design Vehicle;
f) the design of the turn movements is checked to ensure that adequate provision has been made to cater for all possible traffic signal phase arrangements and sequences;
g) signal groups, detectors, phasing and posts are designed in accordance with DPTI standard drawings S-6841 sheets 1 and 2;
h) the design of pedestrian activated crossings is in accordance with DPTI standard drawings:
   - GD 704 “PAC Standard - No Median”,
   - GD 705 “PAC Standard Median up to 3m (solid or painted)”, and
   - GD 706 “PAC Standard Dual Carriage Way Raised Median more than 3m”;
i) the pedestrian push button orientation shown in S-4074 Kerb Ramps for Signalised Locations shall apply;
j) pedestrian displays are incorporated in the phasing at all sites except where there is no demand demonstrated by the design process, or at “T” intersections following the standard arrangement;
k) provision of vehicle and pedestrian detection is included at all signalised intersections;
l) a vehicle stopline detector is required for every discrete traffic lane at an intersection including left turn lanes which are not controlled by a signal group, (These loops in left turn lanes will initially be used for counting, but can be used to control traffic in adjacent lanes);
m) provide queue detectors at intersections and level crossings where blocking back is anticipated from upstream intersections or level crossings;
n) the design is documented in accordance with the Design Presentation – Construction Drawings DP011 - Traffic Signals;
o) where an intersection is large i.e. requiring 14 signal groups or more, and/or more than 22 detectors the design shall assume the provision of a single controller capable of controlling 32 signal groups and 48 detectors (VC6 personality), and document this in the design report; and
p) drawings are to document separate ducting for connecting conductive loop detection, and low voltage/ extra low voltage cabling to the traffic signal lanterns and auxiliary equipment e.g. push buttons;

5 DESIGN DOCUMENTS

5.1 Drawings and schedules

At a minimum, the design shall be documented in the following drawings and schedules:

a) traffic signal layout drawings;
b) turning path drawings to demonstrate clearances achieved;
c) signal conduit and pits layout drawings;
d) site wiring diagrams;
e) cable connection schedules, including the identification of spare cores;
f) hardware schedules;
g) traffic signal phasing plan; and
h) equipment drawings;

5.2 Traffic Signal Design Report

A Traffic Signal Design Report shall be prepared, which at a minimum includes details of the following:

a) system description;
b) reference to all applicable standards and specifications;
c) details of design inputs from the Traffic Signal Operation Performance Report;
d) details of Interfaces to existing or third party systems;
e) operational description, including phasing philosophy;
f) location of all equipment;
g) explanations for non-standard equipment locations;
h) controller input/output allocations;
i) signal group allocations;
j) detector input allocations;
k) power system, volt drop and fault loop impedance calculations;
l) details of all proposed construction materials;
m) construction designs for all equipment;
n) traffic signal hardware documentation;
o) specification for supply and installation of traffic signals; and
p) Design, procurement, installation integration and commissioning program.
q) Drawings showing the swept paths are capable of achieving the proposed design operation.
r) All data collected in the course of developing the traffic signal design and traffic models.

6 TRAFFIC SIGNAL HARDWARE

6.1 Approved Products

Where the designer has assumed specific propriety products shall be used these shall be listed in the design report.

Details of DPTI approved traffic signal products are available from http://www.dpti.sa.gov.au/contractor_documents/specifications.

6.2 Traffic Signal hardware Documentation Requirements

Where the Traffic Signal hardware requirements are known they shall be documented in the Traffic Signal Design Report, including:

a) traffic signal site number;
b) Telstra PSTN and port service numbers;
c) 3G/4G mobile number;
d) fibre optic and switch details (Applicable for connecting directly to the DPTI ITS network); and
e) confirmation of site specific parameters;

6.3 Traffic signal Operating Voltage

Traffic Signal Design shall incorporate extra low voltage (ELV) traffic signal controllers, Lanterns and other electrical equipment.

6.4 Traffic Signal Lanterns

At new traffic signal sites, all traffic signal lanterns shall use a Light Emitting Diode (LED) optical system compliant with AS 2144 .

Where additional lanterns are to be provided at an existing signal site, all existing non LED, or non-current generation LED lanterns shall be changed to current generation LED aspects. All lanterns at a discrete site shall be of the same brand and version. 200mm or 300mm aspects and shall be provided in accordance with DPTI: Operational Instruction 14.2 “Traffic Signal Faces”.

6.5 Location of Signal Equipment and Signal Face Layouts and Display Sequences

The arrangement of traffic signal faces shall be in accordance with DPTI: Operational Instruction 14.2 "Traffic Signal Faces".

6.6 Traffic Signal Controller

All new traffic signal controllers shall conform to Transport for New South Wales Road and Marine Services, NSW specification TSC/4 and be approved by DPTI.

