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1.0 General

1.1 Intent

1.1.1 Maintenance Quality Standard

The requirements given in this Chapter supplement but do not replace all applicable previous memorandums and Maintenance Quality Standards issued.

1.1.2 Devices Covered

This Chapter covers the field (outdoor) maintenance of traffic signal actuation devices currently in use and approved by Toronto Transportation (TTD).

Currently approved devices include plain wire loops, wire loops with protective sleeving, microwave actuator and pushbuttons. Loop configurations include "dipole" and "quad" types in square, rectangular or irregular patterns. Other devices should not be installed without the permission of Toronto Transportation.

1.1.3 Standardization of Procedures

Due to widespread previous difficulties with loops, many maintenance personnel have developed their own techniques for repairs or replacement over the years. While many of these methods have been discussed and tested, the procedures given here have proven to be the most effective at this time and it is therefore in Toronto Transportation's interest to standardize the procedures to be used.

It is Toronto Transportation's intent that all Contractors install and maintain vehicle detection devices in the same manner and with the same care. Where failures are encountered, it is also mandatory to carry out some testing of components to determine the actual causes of failure and to replace only those elements that require replacement.

There are always exceptions to the rule; where non-standard conditions are encountered; Toronto Transportation must be contacted for direction.

1.2 Coordination

1.2.1 Electrical Standards

Toronto Transportation is committed to the use of the Electrical portion of the Toronto Transportation Department Standard Drawings (TTD) and the Electrical portion of the Toronto Transportation Department Specifications (TTS). Maintenance staff should be familiar with the applicable TTD drawings and with TTS 810.100 prior to undertaking maintenance related to this Chapter.

1.2.2 Electrical Design Recommendations

The Electrical Design Recommendations for Traffic Actuation Equipment may be used as a reference for the theory and calculation of the proper loop sizes and parameters. Since the detector cable length and number of turns of the loops may seriously affect the performance of a loop, it is not good enough to guess the requirements upon arriving in the field.

1.2.3 Toronto Transportation Services

This Chapter deals with some maintenance work not normally undertaken by electrical crews. This work includes routing and sealing of pavement cracks, all sawcut slots and major lane closures, etc. Close cooperation with other Toronto Transportation Sections may be required.

Toronto Transportation should be contacted if loop re-cuts are required in order to check whether or not any reconstruction is planned for the intersection.

2.0 Inspection

2.1 Maintenance

.1 Minor Maintenance

An inspection of the full detection system at each intersection should be carried out. It is desirable to perform this inspection in the spring, after all frost is out of the ground, so that the effects of the winter environment can be assessed.

The inspection should include the following:

- Cleaning and tightening of all traffic signal actuation equipment and cable terminals on the terminal board in the traffic signal cabinet.
- Inspection of slot sealant for deterioration, including encroachment of pavement cracks, sections missing, etc. These should be reported for sealing.
- Inspection of pavement in the area of loops for crack progression. Any cracks pointed towards, and within 1.2m (4') of loop slots, should be marked for routing and sealing and reported to Toronto Transportation.
- Observation of call registration by observing traffic crossing or stopping over the loops and the LED actuation on the Detector Sensor units.
- Registration from passage ("extension") loops by noting the LED registrations and that the controller extension times are called up.
- Registration from area presence loops by noting the LED registration and that all phases are called up.
- "False calls" due to crosstalk where a vehicle approaching normally in a lane activates the detector sensor unit in the adjacent lane and the loops are connected to

separate detector amplifiers. Note that it is not necessary to eliminate the crosstalk for adjacent lanes, which serve the same purpose.

- If detection calls not being placed then retune Detector Sensor units as per Section 2.2.. For Bike Detection make adjustments as per the Bike Detection Report guidelines.

- The mode settings for detector sensor units should be checked against the signal timing sheets kept in the cabinet. The settings for lock, delay filtering and extension should also be checked. Toronto Transportation will advise of any required settings, which are non-standard.

