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16. Abstract Successful implementation of both the FHWA Traffic Monitoring Guide and the SHRP Long Term Pavement Performance traffic monitoring effort depended upon reliable, durable, and economically feasible axle sensors, and the creation of efficient, cost-effective, and technically sound procedures for installing the Automatic Vehicle Classification System. TTI successfully developed a procedure to install Automatic Vehicle Classification sites in the most cost-efficient and expeditious manner possible, while still meeting all of the criteria specified by Texas Department of Transportation. The total number of lanes installed since the inception of this study is 1999. The sites installed had two and more lanes, and are located throughout Texas.			
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INSTALLATION OF SITES FOR AUTOMATIC VEHICLE CLASSIFICATION

by

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and

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Research Report 1901-1F

Research Study No. 2-10-92-1901

Sponsored by:

Texas Department of Transportation

Texas Transportation Institute

The Texas A&M University System

College Station, Texas 77843

November 1992

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
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LENGTH

in	Inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km

AREA

in ²	square inches	645.2	centimetres squared	cm ²
ft ²	square feet	0.0929	metres squared	m ²
yd ²	square yards	0.836	metres squared	m ²
mi ²	square miles	2.59	kilometres squared	km ²
ac	acres	0.395	hectares	ha

MASS (weight)

oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

VOLUME

fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft ³	cubic feet	0.0328	metres cubed	m ³
yd ³	cubic yards	0.0765	metres cubed	m ³

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
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LENGTH

mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi

AREA

mm ²	millimetres squared	0.0016	square inches	in ²
m ²	metres squared	10.764	square feet	ft ²
km ²	kilometres squared	0.39	square miles	mi ²
ha	hectares (10 000 m ²)	2.53	acres	ac

MASS (weight)

g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T

VOLUME

mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m ³	metres cubed	35.315	cubic feet	ft ³
m ³	metres cubed	1.308	cubic yards	yd ³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

Successful implementation of both the FHWA Traffic Monitoring Guide and the SHRP Long Term Pavement Performance traffic monitoring effort depended upon reliable, durable, and economically feasible axle sensors, and the creation of efficient, cost-effective, and technically sound procedures for installing the Automatic Vehicle Classification System. TTI successfully developed a procedure to install Automatic Vehicle Classification sites in the most cost-efficient and expeditious manner possible, while still meeting all of the criteria specified by Texas Department of Transportation. The total number of lanes installed since the inception of this study is 1999. The sites installed had two and more lanes, and are located throughout Texas.

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DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

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INTRODUCTION

The Federal Highway Administration (FHWA) issued the Traffic Monitoring Guide (TM Guide) in 1985. The TM Guide, as well as the traffic data collection portion of the Long Term Pavement Performance (LTPP) monitoring effort within the Strategic Highway Research Program (SHRP), require the use of Automatic Vehicle Classification (AVC) for their implementation. The vehicle types specified in both the TM Guide and the SHRP LTPP traffic data requirements can only be identified using axle sensors. Axle sensors that were available prior to this project inception were either inappropriate or too costly to use for this application.

Current conventional traffic data collection practice includes only one proven axle detector technology - pneumatic tubes. Unfortunately, pneumatic tubes are inappropriate in many situations. For example, the electronic data collection equipment used with these devices must be located at the edge of the lane in which the pneumatic tubes are installed. Therefore, it is not feasible to use this type of detector at many multilane sites. In addition, pneumatic tubes are not durable under high speed and/or high volume conditions. They are also very conspicuous and subject to vandalism.

Several other axle sensor technologies are now available that could be used in either permanent or temporary modes in place of pneumatic tubes. These potential axle sensor technologies include both permanent and temporary devices that incorporate either piezoelectric (piezo) cable, piezo film, fiber optic cable, or triboelectric cable. These technologies were evaluated under Research Study 2038, entitled "Evaluation of Alternative Axle Sensor

Technologies" [1]. The study concluded that the successful implementation of both the FHWA Traffic Monitoring Guide and the SHRP Long Term Pavement Performance traffic monitoring effort depended upon reliable, durable, and economically feasible axle sensors, and that the success of this traffic monitoring effort relied on efficient, cost-effective, and technically sound procedures for installing these devices.

