# TRAFFIC DATA COLLECTION PROCEDURES

## BOWLING GREEN, KENTUCKY

***Prepared For:***

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# TRAFFIC DATA COLLECTION PROCEDURES
# CITY OF BOWLING GREEN, KENTUCKY

## SECTION 1.- INTRODUCTION

Most studies of traffic related problems begin with the collection of a good foundation of the roadway and traffic conditions. Any study can only be as accurate as the data it is based on. For this reason it is important that all traffic studies make special efforts to be thorough and accurate in the collection of all traffic data.

The most common types of data collected for the purposes of traffic engineering are vehicle volume and speed data. The following sections will describe how to record this information and what factors are important to keep in mind as the collection takes place.

## SECTION 2.- VOLUME STUDIES

Engineers will often use the number of vehicles passing a point or entering an intersection in the analysis of roadway operations. The two basic methods of collecting data are manual observation and automatic recording. Each has their use and effectiveness depending on the type of information needed for analysis. The traffic data is the basis of all analysis in a traffic impact study and careful consideration should be given to the locations, types of counts and duration of counts.

### Section 2.1- Manual Counts

#### *A. Purpose*

Manual counts typically require trained observers to collect specific information that cannot be efficiently obtained through automated means. Examples might be vehicle occupancy, pedestrians, turning movements and vehicle classifications. As traffic data collection technology continues to advance many of these types of counts may become automated.

#### *B. Equipment*

The most common types of equipment used are tally sheets, mechanical count boards and electronic count boards.

The use of a tally sheet involves the observer to make a tick mark for every vehicle in a given classification or movement. The tally sheet is prepared prior to going out into the field allowing space for all information to be marked easily once the count has begun. Form 1 in the Appendix shows a typical vehicle turning movement count sheet. These sheets are usually modified for the specific counts being taken. This is used in conjunction with a stopwatch to time the desired interval. Once these counts are collected they are tallied and summarized back in the office. An example of a typical summary sheet is shown in Form 2 of the Appendix.

Mechanical count boards consist of accumulating pushbutton devices with three to five registers. Prior to starting the count, the observer determines the meaning of each of the count board buttons. Examples of typical count board configurations can be found in Figure 2-2 of the ITE Guideline to Traffic Engineering Studies. Like the tally sheets, the use of a stopwatch is necessary to determine the period of each count and to cue the observer. When the end of an interval is reached the observer reads the counter, records the data and resets the counters to zero. Manual adjustment of the data will be required to account for the lost time during the recording and resetting of the data. This procedure is described in further detail in subsequent sections.

Electronic counter boards are light hand-held and battery operated. They are typically lighter, more compact and easier to handle than the manual count boards. They also contain an internal clock and eliminate the need for separate field forms. They also preclude the need for manual data reduction and summary. Data may be transferred directly into a computer via modem or direct connection with a computer. Many electronic count boards are capable of handling several types of common traffic studies such as turning movement, classification, gap, stop delay, saturation flow rate, stop sign delay, spot speed and travel time studies. For most agencies and consultants the electronic count board is a cost effective and laborsaving tool.

### *C. Personnel*

Manual traffic counting requires trained observers. Breaks should be planned for at least 10 min every 3 hours. One observer can easily count turning movements at a four way low volume signalized intersection as long as special classifications or occupancy are not required. A typical four-way signalized intersection may be counted by two observers. Duties may be divided among observers in a multitude of ways. Approach, lane, vehicle types and pedestrians may be divided by observers. For example one person may collect the northbound and westbound directions while the other would collect information for the southbound and eastbound direction.

### *D. Other Classifications*

Most of the discussion above is tailored towards the most typical counts, volume only counts. Other counts such as vehicle classification may become important in highly industrial areas.

Vehicle occupancy counts are used in special cases only, typically statewide averages are used for this information if it is needed for analysis calculations. Due to the complexity and time taken to classify each vehicle no other counts or classifications can be made in conjunction with collecting vehicle occupancy.