The location of the traffic signal controller shall be determined and documented as part of the design using the following criteria:

a) minimisation of obstruction to pedestrians;
b) minimisation of visual obstruction to drivers;
c) minimisation of the risk of accidental damage by traffic;
d) provision of a safe and easy access for maintenance personnel and associated vehicles;
e) permit maintenance staff to have a clear view of the whole of the intersection from the controller as far as is practicable;
f) orientation so that the cabinet door(s) open away from the centre of the intersection; and
g) Close location to the power supply and telecommunications service.

6.7 Video Surveillance (CCTV cameras)

CCTV cameras shall be installed at all new traffic signal controlled intersections. Where CCTV is not required at a discrete location or additional UPS are required for existing controller locations these locations will be listed in the **Contract Specific Requirements.**

Video surveillance equipment shall also be specified as part of the ITS component of the design of a project.

Video surveillance shall also be included to provide coverage at approaches to level crossings where queue relocation management strategies are required to prevent queuing over the level crossing. The video surveillance system for level crossing queue relocation shall be incorporated in the traffic signal controller hardware.

Where CCTV equipment is required to be installed at intersections, the roadside equipment shall be housed in an extension housing attached to the top of the traffic signal controller cabinet and is therefore required to be documented in the Traffic Signal Design Report.

CCTV equipment products shall be approved by DPTI. (Note the supply of a list of CCTV products is to be a HOLD POINT in the construction contract)

6.8 Programming of Traffic Signal Controller(s)

The Programmable Controller Personality Module (PCPM) contains the personality for the controller.

Eight (8) weeks' notice is required by DPTI Traffic Operations for programming the controller after formal approval of the traffic signal arrangement drawings. The designer needs to be aware of this time constraint in processing the Design Documents, including all reports, TSOPR and drawings.

The approval of the Traffic Signals Design report and approval of traffic signals as traffic control devices is a **HOLD POINT**. Programming the controller/s cannot proceed without approved drawings.

6.9 Uninterrupted Power supply

Uninterrupted power supply (UPS) shall be provided at all sites unless nominated not to require a UPS by DPTI in the **Contract Specific Requirements**. UPS equipment products shall be approved by DPTI and the supply of this information is a HOLD POINT in the construction contract.

6.10 Provision of Telecommunications for SCATS®

All traffic signal controllers shall be connected to SCATS® via a DPTI approved method which shall involve a connection directly to the DPTI fibre optic cable network, or a combination of 3G/4G and ADSL service.

Traffic signals installed as a part of a major project will require a fibre optic connection to the DPTI network for both the traffic signals communications and CCTV link to the TMC. An alternative communications path will generally only be considered if this is considered impractical for logistical reasons

The form of the connection is subject to approval by DPTI. The communications path and associated cable and connection products shall be documented. The supply of this product information is a HOLD POINT in the construction contract.

6.11 Vehicle Detection

The designer shall document the location of all loop detectors.

Loops shall be as detailed on DPTI Drawing No. S-4500 sheets 1 and 2. Other loops shall be arranged appropriate to their function.

Vehicle stop line type detectors suitable for SCATS® operations shall be provided for all lanes irrespective of the control function. Loops on non-controlled lanes e.g. left turn lanes, shall be provided and connected to traffic controllers.

Advanced detectors shall be considered on approaches with speed limits 80 km/h and over. The location of the detector relative to the stop line approach is to be calculated on the basis of the design speeds and shall consider the approach gradient. Advanced loops shall be located in accordance with the DPTI design template (ADVDET.xls).

Alternative technologies to loop detection may be considered providing they are compatible with SCATS® operation.

Where queue detectors are recommended in the TSOPR they shall be fully documented by the designer. Their position within the lane shall be in accordance with the DPTI master specification, Part R55 Installation of Traffic Signals.

6.12 Pedestrian and Bicycle Detection

Push buttons provided for this purpose shall be a product approved by DPTI.

All pedestrian movements shall be demand actuated by audio tactile pedestrian push buttons.

Pedestrian push buttons shall:

a) be orientated so that the face of the push button is in line with or parallel to the crosswalk marking; and be clearly documented on the drawings (typical orientation is as shown on standards drawing S-4074 Kerb Ramps for Signalised Locations)
b) incorporate arrow legends (in the audio tactile display) on all pedestrian push buttons;
c) Legends and buttons shall be correctly oriented to guide visually impaired pedestrians in the same direction indicated by cross walk markings;
d) Be provided on median traffic islands.
e) Only one audio tactile pedestrian push button is to be located on a post. (More than one audio tactile signal can cause confusion to pedestrians).

Microwave pedestrian sensors are to be provided where pedestrian displays are controlling marked foot crossings 15 m and longer to facilitate termination of the pedestrian clearance.

Microwave sensors may also be required to record demands from pedestrians waiting on the footpath. The site locations to be provided with this form of detection will be included in the **Contract Specific Requirements**. Where sites are included all the pedestrian crosswalks associated with the site are to be equipped.

Cycle push buttons shall be provided on side road approaches and at locations where extended minimum green clearance is required e.g. for roads >30m wide. Cycle Push button faces are to be parallel to the kerb and positioned adjacent to the road carriageway within reach of a cyclist stopped at the stopline.

