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Surface Transport

Traffic Directorate

Network Performance

VISSIM Saturation Flow Tool v1.0

User Guide

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1. Introduction

When building VISSIM models, an important part of the calibration and validation process is to impose saturation flow limits at stoplines (either from data measured on-street or calculated with the RR67 formula) through the use of Reduced Speed Areas (RSAs). This is achieved in VISSIM by selecting an appropriate Desired Speed Distribution (DSD) for the RSA, such that saturated flows discharge at an equivalent rate to the measured or calculated value.

For validation purposes, saturation flows from a VISSIM model should be within 10% of those measured on-street or calculated using RR67[1].

1.1 Saturation Flows in VISSIM

Saturation flows are commonly obtained from VISSIM through measurement of saturated vehicle headways, which are obtained through the use of Special Evaluation files. This requires the placement of Data Collection Points (DCPs) in each lane just after each stopline, and modification of the VISSIM *.INP file to output the discharge rate for the relevant DCPs. This procedure is explained in the VISSIM manual[2].

Once VISSIM has been configured and a run has been completed, discharge rate evaluations are written to separate output files with the extension *.Axx (Axx files), where xx is an ascending number starting from 00. The total number of output files will be equal to the total number of DCPs for which discharge rate output has been configured. This can be of the order of 50-100 in a typical model (one per lane for each stopline).

1.2 Previous Methodology

Initially a VISSIM modeller requiring calibrated saturation flows had to manually interrogate discharge rate evaluation files to calculate the rate of saturated discharge from the saturated component of headway data. In response to this a macro-enabled spreadsheet was created by [redacted] to parse data, however, the data still required manual processing, removed users from the decision-making

[1] *TD Model Auditing Process – Design Engineer Guide*, v3.0, Traffic Directorate, Transport for London, 2011.
[2] *VISSIM 5.30 User Manual*, Section 11.20, pp551-553, Planung Transport Verkehr (PTV) AG, 2010.

process about measurement suitability, and importantly only interrogated individual Axx files.

1.3 New Approach

The VISSIM Saturation Flow Tool v1.0 addresses limitations of previous approaches by allowing interrogation of multiple Axx files to reduce the time spent on manual processing. The tool also helps engineers measure saturation flows from VISSIM in a similar manner as they would on-street through the specification of measurement criteria.

Functional improvements that have been included in the new tool include:

- No limit on the number of cycles during which measurements are taken (previously a maximum of 30 cycles could be measured);
- No limit on the number of vehicles measured per cycle (previously only the first ten vehicles in each cycle were considered);
- A user-configurable number of vehicles can now be discarded after the start of green to avoid underestimating saturation flows due to the effect of accelerating vehicles;
- A minimum number of vehicles can be specified for a single saturation flow measurement to be considered valid – previously cycles with only a few vehicles would still contribute towards saturation flow calculations;
- No further headways contribute to saturation flow calculations following the end of saturation – previously additional headways could contribute towards saturation flow calculations even after saturated conditions had ended;
- A minimum number of measurements can now be specified for an overall average measurement to be considered valid – previously the overall average would always be reported even if only one headway was measured
- The limit for saturated headway conditions is now user-configurable (previously set to 3.5s); and
- New additional ways of specifying saturated headway conditions – by max/min headway ratio or percentage increase between successive headways.

2. Pre-Calibration Requirements

Before using the VISSIM Saturation Flow Tool, it is important that the VISSIM model satisfies the following conditions before Special Evaluation files are generated:

- Driver behaviour at stoplines should be correct;
- It is recommended that only cars be used in the model, to ensure a PCU factor value of one. Otherwise appropriate and representative PCU factors should be determined for the links and network being modelled;
- Free-flow conditions should exist at stoplines, such that no downstream interference (exit blocking) takes place; and
- Sufficient queues should exist at stoplines to allow for satisfactory measurement.

If necessary, adjustments should be made to a 'calibration-only' version of the VISSIM model (e.g. adding extra flows, breaking downstream links and modifying signal timings) in order to help achieve these aims.

