# SOUTH AFRICAN ROAD TRAFFIC SIGNS MANUAL

3rd Edition

# VOLUME 3 TRAFFIC SIGNAL DESIGN



**DIGITISED VERSION - May 2012** 

# SOUTH AFRICAN ROAD TRAFFIC SIGNS MANUAL

3rd Edition

# VOLUME 3 TRAFFIC SIGNAL DESIGN

# DIGITISED VERSION May 2012



#### TITLE

# SOUTH AFRICAN ROAD TRAFFIC SIGNS MANUAL VOLUME 3: TRAFFIC SIGNAL DESIGN

ISBN	STATUS	DOT FILE	DATE
	DIGITISED		April 2001
		000/0/0/0	2 <sup>nd</sup> Print (Aug 2004)
			Digitised (May 2012

#### **COMMISSIONED BY:**

National Department of Transport

Private Bag X193 PRETORIA

0001

SOUTH AFRICA

Committee of Transport Officials (COTO)

Workgroup: Updating of SARTSM Volume 3: Traffic Signal Design

#### DIGITISING CARRIED OUT BY ORIGINAL AUTHORS

TTT Africa Dr JD Sampson Jeffares & Green Inc
p/a Jeffares & Green Inc
PO Box 1109 Dr HS Joubert Arcus Gibb
Sunninghill 2157 Mr G Dazeley Traffic Engineer
Greater Johannesburg Mr FJ Labuschagne Transportek, CSIR

#### **COMMENTS**

Comments on, and other contributions, to this publication will be welcomed and appreciated. Such contributions and comments should be forwarded to the National Department of Transport at the above address. Contributions of significant extent will be acknowledged in future editions of the manual.

#### **COPYRIGHT**

This publication is protected by copyright under the Bern Convention. In terms of the Copyright Act No. 98 of 1978, no part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage or retrieval system, without permission in writing from the publisher.

© National Department of Transport, South Africa, 2001, 2004, 2012

#### **KEY WORDS**

Road sign, Traffic signal

# COMMITTEE OF TRANSPORT OFFICIALS (COTO) WORKGROUP: UPDATING OF SARTSM VOLUME 3: TRAFFIC SIGNAL DESIGN

#### Participating members of the workgroup

Chairman: Mr RJV Slater National Department of Transport

Members

Mr BH Botha Johannesburg Roads Agency

Mr GW Botha Free State Public Works, Roads and Transport

Mr IS Boyd City of Johannesburg
Mr D Davey City of Cape Town

Mr PW Douglass
Mr T Fourie
Mr T Fourie
Mr WJ Gorny
Ms LB Johnson
Nelson Mandela Metropolitan Municipality
South African Bureau of Standards
KwaZulu-Natal Department of Transport
National Department of Transport

Mr HAD Kirsten uMhlathuze Municipality

Mr MR Meijer Gautrans

Mr CJ Mollett Provincial Administration Western Cape, Dept of Transport

Mr DH Thomas Durban Metro Council

Mr HD Vorster City of Tswane Metropolitan Municipality

#### Acknowledgements

The following persons are gratefully acknowledged for valuable contributions to and comments made on the manual:

Mr JL Coetzee Pretoria
Mr D Davey Cape Town
Ms SA Hinrichsen Cape Town
Ms J Oliver Cape Town
Mr P Reynolds Pretoria
Mr B van Biljon Johannesburg
Mr KM Wolhuter Pretoria

## SOUTH AFRICAN ROAD TRAFFIC SIGNS MANUAL

#### LIST OF UPDATES

UPDATE NO.	UPDATES		VOLUME NO./ PART NO.	DESCRIPTION OF THE
	NUMBER OF PAGES	DATE		UPDATES
1	1	Aug 2004	Volume 3	Page 2.5 replaced
2		26/03/12	Volume 3	Numerous, see V3 error record