- Where crosstalk (two loops running at approximately the same frequency) is a problem, a 0.02 μF, 24V capacitor can be installed across the detector cable terminals. If this method is ineffective, a separate sensor unit should be installed.

- When it is not practical to repair or adjust components during a response to a trouble call, the component's failure should be reported to Toronto Transportation so that the repairs can be scheduled.

.2 Major Maintenance

- Replacement of defective detector loops or lead-in cables.

- Installation of additional detector loops or detector sensor units.

2.2 Adjustments of Detector Sensor Units

Tuning of Sensor Units

General

The detector sensor units are normally set to Sensitivity Level 3 (0.32%) during installation. While this setting suffices for most applications, instances of non-detection may occur due to drifting of the electrical characteristics of the loop system. Where loops are used for occupancy, volume counts, calculation of vehicle speed or length category (usually system loops), errors may be observed.

An effort should be made to tune the detector sensor units prior to undertaking any other repair procedure.

Procedure

(a) Alternate the High (FH) and Low (FL) frequency switch on each channel to help eliminate crosstalk experienced between the adjacent loops of one or more channels of one unit with those of another unit in the cabinet.

(b) Observe vehicle calls on the LEDs.

2.3 Roadway Aspects

2.3.1 Pavement Inspection

Pavement strength and condition plays a vital role in the life of wire loops. Pavement less than 75 mm (3") thick will generally lead to rapid loop deterioration. Old pavement with many visible cracks, will eventually produce cracks through the loop slot area and cause stone aggregate to cut the wire insulation and produce a short to ground.

Inspection of the pavement for cracks within 1.2 m (4') of a loop should be carried out. The expansion of the cracks can normally be arrested, for some time at least, by routing out the cracks with a power router and filling them with sealant.

Where the pavement is so bad that crack filling will be inadequate, there are several options available to replace the loops:

1. Install loop wires in 25 mm (1") conduit using LB fittings and installing the conduit at 100 mm (4") below the top of pavement.

2. Arrange for local repaving to an adequate standard and install new loops.

2.3.2 Roadways to be Reconstructed

The pavement area of the loops should be inspected prior to design of a new system. Where more minor work, such as local repaving (maintenance work projects) is planned, the inspection should be carried out in conjunction with Toronto Transportation. As a result of the inspection, it should be decided whether to replace the detection or try to maintain existing detection.

Where the pavement is badly rutted or rippled, or where excavation at loop lead wire areas is required, there is no point in attempting to maintain the loops in operation during construction. Where repaving requires only local partial pavement removal, for feathering in the new pavement, it is sometimes practical to wait and see if the construction will harm the loops as the standard installation should have at least 25 mm (1") of sealant cover over the wire.

3.0 Repair To Loops

3.1 Testing Detection System

.1 Inspect detector amplifiers for constant call.

.2 Remove detector amplifier with constant call present

.3 Confirm that detector amplifier settings correspond with the documentation for the specific location.

.4 Replace detector amplifier.

.5 If the constant call still persists, continue with the following sections.

3.2 Testing of Loops and Sensor Units

3.2.1 Testing Electrical Characteristics of Loops

If it has been determined that the loop system (sensor unit, detector cable, loop) has failed, the following steps are recommended for troubleshooting the problem:

1. Replace the detector sensor unit. If the problem is corrected, adjust the sensor unit as stated in sub-section 2.2.2(3)c. If the problem persists, leave the new detector sensor unit in place and proceed to step 2.

2. Check the detector cable by first disconnecting the cable from the loop at the input file terminals and at the splice point. Short the ends of the cables together in the controller cabinet. Check for continuity with an ohmmeter at the splice point. If this test is satisfactory, continue to step 3, otherwise replace the detector cable.

3. Check the wire loop cable for leakage to ground using a 600V megger. If this test is satisfactory, continue to step 5, otherwise replace the loop.