Truck percentage however is used on a regular basis with most capacity analysis calculations. Truck percentages can be collected at the same time as other vehicle counts. A truck is typically classified as any vehicle with more than two axles. Further sub-categories can be collected as necessary for multi-axle vehicles.

### *E. Count Periods*

Typical count periods may depend on the type of nearby land uses. Use Table 1 as a general guideline for determining the appropriate period to collect peak hour information. Many nearby land uses may influence peak times of a particular intersection. For example an intersection near a hospital may peak during a mid afternoon shift change rather than the typical pm peak hour. Schools, churches, hospitals or shipping centers may impact peak periods due to their individual peaking characteristics. Care should be given to understand the surrounding land uses before scheduling peak hour counts over a limited time period. It is suggested that an investigation of the daily counts be conducted prior to collecting the peak-hour counts to allow a determination of a typical range of peak hour traffic movements on a roadway facility.

For most studies an AM and PM count will be sufficient. However, additional traffic counts may be requested if in the opinion of the city traffic engineer that they are warranted. Saturday counts are sometimes needed near high shopping areas. Count periods should avoid special events and adverse weather conditions. A count interval of 15-minutes should be used for most studies.

**Table 1 – Typical Peak Flow Traffic Hours**

| Land Use | Typical Peak Hours |
|---|---|
| Residential | 7:00-9:00 am weekday<br>4:00-6:00 pm weekday |
| Regional Shopping center | 5:00-6:00 pm weekday<br>2:30-3:30 pm Saturday<br>12:30-1:30 pm Saturday |
| Office | 7:00-9:00 am weekday<br>4:00-6:00 pm weekday |
| Industrial | Varies |
| Recreational | Varies |
| Hospital | Varies based on shift changes |
| School | Varies based on school release times |

## *F. Procedures*

Preparation - An accurate and reliable count begins in the office. The first step is to review the following checklist as shown in Figure 1. Preparation should start with a review of the purpose and type of count to be performed, the count period and time intervals and geometric layout of the site. This should help the engineer determine the type of equipment to be used, the field procedures and number of observers required. All data forms should be produced with all available information filled in before leaving the office.

**Figure 1 – Manual Count Checklist**

Project:_____________________________________________
Count Location:______________________________________
Date:_______________________________________________
Time of Count:_______________________________________

____ 1. Check data collection equipment for proper operation and calibration
____ 2. Label the field equipment as needed
____ 3. Bring necessary accessory equipment (Batteries, flashlight, etc)
____ 4. Stopwatch
____ 5. Bring data collection forms and fill in as much data as possible before leaving the office.
____ 6. Extra pens and paper for taking notes
____ 7. Clipboard or writing surface
____ 8. Business cards of the engineer to contact and be prepared to answer the question “What are you doing here?”
____ 9. A map to the site
____ 10. Weather condition equipment (Sunscreen, umbrella, jacket or warm coat)
____ 11. Safety equipment (Flags, Signs, safety vests, or other reflective materials)

Observer Location – Observer must be positioned to clearly see the traffic they are counting. Avoid vantage points typically blocked by trucks, buses, parked cars or signs. They should be located away from the traveled way for safety of the counter as well as affecting the drivers. If more than one observer is counting the same site, they should remain in contact at all times via radio or other means. Safety vests should be worn if the observer is near traffic at any time. Sitting in a parked car may provide protection from the elements and provide safety for the observer, however it should be located as not to interfere with typical traffic movements. If parking on private property always ask permission from the property owner. A sign indicating that a traffic count is in progress may satisfy most driver curiosity and avoid unwanted interruptions.

Data Recording – The key to proper data recording is in keeping the data organized and labeled correctly. This can be accomplished by inputting all needed information on the form. Each data form should have the following information at the header: count location, observer’s name, time of study, and field conditions. Use a form similar to the example in Form 1 found in the Appendix. Fully complete as much site location information as possible before leaving the office. The observer must be able to focus on recording the proper event with the proper button or place on the form. Proper orientation of the count board is important to the geographic and geometric layout of the intersection.

When mechanical count boards are used taking a short break to record the data and reset the counters is recommended. This can be adjusted for in the office. Typically, count periods are every 15 minutes. A method for counting this period manually would be as follows and shown in Table 2.