LIST OF CONTENTS 0.1

# SOUTH AFRICAN ROAD TRAFFIC SIGNS MANUAL

### **VOLUME 3: TRAFFIC SIGNAL DESIGN**

#### **LIST OF CONTENTS**

0.1

0

**CONTENTS** 

0.1 0.2 0.3 0.4 0.5 0.6	Part 1 - Traffic Signal Control – Chapters and Sections Part 2 - Traffic Signal Equipment – Chapters and Sections Part 3 – Traffic Signal Management – Chapters and Sections Appendices List of Figures List of Tables Colour Details	0.1 0.4 0.5 0.6 0.7 0.8 0.9
	PART 1 – TRAFFIC SIGNAL CONTROL	
1	INTRODUCTION	
1.1	Background	1.1
1.2	Traffic signal design and approval	1.1
1.3 1.4	The traffic signal Recommended and alternative systems	1.2 1.2
1.4	Terminology	1.3
1.6	Organisation of the manual	1.3
2	TRAFFIC SIGNAL WARRANTS	
2.1	Introduction	2.1
2.2	Minimum requirements	2.1
2.3	Alternatives to traffic signals	2.1
2.4	Traffic signal warrants	2.2
3	TRAFFIC SIGNAL FACES	
3.1	Introduction	3.1
3.2	Light signals and faces	3.1
3.3	Area of control	3.1
3.4	Control precedence	3.1
3.5 3.6	Vehicular light signals Flashing and other modes of operations	3.4 3.7
3.7	Arrangement of light signals on a signal face	3.7
3.8	Standard signal faces	3.7
3.9	Number and location of traffic signal faces	3.11
3.10	Signals on high-speed roads	3.12
3.11	Visibility requirements	3.12
3.12	Mounting of vehicular traffic signals	3.14
3.13	Traffic signal layout plans	3.16

MAY 2012 SARTSM – VOL 3 TRAFFIC SIGNALS

4	PEDESTRIAN AND PEDAL CYCLIST SIGNALS	
4.1	Introduction	4.1
4.2	Pedestrian and pedal cyclist signals	4.1
4.3	Operation of pedestrian and pedal cyclist signals	4.2
4.4	Provision of pedestrian signals at junctions	4.2
4.5	Pedestrian scramble phase	4.3
4.6	Layout of pedestrian and pedal cyclist signals	4.3
4.7	Mounting of pedestrian and pedal cyclist signals	4.3
5	JUNCTION LAYOUT	
5.1	Introduction	5.1
5.2	Geometric design of signalised junctions	5.1
5.3	Auxiliary lanes	5.4
5.4	Road signs	5.10
5.5	Road markings	5.10
5.6	Road lighting	5.14
5.7	Bibliography	5.14
6	SIGNAL TIMING AND PHASING	
6.1	Introduction	6.1
6.2	Timing parameters	6.1
6.3	Definition of phases	6.1
6.4	Managing signal settings	6.2
6.5	Signal timing plans	6.3
6.6	Traffic counts	6.3
6.7	Signal phases	6.4
6.8	Main signal phases	6.4
6.9	Left-turn signal phases	6.4
6.10	Right-turn signal phases	6.5
6.11	Warrants for right-turn signal phases	6.7
6.12	The intergreen period	6.7
6.13	Traffic signal timing	6.10
6.14	Fixed time signal co-ordination	6.16
6.15	Fine-tuning traffic signals	6.21
6.16	Signal timing configuration diagrams	6.21
6.17	Bibliography	6.24
7	VEHICLE-ACTUATED CONTROL	
7.1	Introduction	7.1
7.2	Application of vehicle-actuated control	7.1
7.3	Strategies of vehicle-actuated control	7.1
7.4	Fully- and semi-actuated control	7.2
7.5	Minimum and maximum green	7.3
7.6	Stage reversion	7.3
7.7	Vehicle detection	7.3
7.8	Detector configurations	7.4
7.9	Pedestrian detection	7.6
7.10	Bibliography	7.6

8	VEHICLE-RESPONSIVE CONTROL	
8.1	Introduction	8.1
8.2	Control principles	8.1
8.3	Bibliography	8.2
9	AREA TRAFFIC CONTROL	
9.1	Introduction	9.1
9.2	Master signal control	9.1
9.3	Fixed time area traffic control	9.2
9.4	Adaptive area traffic control	9.2
9.5	Traffic responsive control	9.2
9.6	Benefits of adaptive and responsive systems	9.6
9.7	Data acquisition benefits	9.6
9.8	Bibliography	9.6
10	VEHICLE PRIORITY	
10.1	Introduction	10.1
10.2	Detection of vehicles	10.1
10.3	Priority strategies	10.1
11	INDIVIDUAL VEHICLE CONTROL SIGNALS	
11.1	Introduction	11.1
11.2	Toll booths and checkpoints	11.1
11.3	Ramp metering	11.1
12	SIGNALS AT ROADWORKS	
12.1	Introduction	12.1
12.2	Vehicle-actuated control	12.1
12.3	Two-way traffic in a single lane at roadworks	12.1
13	LANE DIRECTION CONTROL SIGNALS	
13.1	Introduction	13.1
13.2	Installation	13.1
13.3	Operation	13.2
14	RAILWAY CROSSING SIGNALS	
14.1	Introduction	14.1
14.2	Installation	14.1
14.3	Operation	14.2
15	HAND AND OTHER SIGNALS	
15.1	General	15.1
15.2	Control hand signals for use by traffic officers SS1	15.1
15.3	Flag signals SS2	15.2
15.4	Flashing yellow warning signals SS3	15.2
15.5	Flare signals SS4	15.3