PURPOSE AND SCOPE

The overall objective of this contract was to produce well-defined installation and maintenance procedures and to deploy permanent axle sensors for use in AVC. The strategies and steps used to accomplish the production of a procedure and the installation of the sensors are shown below:

- prepare specifications for installation and acquisition of materials and contractor services;
- acquire contractor services for the installation of sensors;
- select sites in cooperation with the Texas Department of Transportation's (TxDOT) personnel;
- acquire traffic control plans from the contractor for the selected sites;
- locate and prepare sites prior to installation;
- install sensors and related hardware;
- test sensors;
- clean-up site.

SPECIFICATIONS FOR INSTALLATION, MATERIALS, AND SERVICES

TTI prepared an experimental design procedure that was used to determine the logistical and operational parameters characteristic to the installation of axle sensors. Various factors were considered in developing this experimental procedure. The factors included: the functional classification of possible site locations, whether the locations were rural or urban, traffic volumes at the location, and results of Research Study 2038, entitled "Evaluation of Alternative Axle Sensor Technologies." This study evaluated different types of axle sensor technologies using in-place testing. TTI also met with TxDOT's staff to discuss topics that could influence the experimental design and to ensure that all pertinent factors were considered in the development of the design procedure. The design procedure was then used to develop specifications for the acquisition of contractor services for the installation of AVC sites.

The specifications included materials and equipment to be used in the installation process. Materials specifications were developed using the results of Research Study 2038 and guidelines provided by TxDOT. AtoChem, the manufacturer of the piezo film axle sensor, also contributed information for determining reliable and cost-effective materials and methods for the installation of their sensors.

Contractor Services Acquisition

The Texas A&M University Purchasing Department acquired contractor services for the installation of the AVC sites. The contractor services were acquired for one year periods, so the following procedures were followed on an annual basis throughout the contract. A request for

competitive sealed bid proposals was developed using the previously determined specifications. The contractor was required to furnish all materials, labor, equipment, storage facilities, and supplies as required to initiate, facilitate, manage, and complete the AVC sites installation project on a timely and efficient basis. This included the required engineering, planning, coordination, traffic control, and supervisory services.

The Texas A&M University Purchasing Department pre-approved eight to ten contractors each year of the project, then contacted them to determine their interest in participating in the project. All of the pre-approved contractors had been utilized by TTI or TxDOT in the past for similar work. The proposals were evaluated and a contractor was selected.

Site Selection

There are various types of classification sites located throughout the State of Texas. TxDOT staff determined which of these sites would be selected for permanent axle sensor installation under the auspices of this project. The site selection process took into account both the needs of the installation design procedure and the site definitions provided in both the FHWA Traffic Monitoring and SHRP LTPP programs. One installation design procedure consideration used in site selection was that the site be relatively flat with little to no rutting or pavement wear, because the permanent piezo film axle sensor comes in a rigid aluminum channel. Both rural and urban locations were chosen for sites.

Traffic Control Plans

The contractor provided traffic control during AVC site installation, except for sites in heavily travelled urban areas or in other complex situations where a separate traffic control subcontractor was hired. The installation contractor was required to submit a site specific Traffic Control Plan (TCP) for every site installed. This required a trip to each site prior to installation to preview the site and prepare the TCP. The contractor's Professional Engineer was responsible for this effort. He was also responsible for submitting a set of typical traffic control drawings for two, four, six, eight and ten-lane sites. All TCP drawings were submitted to TxDOT for approval.

Site Preparation Prior to Installation

After site selection, each AVC site was marked by TxDOT personnel. On the day of installation, the contractor crew and the TTI inspector met at the site to be installed. The contractor crew chalk traced the pavement for loop, axle sensor, and lead-in wire and cable runs. The detailed procedure for chalk tracing the site included the following steps:

1. Trace the sensor channel and other cuts starting at the outside edge of the lane (right wheel path). Make sure channel is perpendicular to traffic.
2. Mark all saw cuts with a chalk line.
3. Mark the lead-in cable slot with a chalk line starting at the center of the channel end closest to the control box location and ending at the edge of pavement.