Step 1. Count for 14 minutes

Step 2. In the next minute record the data and reset the counters

Step 3. Continue the count for the next period

Step 4. Upon completion of the counts, calculate a conversion factor by the ratio of total count period (15min) to actual count time (14 min). The resultant factor would then be applied to all of the partial counts (15/14=1.0714).

**Table 2 – Example Manual Traffic Count Conversion**

| Movement | 14-min Count | Factor | 15-min Count |
|---|---|---|---|
| NB Left | 150 | 1.0714 | 161 |
| NB Right | 100 | 1.0714 | 107 |
| EB Trough | 200 | 1.0714 | 214 |
| WB Through | 200 | 1.0714 | 214 |
| WB Left | 50 | 1.0714 | 54 |

## Section 2.2 - Automatic Counts

Automatic counts are used for volume data that does not require complex classifications. These counts can be collected for extended periods of time such as several days, a week or more. Automatic counts should be taken at a minimum for a period of 24-hours and on a typical weekday from Tuesday to Thursday. Counts should avoid special events and adverse weather conditions

Equipment failure is very common using this type of equipment due to vandalism, weather, or larger vehicle interference. Care should be taken to minimize this possibility. Equipment consists primarily of a data recorder and a sensor. Permanent counters may use vehicle induction loop installed into the pavement. These counters may be maintained by the city or state for long-term data gathering. Portable counters typically use pneumatic tubes placed in the travel lanes.

Video tape recorders can be used to collect information to then be tallied using the same methods described in the manual data collection section. The main benefit is that time can be stopped and reviewed if necessary. Accuracy is much higher for these types of counts and the information may be used for other studies or information gathering.

Crew sizes of two to three are sufficient to deploy and recover most portable equipment. One person would be primarily responsible for watching and warning approaching traffic while the other person(s) installs the equipment.

Proper preparation procedures should be conducted in the office prior to leaving for the field. Figure 3 shows a list of items to be checked prior to conducting the automatic traffic count:

**Section 2.3 - Data Reduction and Analysis**

All data should be placed in a form suitable for analysis. A graphic summary of the data should also be provided. Many automatic data collection equipment may have data summary software included for formatting purposes. Summarize by providing totals and sub-totals as well as the following information:

- Average daily traffic
- Peak-hour factors
- Percent turns
- Percent trucks
- Peak-hour determination

Axle conversion can be done by taking a small sample of classification percentages and applying this information to the raw axle counts typically gathered by many counters. In most cases this is unnecessary. If a high volume of trucks is expected then this conversion should follow procedures described in the ITE guidelines included in this manual

**Figure 2 - Automatic Count Checklist (Typically 24-hour counts)**

Project:____________________________________________
Count Location:______________________________________
Date:______________________________________________
Time Start:__________________________________________

____ 1. All equipment should be checked for proper operation.
____ 2. Carry an ample supply of accessories such as clamps, nails, chains and locks.
____ 3. Identify collection in the office and then adjust as necessary in the field.
____ 4. Do not place sensors across parking lanes.
____ 5. Avoid placing sensors near sharp pavement edges or curves.
____ 6. Deploy sensors at right angles to traffic flow.
____ 7. For directional counts keep at least 1-foot of space from the centerline.
____ 8. Do not place sensors in transition areas.
____ 9. Fasten counting sensors securely to pavement with nails and clamps. Loose sensors will collect false data and provide a threat to the motorist.
____ 10. Avoid locations close to driveways or intersections where turning vehicles may cause inaccurate counts.
____ 11. Locate data recorder near signpost, utility pole or large tree so that it can be properly secured with a lock and chain to avoid theft of equipment and vandalism.
____ 12. Roll the extra tubing next to the counter. While it is advisable to have some extra tubing length, avoid having too much extra tubing that would reduce the pulse sent to the sensor. (over 25' extra is too much)
____ 13. Sketch count location including lanes, sensor layout, traffic flow, north arrow, etc.
____ 14. Use a test vehicle to insure bi-directional counters are counting properly.
____ 15. Note the beginning time of counting operation.
____ 16. Periodically check the counting equipment to insure proper operation especially during poor weather conditions.
____ 17. Deployment and recovery of traffic counting equipment should be made during periods of low volume and good visibility.
____ 18. Police assistance may be required to ensure the safety of the crew and driving public.
____ 19. Select areas with uniform speeds.