0.4 LIST OF CONTENTS

## **PART 2 – TRAFFIC SIGNAL EQUIPMENT**

16	LIGHT SIGNALS AND POSTS	
16.1	Introduction	16.1
16.2	Signal aspects	16.1
16.3	Signal louvres and visors	16.2
16.4	Signal heads and background screens	16.2
16.5	Posts for supporting light signals	16.2
17	FACILITIES FOR DISABLED USERS	
17.1	Introduction	17.1
17.2	The problems of pedestrians with visual impairments	17.1
17.3	Facilities to assist visually impaired pedestrians	17.1
18	TRAFFIC SIGNAL CONTROLLERS	
18.1	Introduction	18.1
18.2	Controller types	18.1
18.3	Controller functions	18.1
18.4	Conflict monitoring	18.1
18.5	Fault monitoring	18.2
18.6	Signal synchronisation	18.2
18.7	Controller cabinets	18.3
19	CENTRAL CONTROL SYSTEMS	
19.1	Introduction	19.1
19.2	Control centres and rooms	19.1
19.3	Central control computers	19.1
19.4	Outstation control	19.2
19.5	Communications	19.2
19.6	Signal timing plans	19.3
19.7	Emergency signal plans	19.3
20	DETECTORS	
20.1	Introduction	20.1
20.2	Pedestrian push buttons	20.1
20.3	Vehicle detectors	20.1
20.4	Detector operation	20.1
20.5	Inductive loop detectors	20.2
20.6	Bibliography	20.4
21	AUTOMATED LAW ENFORCEMENT	
21.1	Introduction	21.1
21.2	Violations at traffic signals	21.1
21.3	Implementation	21.1
22	POWER SUPPLY	
22.1	Introduction	22.1
22.2	Electrical requirements	22.1
22.3	Power supply cables	22.1
22.4	Trenching and ducting	22.2

TRAFFIC SIGNALS SARTSM – VOL 3 MAY 2012

LIST OF CONTENTS 0.5

## **PART 3 - TRAFFIC SIGNAL MANAGEMENT**

23	RESPONSIBILITIES AND DUTIES	
23.1	Introduction	23.1
23.2	Institutional responsibility	23.1
23.3	Institutional co-operation	23.1
23.4	Signal management	23.1
24	RISK MANAGEMENT	
24.1	Introduction	24.1
24.2	Standards and guidelines	24.1
24.3	Notices of defect	24.2
24.4	Construction and repair	24.2
24.5	Risk management strategy	24.2
24.6	Personal liability	24.3
25	MANPOWER REQUIREMENTS	
25.1	Introduction	25.1
25.2	Traffic engineering	25.1
25.3	Electrical and electronic engineering	25.2
25.4	Staffing levels	25.2
25.5	Education and technology transfer	25.3
26	TRAFFIC SIGNAL INSTALLATION	
26.1	Introduction	26.1
26.2	Candidate site identification	26.1
26.3	Warrant study	26.1
26.4	Signal design	26.1
26.5	Signal installation	26.2
26.6	Commissioning	26.3
27	REMOVAL OF TRAFFIC SIGNALS	
27.1	Introduction	27.1
27.2	Identification of signals requiring removal	27.1
27.3	Removal procedure	27.1
28	TRAFFIC SIGNAL MAINTENANCE	
28.1	Introduction	28.1
28.2	Consequences of maintenance deficiencies	28.1
28.3	Reducing maintenance requirements	28.1
28.4	Types of maintenance	28.1
28.5	Routine maintenance	28.1
28.6	Repair maintenance	28.3
28.7	Maintenance records	28.4
28.8	Maintenance personnel	28.4
28.9	Maintenance resources	28.4
28.10	Contract maintenance	28.5
28.11	Bibliography	28.5
<b>29</b>	SIGNAL TIMING UPGRADING	20.4
29.1	Introduction	29.1
29.2	Need for updating	29.1
29.3	Data requirements	29.1
29.4	Traffic counting systems	29.2