Before using the VISSIM Saturation Flow Tool, macros should also be enabled in Microsoft Excel.

3. Using the VISSIM Saturation Flow Tool

Figure 1 shows a process flow diagram showing the steps involved when using the VISSIM Saturation Flow Tool. These can essentially be broken down into:

- Specification of Measurement Criteria;
- Specification of Saturation Criteria;
- Running on Individual Axx Files;
- Running on Multiple Axx Files; and
- Entering Survey Data (Optional).

These will be discussed in further detail in the following sections.

Figure 1 is colour-coded so that individual steps correspond to the relevant coloured Worksheet tabs in Microsoft Excel.

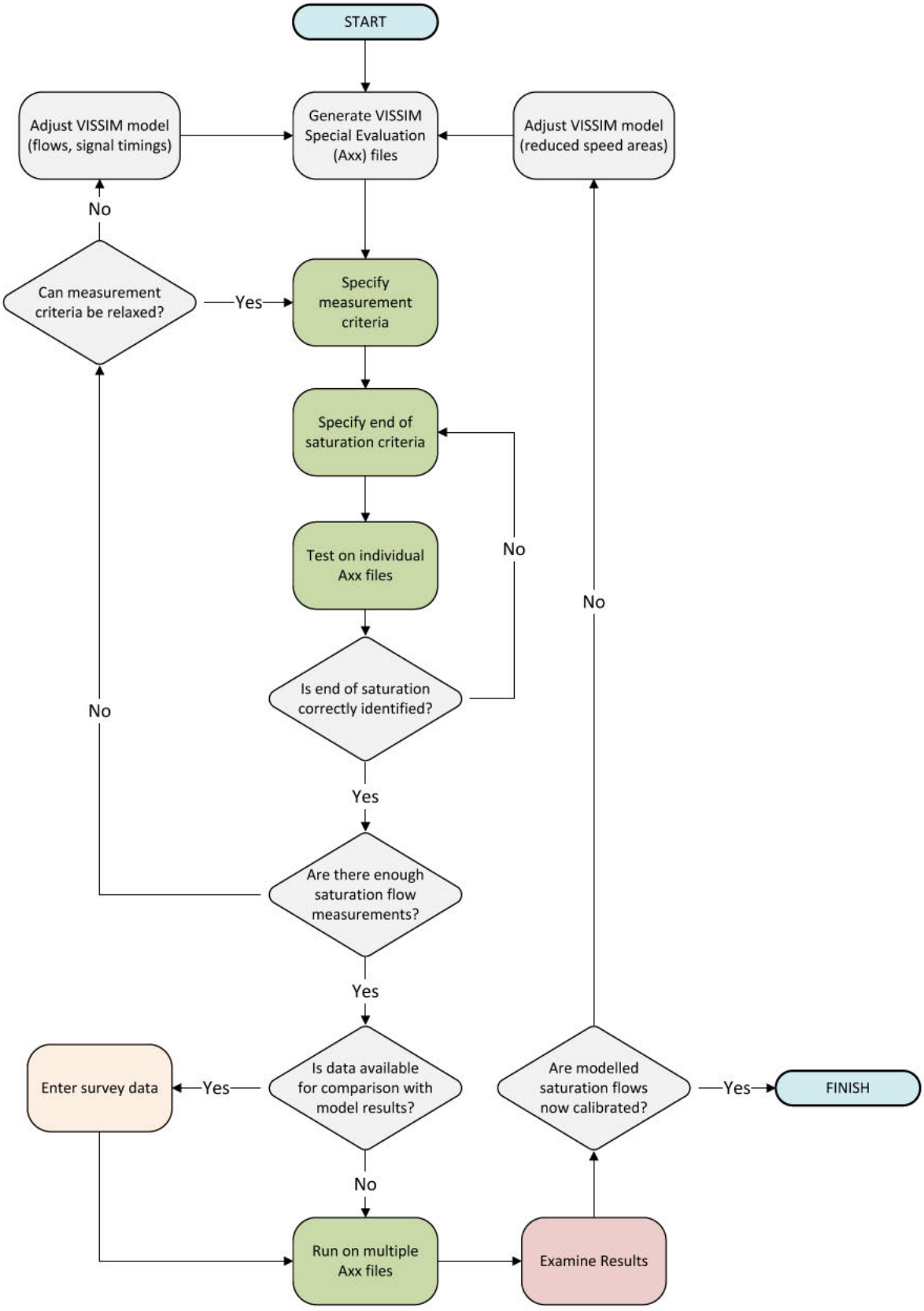

Figure 1: Calibration process using the VISSIM Saturation Flow Tool

3.1 Specification of Measurement Criteria

Measurement criteria are specified under 'Tool Settings' on the 'Configure + Run' worksheet. The following measurement criteria need to be specified:

- **Number of vehicles across stopline to ignore at start of green**

  This represents the number of vehicles crossing the stopline at the start of the green signal that are not included in the saturation flow measurement, in order to avoid under-estimating the saturation flow due to accelerating vehicles.

  The recommended values are one or two, as are commonly employed during on-street saturation flow measurement.

- **Minimum number of vehicles required in a single measurement**

  This represents the minimum number of vehicles for a single saturation flow measurement (i.e. during a single cycle) to be considered valid.

  Modelling Guidelines V2.0 recommend that saturation flows should be measured over a period of 12 seconds where possible[3]. This corresponds to approximately 6 PCUs for a single lane.

- **Minimum number of measurements for average saturation flow calculation**

  This represents the minimum number of individual saturation flow measurements that are required at a stopline before an average saturation flow is calculated and considered representative for that stopline.

  A recommended minimum number of measurements is ten, as is commonly employed during on-street saturation flow measurement. The number should be sufficient to give confidence in the average saturation flow calculated, and depends on the variability observed between individual measurements and engineering judgement.

[3] *Traffic Modelling Guidelines*, v3.0, Section 2.4.7, pp70-71, Traffic Directorate, Transport for London, 2010

- **Start/End Simulation Time**