4. Spray all chalk lines with a clear coating (clear lacquer) to prevent chalk from being blown or washed away.

Sensor Installation

Specific installation procedures were followed for the installation of both piezo-film axle sensors (ROADTRAX Series P Traffic Sensors) and inductive loop detectors. These procedures are described in detail below.

Piezo-Film Axle Sensors

Each axle sensor consists of a one-inch square cross-section aluminum U-shaped channel that contains the piezo-film strip surrounded by an elastomer. The sensor is approximately six feet (75 inches) in length and comes with 100 feet of coaxial cable. The sensor is installed in the road with the top part (rubber) positioned 1/8 inch (plus or minus 1/16 inch) below the pavement surface in the right wheel path. In order to accomplish this, a channel is cut in the pavement using a "plunge saw" (ganged saw blades) to cut the slot. The measurements for the channel are 1.8 inches \pm 0.10 inches in width, 1.6 inches (minimum) in depth, and 77 inches in length. This channel must be perpendicular to traffic. Epoxy grout (the pourable mixture of resin plus hardener) is poured into the excavated sensor slot. The sensor is immediately pushed gently downward into the epoxy grout before curing begins, extruding the epoxy from each of the four sides. The excess epoxy grout is troweled to a smooth surface surrounding the sensor. Under no circumstances should the sensor be bent to conform to the pavement cross-section. No other material besides epoxy should be used to backfill the sensor slot. A slot is cut from the

end of the channel to the edge of the road for one lead-in cable. No more than one cable is placed in each slot. Adequate epoxy cure time must be observed before allowing traffic to pass over the installed sensor.

The following is a step-by-step description of the axle sensor installation procedure.

1. Trace the channel starting at the outside edge of the lane (right wheel path). Make sure channel is perpendicular to traffic.
2. Mark the channel with a chalk line to indicate the saw cuts.
3. Mark the lead-in cable slot with a chalk line starting at the center of the channel end closest to the control box location and ending at the edge of pavement.
4. Spray all chalk lines with a clear coating (clear lacquer) to prevent chalk from being blown away.
5. Make 1/4-inch width saw cuts such as inductance loops and sensor cable slot. The sensor cable slot must be cut prior to installing the sensor.
6. For the sensor channel, cut the pavement with a concrete "plunge saw" to a depth of 1.6 inches minimum and a width of 1.8 inches \pm 0.10 inches with the ganged saw blades. The cable slot will have been pre-cut to 1/4 inch wide and one inch deep.
THE SENSOR SLOT PROCEDURE SHALL NOT USE A JACK HAMMER.
7. Use air compressor to blow all dust, water, and debris from the channel.
8. The TTI Inspector records the sensor serial number and tests it using a rubber mallet before it is placed in the pavement slot. The sensor is supported along its full length, then struck twice with the rubber mallet. The resulting signal is then recorded on a strip chart recorder.

9. Following testing and approval by the TTI Inspector, the contractor covers the entire length of the sensor along the top with duct tape.
10. Mix the epoxy¹ and hardener until a uniform color is obtained and then pour into the prepared sensor channel. Position sensor in channel by applying downward force to sink the sensor into the poured epoxy grout. The sensor is to be positioned 1/8 inch (\pm 1/16 inch) below the road surface in the right wheel path. The sensor should not rest on the bottom or the sides of the channel. An aluminum jig may be used to maintain this position as desired. Smooth the epoxy using a trowel, and discard any excess epoxy.
11. Place cable into pre-cut slot and seat with a blunt tool, then seal with 3M loop sealant.²
12. When epoxy has hardened, the duct tape is removed and (optional) jig tabs are broken off.
13. Add three or more layers of scale tape (e.g. Polyguard) to build up sensor to match pavement level. Each strip of tape is two inches wide, except the final (top) layer which is four inches wide.
14. When lane is reopened to traffic, the TTI Inspector uses a strip chart recorder to test the sensor. One contractor truck pulling a trailer should be made available for driving across the sensor.