MAY 2012 SARTSM – VOL 3 TRAFFIC SIGNALS

0.6 LIST OF CONTENTS

30	TRAFFIC SIGNAL RECORDS	
30.1	Introduction	30.1
30.2	Installation records	30.1
30.3	Fault log and advice records	30.1
30.4	Maintenance records	30.1
30.5	Controller logs	30.2
30.6	Archiving of records	30.2
30.7	Referencing systems	30.2
31	CONTRACTS	
31.1	Introduction	31.1
31.2	Content of contract documents	31.1
31.3	Structure of contract documents	31.1
31.4	Tender process	31.2
31.5	Procurement	31.2
31.6	Service level agreements	31.2
31.7	Bibliography	31.2
32	ANNUAL REPORTS	
32.1	Introduction	32.1
32.2	Contents of the annual report	32.1

### **APPENDICES**

Α	GLOSSARY	OF TERMS
---	----------	----------

- B EXAMPLE TRAFFIC SIGNAL LAYOUTS
- C TRAFFIC SIGNAL CHECKLISTS
- D TRAFFIC SIGNAL FORMS

LIST OF TABLES 0.7

## **LIST OF FIGURES**

2.1	Queue length observations	2.4
3.1	Definition of intersections, junctions, slipways and pedestrian crossings	3.2
3.2	Examples of road signs used in conjunction with traffic signals	3.3
3.3	Standard traffic signal faces and traffic signal arrow signs	3.8
3.4a	Signalling for protected-only right turn at a T-junction	3.10
3.4b	Signalling for protected-only right turn at a 4-way junction (road divided by median)	3.10
3.5a	Traffic signal sequence for protected/permitted right-turn phases using a S8 signal face	3.13
3.5b	Traffic signal sequence for protected-only right-turn phases using the S1 and S1R signal faces	
	in conjunction with the ST5 and St2 traffic signal arrow signs	3.13
3.6	Cone of vision in horizontal plane	3.15
3.7	Standard post mounting	3.17
3.8	Extended post mounting	3.17
3.9	Overhead (cantilever) mounting of traffic signal faces	3.17
3.10	Example traffic signal layout plan	3.18
3.11	Alternative traffic signal layout plan using graphic symbols for signal faces	3.19
4.1	Alternative positions for pedestrian and pedal cyclist signals at signalised junctions	4.4
4.2	Pedestrian (and pedal cyclist) signal faces at a mid-block crossing	4.4
4.3	Staggered mid-block pedestrian crossing	4.5
4.4	Staggered pedestrian crossing on a wide junction	4.5
4.5	Pedestrian crossing road markings at a junction	4.6
4.6	Mounting pedestrian and pedal cyclist signals	4.6
5.1	Vehicle swept paths through a signalised junction	5.3
5.2	Auxiliary through lanes at signalised junctions	5.3
5.3	Provision of right-turn lanes at a signalised junction	5.6
5.4	Restricted sight distance for right-turning traffic due to a very wide median	5.7
5.5	Restricted sight distance for right-turning traffic due to a horizontal curve (bottom-to-top direction)	5.7
5.6	Free-flow and controlled slipways at a signalised junction	5.9
5.7	Road junction with pedestrian crossing markings	5.13
5.8	Guide lines through a junction	5.13
6.1	Example of signal intervals for a three-stage traffic signal with six signal groups	6.2
6.2	Various types of traffic signal phases at a signalised junction	6.5
6.3	Measurement of clearance widths W	6.11
6.4	Example signal timing of a signalised T-junction	6.15
6.5	Example progression diagram	6.17
6.6	IN and OUT flow patterns at a traffic signal	6.18
6.7a	Example platoon dispersion diagram	6.20
6.7b	Example platoon dispersion diagram with improved offsets	6.20
6.8a	Example signal timing diagram – Signal groups and staging	6.25
6.8b	Example signal timing diagram – Signal group and stage data	6.26
6.8c	Example signal timing diagram – Signal plans and timings	6.27
7.1	Searching for gaps in the traffic stream	7.2
7.2	Right-turn detector configuration	7.5
7.3	Single stop line detector configuration	7.7
7.4	Double detector configuration (design speed 40 km/h)	7.7
7.5	Triple detector configuration (design speed 20/30 km/h)	7.7
8.1	Typical layout of detectors	8.2