  If desired, measurements can be restricted to particular modelled time frames within a simulation run. For example, if a network becomes congested measurements can be discarded after a certain time, or undersaturated warm-up periods can be ignored.

  It is generally recommended to keep the start and end time limits the same as the start and end times for the modelled simulation run, unless there is good reason to change them.

- **Global PCU Factor**

  If specified, all calculated saturation flows (in veh/hr) will be multiplied by this value to give saturation flow figures in PCU/hr. By default this value is set to one, assuming that only single-PCU vehicles exist in the model.

  Whilst a global PCU factor is supported for networks containing different vehicles, consideration should be given to whether a network-wide PCU factor is representative for all stoplines. If necessary, PCU factors can be changed for individual stoplines on the results sheet to capture non-homogenous flow compositions.

3.2 Specification of Saturation Criteria

Saturation criteria, defining the characteristics that will be used to determine the end of saturation during a saturation flow measurement, are specified under ‘Tool Settings’ on the ‘Configure + Run’ worksheet.

The following saturation criteria can be specified:

- **Headway Limit**

  Any headway above the limit value specified will be treated as unsaturated and will not count towards saturation flow calculations.

- **Headway Increase**

  During a single saturation flow measurement, the end of saturation will be assumed when the increase in headway between one vehicle and the next exceeds the percentage specified.

- **Max/Min Headway Ratio**

  During a single saturation flow measurement, the end of saturation will be assumed when the maximum of all headways during that measurement, divided by the minimum of all headways during that measurement, exceeds the ratio specified.

It should be noted that the three saturation criteria listed can be used independently or in combination, using the tick boxes provided on the spreadsheet. When used together, the end of saturation will be considered when any one of the criteria specified exceeds the specified value.

The values in the spreadsheet should not be considered recommended values, although they have been used during limited testing and may produce satisfactory results.

The previous methodology developed by Alex Roberts treated any headway below 3.5s as saturated, so this value has been chosen as the default headway limit value.