¹ E-Bond Epoxies, Inc. P.O. Box 23069, 501 NE 33rd St., Fort Lauderdale, FL 33307

² Consolidated Traffic Controls, Inc., P.O. Box 3461, Arlington, TX 76010-3461

Inductive Loop Detectors

The following is a step-by-step description of the inductive loop detectors installation procedure.

1. Wire colors by lane are: Lane 1: brown; Lane 2: red; Lane 3: orange; Lane 4: yellow. Upstream (entry) loops use solid colors and downstream (exit) loops use a white stripe with the same colors stated above. For example, the lane 1 entry loop uses a solid brown, and the exit loop uses a brown/white stripe.
2. Loop dimensions should be 6 feet by 8 feet with the 8-foot dimension being parallel to the centerline of the roadway. The loops should be centered in the lane with a minimum distance of 5 feet between adjacent loops. For narrow roadways where the 5-foot minimum cannot be maintained when the loop is centered in the lane, the 6-foot width should be reduced.
3. Lateral tolerances for saw cuts on the loops should be a maximum of $\pm 1/2$ inch from the center of the chalk line. The TTI Inspector will inspect the chalk lines and saw cuts to insure adherence to these tolerances.
4. Each saw cut should be a minimum of one inch in depth to insure adequate cover over loop wires by 3M loop sealant. Wires should be pushed downward (seated) with a blunt object so as to keep them in the bottom of the cuts.
5. Begin marking and cutting lanes farthest from the cabinet. For a two-lane roadway, begin in lane 2. Make all saw cuts, run all wires within that lane, and seal all cuts before moving on to lane 1. The process is similar for a four-lane roadway which uses two cabinets -- begin with lane 2. For a four-lane roadway with only one

cabinet, do lanes 3 and 4 simultaneously, then do lanes 1 and 2 simultaneously.

6. Procedure for installing wire in each loop: for each lane, begin 15 feet beyond the cabinet (point X on Figure 1 of Appendix section #P0991/02) rolling wire off the spool. As one person walks along the saw cuts with the spool, another follows behind to secure the wires in the cuts. This following person carefully seats each wire in the cuts using a blunt object so as not to cut the insulation on the wiring. From point X, proceed to point Y, then A to B to C to D and back to A in that order. This forms one complete counterclockwise turn of wire. Complete two more turns, returning then to point Y and to point X. Repeat the process for other loops.
7. Seal each loop with 3M loop sealant. Hold a slight downward pressure against the wires in the loops by the tube nozzle as sealant is applied, encapsulating the wires. Fill the saw cuts completely so that sealant is flush with (but not above) the roadway surface. Smooth top surface of sealant.
8. Once all wires from all loops and piezoelectric sensors have been installed and sealed, they should be cut to the same length and taped together for pulling through the conduit to the cabinet. After all wires have been pulled into the cabinet, they should be cut so as to allow a minimum of 4 feet extending into the cabinet.
9. At the edge of the roadway, saw cuts should be deep enough so that all wiring has a minimum of one inch cover for protection. The TTI Inspector judges the adequacy of this depth. Once wires are pulled through the conduit, a polyurethane foam plug and loop sealant are applied at the interface between the pavement edge and end of the conduit to encapsulate the wires and waterproof this area as much as possible.

Cabinet Installation

The specification for the detector (control) cabinet installation provides details on both the trenchment scheme and the concrete foundation. The detailed process of installation is described as follows:

1. All cabinet foundations are located by one of the following criteria:
 - a. installed as marked by TxDOT stake near right-of-way (ROW), or
 - b. if not marked, at 30 feet from travel lane to nearest edge of slab, or
 - c. as far as possible from edge of roadway but not outside ROW, or
 - d. in some special circumstances, as approved by TTI Inspector who has contacted the local TxDOT District office for approval. Such change should be recorded as a Field Change that is initialed by both the TTI Inspector and the Contractor's Foreman.
2. Pouring of foundations should be done immediately upon arrival at each job site to allow time for the concrete to cure while the remainder of the work at the site is being completed. All concrete require a cure time of a minimum of 24 hours before installing the cabinet. This cure time will be longer when the ambient temperature drops below 50° Fahrenheit (F) at night.
3. All concrete slabs should be poured using standard sacked cement containing pea gravel to one-inch size rock combined with sand and portland cement to attain 3,000 psi test in 28 days.
4. Reinforcing steel of 3/8 inch diameter is placed in the wet cement, so as not to touch

the ground.