Where a cycle lane is created between marked vehicle lanes, in-ground stop line loop detection shall be provided.

6.13 Level Crossings

Interlocking between level crossings and adjacent traffic signal installations shall be provided with a hard-wired connection.

Four standard inputs are to be provided via the hard wire connection and these shall be documented in the Traffic Signal Design Report.

Level crossings are considered adjacent to traffic signals where the traffic signals could be interpreted to conflict with the level crossing wigwag signs or where the level crossing is expected to create queues across the intersection, or vice versa. There shall be a cable link provided in duct between the level crossing controller and the traffic controller, which will enable the traffic signal controller to be forced to a "safe" state before the level crossing closes to permit the passage of a train.

Queue relocation signals may be required which are controlled independently from the adjacent intersections separate controller. The Q relocation signal controller will also be required to be connected to the level crossing in a similar fashion.

6.14 Traffic Signal Posts

The location of traffic signal posts shall take into account site constraints such as services and roadside furniture. The Post location(s) shall ensure that the signals can be sited where they can be clearly seen by approaching drivers. (Refer to DPTI: Operational Instruction 14.2 “Traffic Signal Faces”). Notwithstanding the above care shall be taken not to locate posts in locations where, lanterns including backing boards and visors, are likely to be struck by vehicles following a conventional turning path, or where long vehicles may mount the kerb while negotiating a turn.

The designer is responsible for ensuring the post locations are achievable without compromising the driver’s visibility to all the signal aspects, or safe clearances. Primary lanterns are to be located in line with, or downstream of the stop line.

Traffic signal posts shall not be located within painted medians/islands; i.e. where there are no kerbed islands or there is an area physically raised from the road, which is designed only to discourage overrunning by large vehicles.

Wherever possible, combination posts comprising road lighting and or mast arms shall be used to minimise the number of signal posts. Where a site is specified to be ELV operation and low voltage (LV) road lighting is used, appropriate electrical segregation shall be maintained between the two systems.

Where combination posts are to be incorporated into the traffic signal design consideration shall be given to source of the energy supply for the street lighting. Provision of this type of post is not to compromise the design of either the street lighting or the traffic signals.

The provision of road lighting is not to compromise the safe location and distribution of traffic signal posts. Traffic signal posts are to be located for optimal design. Where the signal post location is also a suitable location for a road lighting post then combining of the functions on a common post shall be considered.

6.15 Pavement Markings

Where the speed limit is 80 km/h or higher, 600 mm stop lines on approaches shall be provided.

6.16 Signs

Where regulatory signs are to be provided for part time regulation, a symbolic internally illuminated sign (no left turn/no right turn) shall be provided at a stop line post and a secondary (or tertiary) post.

Sign equipment shall be approved by DPTI.

Signs shall be equipped with fault monitoring, and report faults back to the signal controller.

7 PERIODS OF NOTICE AND HOLD POINTS

Where the modelling is required as part of a contract, in determining the design requirements the designer shall be aware that hold points and periods of notice are required by the contract.

Typical hold points and periods of notice are shown below:

HOLD POINTS -DESIGN:

1. The provision of the "traffic model scoping proposal" document shall be a **HOLD POINT**.
2. The provision of a Base Case calibrated and validated report shall be a **HOLD POINT**
3. Provision of the "Traffic Operational Performance Report" shall constitute a **HOLD POINT**.
4. Provision of each construction stage model shall constitute a **HOLD POINT**.
5. Provision of the traffic signals design report shall constitute a **HOLD POINT**

HOLD POINTS – CONSTRUCTION:

6. The designer is responsible for ensuring that the traffic signals (TCD's) are properly approved by DPTI prior to applying for controller programming. Provision of Approved drawings, TSOPR and Traffic Signals Design Report is a **HOLD POINT**.
7. Where there is a specific contract for the provision of traffic signals the designer shall be responsible for ensuring that provision is made in construction documents for the supply of a cable connection chart. The approval by DPTI of the connection chart constitutes a **HOLD POINT**. Where there is no specific contract the designer is responsible for documenting the cable connection chart for traffic signals as part of the Traffic Signals Design report,

PERIODS OF NOTICE:

8. 15 working days (three weeks) is required for the approval of traffic control devices which includes Traffic signals. (Traffic Control Devices (TCD's) require approval pursuant to the Road Traffic Act 1961 (SA))
9. 8 (eight) weeks' notice is required prior to switching on new traffic signals, or changing the personality(s) in existing traffic signals.

Note the above two periods of notice are consecutive not concurrent, i.e. eleven weeks overall.

8 RECORDS

Where specified the following records shall be provided to DPTI:

Drawings

The drawings described in Clause 6 "Design Documents"

Relevant standard drawings from the DPTI: Road Design Standards and Guidelines

Reports

Traffic Signal Operational Performance Report

Traffic Signal Design Report

Written reports will normally be submitted in PDF format.

Models

On completion of project the native model data files are to be supplied, and shall become the intellectual property of Department of Planning, Transport and Infrastructure

For AIMSUN models the database output is are also required.