## SECTION 3 .- SPOT SPEED STUDIES

### Section 3.1 - Definitions

An understanding of the typical variables used when determining speed is necessary. The following list of terms are used most often for description of vehicle speed:

- **Speed** is the rate of movement of a vehicle in distance per unit time. (Typically mph)
- **Spot speed** is the instantaneous measure of speed at a specific location on a roadway.
- **Time-mean speed** is the arithmetic mean or average of several spot speed measurements. It is the sum of the measured spot mean speeds divided by the number of measurements.
- **Space-mean speed** is another type of average speed. It is the length of a segment divided by the mean travel time of several vehicles or trips over the segment.
- **Median spot speed** is the middle value in a series of spot speeds that have been ranked in order of magnitude.
- **Modal spot speed** is the value that occurs most frequently in a sample of spot speed measurements
- **ith percentile spot speed** is the value at or below which I percent of the spot speeds occur. For example the $85^{th}$ percentile speed is the speed at or below which 85% of the total observed values fall in a sample of measured spot speeds.
- **Pace** is the specified increment of spot speed, usually 10 mph, that includes the greatest number of speed measurements.
- **Standard Deviation** is a commonly used measure of the spread of individual speeds around the mean. It is the square root of the sum of squares of the deviations of the individual spot speeds from the mean divided by the number of measurements less one.

### Section 3.2 - Equipment and Personnel

Radar Meters are the most common device for determining vehicle speeds. These devices can be hand-held, mounted on a tripod or in a car. The device transmits a high frequency continuous beam of microwaves. The waves reflect off of the moving vehicle, and the change in the frequency is proportional to the change in the speed

With the readily availability of radar units this is the preferred collection method of speed data. However, several other methods may be used. Many automatic traffic counters can also collect speed along with volume data. A speed trap can be implemented utilizing video taping equipment or manually using multiple observers. The speed trap is created by measuring the time it takes a vehicle to pass between two points of a known distance apart. These methods is a low technology approach, but may be used if more accurate equipment isn't readily available.

**Section 3.3 - Safety**

As with any field collection of traffic data, care should be taken to protect the observer at all times. Workers should park their vehicles off the traveled way, wear reflective vests, and act in a manner that does not distract motorists or influence their driving behavior.

**Section 3.4 - Location, Time and Conditions of the Study**

Generally, this is a matter of common sense. Typically as required by the traffic analysis, speeds should be measured in good weather, daytime, free-flow speeds. If the intent of the study is to assess the impacts of any of these factors then a different day or time period may need to be chosen. For example if a study was requested to determine the impact of wet roads at night on vehicle speeds then time and location may need to be adjusted. Typically however optimum conditions are required.

**Section 3.5 - Vehicle Selection**

Vehicle selection can be tricky. Observers have a natural tendency to record those vehicles that stand out in some way, such as fast cars, slow cars, trucks, platoon leaders. In order to avoid this tendency, a procedure may be used selecting every 3rd, 4th or nth vehicle to record.

**Section 3.6 - Sample Size**

The number of observations required to make a statistically valid result can be calculated by one of the following formulas.