5. The trench should be dug its entire length to minimum dimensions of 6 inches wide by 18 inches deep.
6. All conduit should be two-inch diameter schedule 40 (gray) PVC pipe. Pipe may have either preformed joint end or straight end. If straight, pipe connectors are used. All connections should be glued with PVC cement.
7. The conduit proximal to the road is sealed with a polyurethane foam plug and loop sealant. The conduit distal end penetrates the slab using a PVC cemented long radius "ell" and terminated such that the terminal pipe rests 4 inches above the finished slab surface.
8. The location of the concrete slab, the ground excavation for the slab, and the slab form placement are verified by the TTI Inspector. The front of the slab will be located at the position of the TxDOT stake or as indicated by the TTI Inspector.
9. The slab should generally be positioned so that the back of the cabinet is facing toward the roadway with the two-foot dimension of the slab parallel with the roadway. In no case should the foundation be built partially or completely on earth fill without the approval of the TTI Inspector. Placing the foundation on a slope requires excavation of the high side so that the opposite side of the foundation is at existing/natural ground level. Whether on flat or sloping terrain, the 4 inch by 4 inch beam (footer) along the bottom of the foundation should be below the existing ground level around its entire perimeter. A 2-inch by 4-inch timber form is laid out so that the 4-inch (nominal) dimension is vertical, forming a slab of this thickness

above the excavated flat ground and will measure two feet by three feet in the horizontal plane. The excavation should be flat from front to back and side to side. The beam will extend below the bottom of the slab level four inches to provide stability.

10. The anchor bolt weldment and 3/8 inch reinforcing steel will be installed. The bolt-weldment is positioned such that it will be seven inches behind the front edge of the form and centered from side to side within the form. The weldment is elevated to provide 2 1/2 inches of threads above the finished concrete slab. The bolt threads should be protected with duct tape during pouring of cement.
11. The quantity of cement should be 4 to 5 bags per slab. The two-inch by four-inch forms are filled to the top, finished smooth, and allowed to remain undisturbed for 10 to 15 minutes, then curb troweled.
12. Mix the water to form cement in the proportions provided for by the manufacturer, usually printed on the bag. This water/cement ratio is usually four quarts of water per bag of cement. Only the TTI Inspector can approve additional water, and he will stipulate how much additional water will be allowed in one-quart increments. If too much water is added for a given amount of cement, add more bag mix to attain the correct consistency. Do not pour off water from the top of the cement-water mixture. More cement must be added to correct the consistency.
13. The TTI Inspector inspects the slab and approves the installation of the cabinet when sufficient concrete cure time has elapsed. Begin installation of cabinet components. Bolt the aluminum base to the slab. Insert the threaded end of the pipe into the base

and tighten until snug. Bolt the collar to the bottom of the cabinet. Install the cabinet with collar assembly onto the pipe, making sure it is aligned with the roadway and that it is level. Tighten set bolts to the pipe to secure the cabinet in this position.

Sensor Testing

Prior to installation the axle sensors were tested with an oscilloscope and a capacitance meter. After the installation was completed, the axle sensors were tested to ensure that they were not damaged during the installation process. The Inductive loop wire was similarly tested for continuity using an ohmmeter or a continuity tester.

Site Clean-up

After completion of the installation and prior to the contractor's crew departing each site, the crew removed all accumulation of waste materials and rubbish caused by the work under this contract. The TTI Inspector ensured that each site was left in a clean and neat condition.

RESULTS

Specifications and installation procedures were developed to install and verify AVC systems at various sites throughout the State of Texas. A critical path method was used to determine the time-optimal sequence of tasks needed to be accomplished. This method was used to minimize both the installation time and possible delays caused by lane closure during the installation process. Once the specifications, installation procedures, and pre-designated sites were determined, a site installation schedule was established.