The user is encouraged to experiment with different values to see their effect, and consider testing the criteria individually or in combination, before choosing values most relevant for the modelled network.

Characteristics of individual links (such as upstream width restrictions, yellow boxes, side roads, keep clear areas, parked vehicles, bus stop interference etc) may give rise to limited gapping occurring even during saturated conditions. This can be compensated for by using the saturation criteria in combination, relaxing the restrictions on one criterion (e.g. headway limit) while using another criterion to pick up the end of saturation, producing a less forceful limit allowing for limited gaps. This approach should only be used if such gapping happens regularly and is therefore representative of the link in question.

3.3 Running on Individual Axx Files

In order to test the user-defined measurement and saturation criteria, it is recommended to test the settings on a number of individual Axx files representing different links in the network. This is achieved by pressing the relevant button on the ‘Configure + Run’ worksheet. Once run, the user will be prompted to choose an

Axx file. This file will then be opened and the tool will mark up the headways contained within the file using the colour key shown in Figure 2.

	Headway not within specified parameters
	Headway within specified parameters and included in measurement
	Headway within parameters but discarded due to min no of vehicles requirement
	Values calculated by the VISSIM Saturation Flow Measurement Tool

Figure 2: Colour key used when analysing Special Evaluation files.

The user can then analyse the highlighted headways and determine if the headways being used for saturation flow calculation are appropriate, and whether the end of saturation is being correctly identified by the tool. If not, the tool settings should be adjusted and re-tested.

The average saturation flow calculated for that file will be displayed towards the top of the file, together with the number of measurements it is based on and the standard deviation, if available. Alternatively, if measurement is not possible this will be stated.

3.4 Running on Multiple Axx Files

Once the measurement and saturation criteria have been satisfactorily tested, the tool can be run on multiple Axx files by pressing the appropriate button on the 'Configure + Run' worksheet. The user will then be prompted for the relevant VISSIM INP file, after which all Axx files associated with that INP file will be read from the directory the INP file is stored in.

Once processing of all the Axx files is complete, the results will be tabulated for the user to analyse. At this point the user can decide whether any further changes are required to the measurement criteria, saturation criteria or VISSIM model.

The following information will be included for each Axx file in the tabulated data:

- Axx file number;
- VISSIM data collection point;
- Number of valid saturation flow measurements;
- Calculated average saturation flow; and
- Standard deviation of individual saturation flow measurements.

3.5 Generating Saturation Flow Data using the Tool

If the user finds that the tool produces limited results (i.e. saturation flows are not able to be calculated for many links), the following options should be considered:

- Relax the measurement criteria so that more headway data is regarded as being acceptable for inclusion in calculations;

- Make changes in the VISSIM model prior to generating new Axx files, so that more headway data will become available. This could include the addition of extra flows, breaking of links downstream of stoplines to avoid downstream interference effects, or adjustment of signal timings to create larger queues. Care should however be taken to minimise any impact on driver behaviour at stoplines.

3.6 Entering Survey Data

If available, any of the following supplementary information can be entered on the 'Survey Data' worksheet:

- Surveyed saturation flow;
- Whether the surveyed saturation flow was calculated with RR67;
- Measured PCU factor;
- Link description;
- Junction reference number;
- VISSIM link number; and
- TRANSYT link number.

Any user-entered data will be included in the final table displaying the calculated saturation flows from the model. If a surveyed saturation flow is entered, the final table will highlight any modelled saturation flows that show a difference of more than 10% from the surveyed value.

It should be noted that while all the data fields above are optional, a relevant data collection point must be specified for any data entered. If no data collection point is specified, the data will not be included in the final results table.

4. Support/Feedback

The VISSIM Saturation Flow Tool has been developed by the Network Management Section within Network Performance, TfL Traffic Directorate.

We encourage feedback on the advice given in this document and on the reporting of any bugs found.

Please address all comments, specifying that they are related to VISSIM Saturation Flow Tool, to the primary developer:

Robert.Blewitt[redacted]

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