<u>Average speed formula</u>

$$\mathbf{N=(SK/E)^2}$$

N=Number of Measured Speeds
S=estimated sample standard deviation, mph
K=constant corresponding to the desired confidence level
E=permitted error in the average speed estimate, mph

85th Percentile Speed Formula

$$N=S^2K^2(2+U^2)/2E^2$$

U=constant corresponding to the desired percentile speed
N,S,K,E=same as above

Table 3 shows the number of samples required under the following assumptions of statistical accuracy:

- Standard deviation = 5 mph (can also be calculated based on collected data)
- Desired confidence level = 99%
- Acceptable confidence level = 95%
- Minimum confidence level = 90%
- Permitted error = 1 mph

**Table 3 - Number Of Samples Required For Statistical Accuracy**

| | Minimum | Acceptable | Desired |
|---|---|---|---|
| Average speed | 67 | 96 | 166 |
| 85th Percentile | 103 | 148 | 256 |

## Section 3.7 - Procedures

### *A. Radar Detection*

Record a location sketch of the site including the radar unit, number of lanes, and incidence angle. Observers should record the start time, end time, any non-operational time and prevailing conditions of the study. The manufacturer's recommendations for calibration of the radar detector unit should be at the beginning and end of the data collection.

Angle errors occur because the angle of incidence of the radar beam to travel direction of the target vehicle produces a reading on the unit that is less than the actual speed. Some radar units have built in correction for angle error based on preset angles of incidence. A radar unit is easily operated by one person.

If traffic is heavy or if the sampling strategy is complex, two observers may be needed, one to record the data and one to call out the readings. Positioning of the radar unit is determined by the following considerations:

- Capabilities of the radar unit
- Minimizing the angle of incidence
- Concealing the unit from the view of motorists

Keeping the angle less than 15-degrees will keep the error less than 2 mph. Concealment of the radar unit and operators will prevent motorist distraction and reaction. The equipment crew may be concealed by buildings or vegetation. Concealment will not reduce the reaction of drivers with radar detectors, since they typically slow down when warned by a detector.

### *B. Automatic Counters*

Many automatic counters manufactured today can collect speed information with the proper setup and calibration. Successful studies using automatic counters depend on reliability of the equipment used, the installation of the equipment, and calibration of the data. The equipment should always be maintained and installed using the manufacturers recommendations. If the counters or tubes become worn they can record false information. Follow the installation procedure described in the Section 2.0 on Volume Studies using automatic counter. Figure **3** is recommended as a check list for the collection of volume or speed data using automatic counters. As with any traffic count coordinate all activities with state or local traffic and law enforcement officials.

Equipment should be placed in a location of constant speed and avoid acceleration and deceleration areas near intersections or major driveways. Determining the vehicle mix and typical axle spacing may be critical to the setup of the equipment and should be determined prior to installation of the detectors.

## Section 3.8 - Data Reduction And Analysis

Typical spot speed study analysis is comprised of three parts. Data reduction is the first part and consists of the arrangement of the measured speeds into a convenient tabular form. The second part is to present the calculations of the descriptive statistics which represent the collection of the data. The most common variables include the mean, mode, median, standard deviation, pace and percentile. The third part is a typical analysis of statistical interference. This is a detailed review of the tendencies and distribution of the data. Appendix C of the Traffic Engineering Handbook has details on statistical tests and describes how to perform the necessary calculations.