4. Check the wire loop cable or probe detector for continuity, at the splice point, with an ohmmeter. If this test is satisfactory, continue to step 5, otherwise replace the loop.

5. Check the loop inductance, using a Loop Inductance Meter. If the loop inductance reading is within 25% of the value indicated in Tables 2.1 to 2.3, of Section 4, continue to step 6, otherwise replace the loop.

6. Check the system resistance and capacitance using a digital ohmmeter and capacitance meter. The connection at the splice point should be remade, and the measurements taken at the controller cabinet. If the system (detector cable and loop wire) resistance is greater than 15 ohms or the system capacitance is greater than 0.1μF, replace the detector cable, otherwise go back to step 1.

3.2.2 Testing Electronic Characteristics of Sensor Units

There are several causes of detector sensor unit failures: lighting surges (destruction of the internal lightning arrestor or the optical coupling device) and humidity damage (printed circuit board corrosion, component damage)are the primary causes. The MOVs (Metal Oxide Varistors) on the input's should be replaced if required.

Field repair consists of replacement with a new or reconditioned unit, with the old unit being returned to the shop for bench repairs.

3.2.3 Testing Pedestrian Pushbutton

All pushbuttons should be checked to ensure proper operation.

.1 Remove all vehicle detector amplifiers, thereby eliminating the possibility of vehicles actuating the phase.

.2 Visually inspect all pushbuttons.

.3 Replace any pushbuttons which cannot be manually selected between contacts open - contacts closed.

.4 Replace all vehicle detector amplifiers.

3.3 Remaking Connections

3.3.1 Splicing of Detector Cable

Connections are one of the most important aspects of the loop detection system. Faulty connections account for a large majority of trouble calls; it is therefore necessary to make new connections with great care.

Connections of loop wire to the detector cable should be carefully twisted, soldered and insulated with an epoxy resin splice kit. The use of heat shrink tubing for this purpose will let dampness and dirt penetrate through the cavities present between the two loop wires and will not be satisfactory for long term service.

Connections of detector cable extensions should be done carefully using a butt-to-butt crimping sleeve, soldering the connection and insulating it with heat shrink tubing.

All connections should be made in an accessible "splice point". The preferred locations are above ground, in pole handwells, or in electrical chambers used for other purposes. Where installation in underground electrical manholes or handwells is required, the connections should be tied to the walls as far above the floor as practical (but at least 300 mm (12") below the cover) and out of the way of manhole steps. This requires the installation of concrete inserts and nylon cable ties.

3.3.2 Input Terminals

The input terminals cannot be tightened properly if the conductors are only wound around the terminal bolts. The detector cables require installation of an insulated, crimped and soldered forked-tongue connector.

4.0 Recutting Loops

4.1 Preliminary Work

4.1.1 Determining Loop Location

Loop location is probably the most important aspect of loop cutting. The selection of the location should be made with the following factors considered:

1. The new loop should not cross any obvious pavement patches, utility trenches, major cracks, etc., as settling will occur and the life of the loop will be short. If necessary, the loop can be split into two loops, covering the area required, and these can be connected in series at the splice point.

2. The new loop should not cross pavement cracks where these will be allowed to run unchecked. The sawcut slot has to be double-cut for both depth and width and a sleeve installed, if this is unavoidable.

3. The longitudinal and transverse locations of the loops should be within reasonable tolerance of the dimensions required. For clarification, refer to the Electrical Design Recommendations for Traffic Actuation Equipment.

4. The new loop should be laid out approximately 150 mm (6") from the old loop in order that the pavement is not seriously weakened. Note that if the recutting is the second or third replacement, it may be required to recut in the original slot. This is not desirable but may be necessary to meet other criteria.
5. The new loop should be located so that the sawcut slot will cut through the old loop in at least two locations, so that mutual inductance will not interfere with the operation. (If this is not practical, arrangements should be made to cut the old loop in any event.)