MAY 2012 SARTSM – VOL 3 TRAFFIC SIGNALS

0.8 LIST OF TABLES

9.1	Schematic for linking co-ordinated signals	9.1
9.2	Adaptive traffic control vehicle detector layout	9.3
9.3	Traffic responsive control vehicle detector layout	9.4
9.4	Projected traffic demand profile at downstream junction	9.5
9.5	Flexibility of traffic responsive control	9.7
11.1	Single vehicle release operating sequence	11.1
11.2	Ramp metering application of the S12 signal face	11.2
13.1	Standard lane direction control signals	13.1
13.2	Permitted variants of lane direction control signals	13.1
13.3	Back-to-back mounting of lane direction control signals	13.2
14.1	Flashing red disc light signals at railway crossings	14.1
15.1	Control hand signals for use by traffic officers SS1	15.4
15.2	Flag signals SS2	15.4
15.3	Flashing yellow warning signals SS3	15.4
16.1	Components of a signal aspect	16.1
16.2	Signal head with standard visors	16.2
16.3	Signal head with cut-away visors	16.2
16.4	Improving conspicuity of signals	16.3
18.1	Schematic presentation of controller functions	18.2
20.1	Inductive loop shapes and sizes	20.3
20.2	Inductive loop wire slot cut into the road surface	20.4
22.1	Drip loop on a power cable	22.1
22.2	Example of duct and draw box layout at a junction	22.2

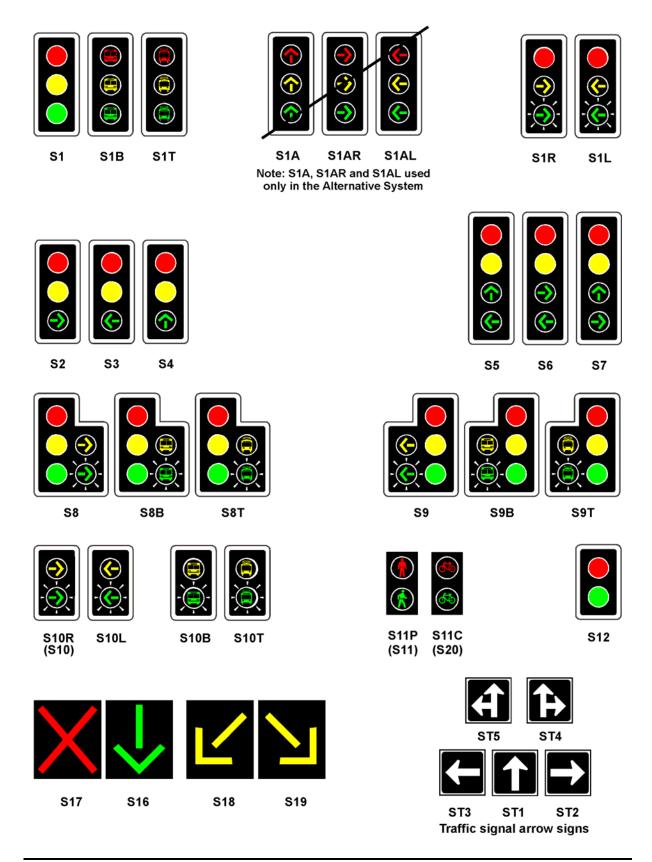
### **LIST OF TABLES**

3.1	Recommended sight distances for traffic signals	3.15
5.1	Summary of road markings for signalised junctions and crossings	5.12
6.1	Recommended yellow and clearance or all-red intervals (seconds)	6.9
6.2	Recommended additional all-red intervals at slipways (seconds)	6.9
25.1	Desirable staffing levels	25.2
28.1	Routine maintenance	28.2
20 1	Signal timing undating cycle (years)	20.1

TRAFFIC SIGNALS SARTSM – VOL 3 MAY 2012

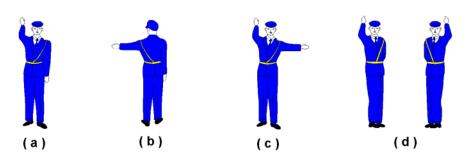
COLOUR DETAILS 0.9

# STANDARD TRAFFIC SIGNAL FACES AND TRAFFIC SIGNAL ARROW SIGNS

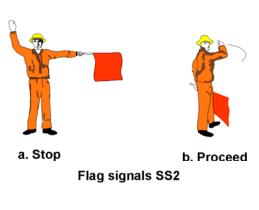


0.10 COLOUR DETAILS

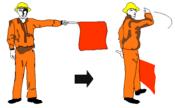
### OTHER ROAD SIGNALS



Control hand signals for use by traffic officers SS1







Using stop/proceed flag signals to slow traffic down



Warning traffic in two directions







Flashing yellow warning signal SS3



Flashing Red Disc (FRD) signal at railway crossings

TRAFFIC SIGNALS SARTSM – VOL 3 MAY2012