# APPENDIX
To
# TRAFFIC DATA COLLECTION PROCEDURES:

# FORMS

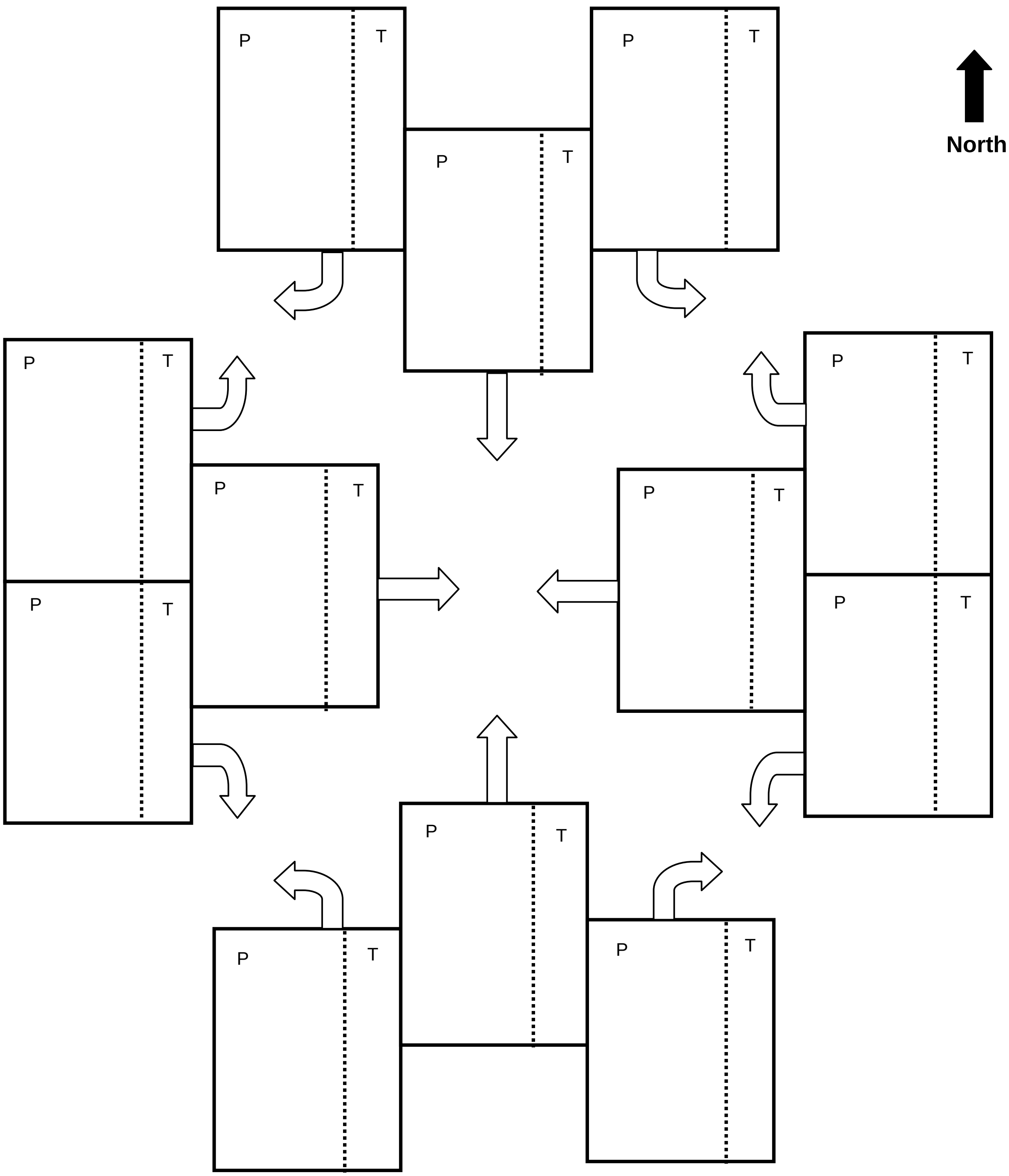
**FORM 2 – VEHICLE TURN MOVEMENT COUNT**
**City of Bowling Green, Kentucky**

# Vehicle Turn Movement Count
## Four-Approach Field Sheet

| | | | | | |
|---|---|---|---|---|---|
| | | Time | ________ | To | ________ |
| North/South Street | ______________________________ | Date | ________ | Day | ________ |
| East/West Street | ______________________________ | Weather | ________________ | | |
| | | Observer | ________________ | | |

P=Passenger cars, mini-vans, two axle trucks, motor cycles and station wagons

T = Trucks, multi-axle vehicle, city bus or school bus



**FORM 2 – VEHICLE TURN MOVEMENT COUNT**
**City of Bowling Green, Kentucky**

# TABULAR SUMMARY OF VEHICLE COUNTS

Observer: ______________________ Date: ____________________ Day: ____________ City: ____________________

R=Right Turn
S=Straight
L=Left Turn

Intersection of: __________________________________ AND ________________________________________

| Time Begins | from North | | | | from South | | | | TOTAL North/South | from East | | | | from West | | | | TOTAL East/West | TOTAL ALL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | S | L | TOTAL | R | S | L | TOTAL | | R | S | L | TOTAL | R | S | L | TOTAL | | |
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