6. Where repaving will leave the top wire of a loop more than 100 mm (4") below finished pavement, the loop should be recut as the sensitivity of a loop below this depth is usually not satisfactory.

4.1.2 Checking Traffic Section Requirements

Since ideas change over the years, it is not advisable to simply recut a loop in exactly the same location, with the same coverage area. The latest standard treatment for loop sizes and coverage areas may be obtained from Toronto Transportation. New loops should be installed to these requirements.

4.1.3 Pavement Inspection

Pavement inspection is required prior to final loop layout. Refer to Sub-section 2.3.1.

4.1.4 Locating Old Loops

Old loops should be located prior to final loop layout, if practical. This can be accomplished by the use of installed permanent markers (such as a cut cross on a curb), by the use of tone detector or by simple visual inspection. Sawcutting in the old slot is not desirable since the copper from the old cables is chewed into small particles, creating a hazard to personnel.

4.1.5 Marking New Loop Locations

New loop locations should be marked on the pavement with paint, chalk or other degradable substances.

4.1.6 Scheduling

Since loop cutting requires several hours and can only be carried out during reasonably warm times of the year, scheduling is required. Scheduling should consider the use of lane closure equipment (where required), predicted weather (temperature above -5 C and rising; no precipitation, no heavy winds), local rush-hours, and availability of equipment, personnel and materials.

4.2 Equipment

4.2.1 Basic Equipment

A 10 mm (3/8") wide, 400 mm (16") diameter diamond-tipped sawblade, mounted on a sawing machine made for the purpose, is required for sawcutting loop slots. The sawing machine should have a water tank for continuous water wash of the slot and a boom for following a pilot wire nailed to the loop location.

An air compressor and suitable nozzle are required to clean the sawcut slots.

4.2.2 Optional Equipment

For large operations, the following equipment is highly useful.

- A wire twisting device is convenient.
- A pump and cart for hot poured sealant.
- A heater cart and heat lance.
- A compressor system for the sawing machine.

4.2.3 Personal Safety Equipment

Due to the dust and flying bits of debris produced by sawcutting, the use of the "dry cutting" method is prohibited except where additional approved personal protection is used and authorization of the Toronto Transportation supervisor has been obtained. Normally, all loops must be cut using water as a dust control agent.

Usual personal safety gear for the saw operator consists of heavy overalls, gloves and headgear with an approved respirator, visor and ear pads. Cutting old copper cable from existing loop slots may require additional protection due to the effects of small pieces of copper being dispersed by the saw blade.

4.3 Sawcutting

4.3.1 Saw Guides

Saw guides in the form of a steel wire suspended about 50 mm (2") above the pavement are suggested. The wire is normally held in place by nails in the pavement. A boom on the sawing machine follows the guides to produce an even, straight cut.

4.3.2 Dust Control

Winds and marginal equipment can produce a dust hazard for the saw operator, other workers, vehicle drivers and nearby residents or pedestrians. Dust control is mandatory.

4.3.3 Traffic Protection

Care should be taken to avoid damage to vehicles and occupants in lanes adjacent to loop cutting operations.

4.3.4 Slot Preparation

Sawcut slots should be carefully prepared to accept the loop wire as follows:

- The corners of the slot must be cut as indicated in the standards, to remove all sharp stone aggregates and to ease the turning radius for the wire.
- All debris should be cleaned out of the slot. This must be followed by cleaning with compressed air.
- If the temperature is below 10 degrees C or if the pavement is damp, it is advisable to blow out the sawcut with a heat lance. This operation helps to ensure that the loop sealant adheres to the walls of the slot and sets properly.

4.4 Connection of Ducts to Splice Points

4.4.1 Selection of Splice Points

Where existing splice points are not in accordance with the requirements of sub-section 3.2.1, selection of better splice points should be considered. In order of preference, the possible splice points are as follows:

- pole handholes
- existing junction boxes above ground
- existing electrical maintenance holes or handwells within 15 m (50') of the loops
- new electrical handwells installed in islands or beyond the shoulder

4.4.2 Installation of Ducts

Rigid ducts, 25 mm (1") diameter must be installed from the edge of traveled pavement to the splice point (or intermediate electrical chamber).

Where a curb and gutter exists at the edge of traveled pavement, a hole of 32 mm must be drilled at 45 degree angle through the curb. The duct is inserted under the curb and into the hole as shown on the standards. Similar methods may be used for paved shoulders. Gravel shoulders may be excavated to provide a minimum of 300 mm (12") trench depth. Efforts should be made to slope the ducts away from the pavement to prevent water accumulation.

4.5 Installation of Cables

4.5.1 Loop Wire Installation to Splice Point

The following sequence of installation is suggested:

1. Tie the loose end of the cable reel near the splice point, leaving about 3 m (10') of slack and marking this end with a few turns of electric tape.

2. Play out the cable from the reel and into the loop feeder slot. Proceed clockwise around the loop, pushing the cable into the slot with a blunt tool and carefully fitting the cable around corners.

3. Continue to the required number of turns (TTD 810.010) to the point where the feeder slot meets the loop slot.

4. Measure and cut the return leg of the cable, following the routing of the loop feeder slot and the ducts to the splice point and allowing more slack.

5. Starting at the point where the feeder slot meets the loop slot, twist the feeder cables together at about 3 turns per metre. Begin installing the twisted cables in the feeder slot, using care due to the right fit.

6. Complete twisting of the cables, wrapping them with electrical tape at convenient intervals.

7. Feed the cables into the duct at the edge of pavement and from there into the splice point. After trimming, re-mark the starting feeder cable (starting clockwise) with tape.

4.5.3 Detector Cables

Install extra-low voltage detector cables in accordance with the requirements of the standards and specifications.

At the splice point, connect the black insulated leg of the detector cable to the marked (clockwise) wire loop feeder and the white insulated leg to the return cable in accordance with the requirements of Sub-section 3.2.1.

4.6 Installation of Sealant

Only approved sealant is to be used. The normal practice includes use of "hot-poured" sealants only.

Sealants may only be applied successfully if the temperature is over -5 degrees C. Adherence to moist pavement is a problem which can be overcome by heating.

The loop sealant should be forced into the slot with care being taken to ensure that the cables do not float and are not forced to the surface. Best results are obtained when a bead of sealant is laid in the slot prior to laying the cable. The final sealant should fill up the slot in a minimum of 3 layers.

Electrical sealant compound should be installed in both ends of the 25 mm (1") duct to ensure that water does not accumulate.

4.7 Testing

4.7.1 Tests Before Sealing Slots

The loop continuity test, ground leakage test and inductance test, as described in Sub-section 3.2, must be carried out prior to sealing the sawcut slots. If any tests fail, remove the loop wire and restart the wire installation.

4.7.2 Tests Before Connecting Detector Cable

A continuity check of the detector cable should be made prior to connecting to the loop wires.

4.8 Selecting Number of Turns

Tables 2.1 and 2.2 list the commonly used loop sizes along with the recommended number of turns and the inductance. New loops should comply with these recommendations.

Table 2.1 Values for Common Dipole Loops

Lane Width (m)	Loop Width (m)	Loop Length (m)	No. of Turns	Inductance (μH)
3.0	1.80	9.0	3	205
3.2	2.00	9.0	3	209
3.5	2.30	9.0	3	213
3.6	2.40	9.0	3	216
	1.80 x 1.80 Diamond	n/a	4	120

Table 2.2Values for Common Quad Loops

Lane Width (m)	Loop Width (m)	Loop Length (m)	No. of Turns	Inductance (μH)
3.8	2.60	9.0	2-4-2	262
4.0	2.80	9.0	2-4-2	268
4.3	3.10	9.0	2-4-2	271
4.5	3.30	9.0	2-4-2	273

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