Site Installation Schedule

The site installation schedule was based on environmental conditions. The epoxy used during sensor installation is a self leveling epoxy grout, which has a pourable consistency when the product temperature is 70° F or higher. Lower temperatures thicken the product substantially resulting in much slower cure and set times. Longer required cure and set times dictate longer lane closure times. This temperature dictated time requirement was significant. For example, when the ambient air temperatures fell below 70° F, the epoxy set time took as much as 2 hours. However, when the temperature was 80° F and above, the set and cure time was 30 minutes. Under the higher temperatures and normal conditions, it took 2 hours to install a 2-lane site. At lower temperatures, installations were still possible, but required a longer time period. When temperature was below 60° F a wooden box 7 feet (ft) x 1.5 ft x 1.5 ft equipped with 8 high-wattage bulbs was used to heat the pavement and decrease the epoxy setting time. Therefore,

it was preferable that a site be installed when the temperature is above 70° F, and the site installation schedule reflected this factor.

Repairs

After the first set of sites were installed, some sites were reported to have malfunctions. Each site that was reported as not functioning was investigated to determine the cause of malfunction. After investigation, all of the sites that were reported as malfunctioning fell into three categories: damage to axle sensors, damage to cabinets, and axle sensor failure. Each of these malfunctions is discussed below in detail.

Damage to axle sensors

When the first set of sites were installed, axle sensors were installed with 1/8 inch of polyurethane protruding. In the Panhandle and North Texas areas, it was discovered that snow plows had damaged some of these axle sensors during snow removal operations. To solve this problem the installation procedure was modified so that axle sensors are installed flush (or as flush as rutting allows) with the pavement surface.

Damage to cabinets

It was discovered that some cabinets were hit by mowers during mowing operation, or by vehicles that had lost control and left the traveled way. Damage to cabinets caused the loop wire and axle sensor cable to be severed at the base of the cabinet. Because splicing was not allowed within 60 feet of the edge of the road and cabinets were located about 30 feet from the edge of the road, these sites had to be reinstalled.

Axle sensor failure

It was also discovered that a few of the axle sensors had problems that were attributed to the manufacturing process.

- In some of the first axle sensors, the Polyurethane containing the piezo film element was not glued properly to the aluminum channel. This caused the breakage of the piezo film, and therefore the failure of the axle sensor.
- Water penetration caused a short-circuit in a few of the sensors. A new version of the sensor with better water-proofing was issued.
- After a new version of the sensor was manufactured and after few installations, it was discovered that some of the installed sensors were failing because the piezo film used to make them was too brittle. This caused either an intermittent short or open-circuit rendering the axle sensor inoperable.

TTI worked closely with Atochem, the manufacturer of the piezo film axle sensors, to remedy all problems that occurred during this process. All these problems were fixed and a final version of the sensor (called Rev. D) was manufactured by AtoChem. All subsequently installed sites have Rev. D axle sensors.

A table detailing the number and location by district of sites that were installed during the project is found below. The table also enumerates the number of sites in each district that required repair.

Number of Lanes Installed and Repaired

District	1988-1989		1989-1990		1990-1991		1991-1992		Total	
	New Lanes	Repair	New Lanes	Repair	New Lanes	Repair	New Lanes	Repair	New Lanes	Repair
1	12					3	30		42	3
2	42								42	
3	12						46		58	
4	29				69				98	
5	23				35	5	91		149	5
6	16					4	101		117	4
7	8				112	6			120	6
8	16						50		66	
9	16						69		85	
10	16				102	2			118	2
11	14		212	7					226	7
13	12				4	6			16	6
14	12								12	
15	42				80	17			122	17
16	12								12	
17	22		78			1			100	1
18	45				1	2			46	7
19							68		68	
20	6		179	2	38				223	2
21	14		108	7					122	7
23	8						52		60	
24	28						23		51	
25	16						30		46	
Annual Total	421		577	16	441	46	560		1999	62

CONCLUSIONS

A procedure was developed to successfully install Automatic Vehicle Classification sites in the most cost-efficient and expeditious manner possible, while still meeting all of the criteria specified by TxDOT. The total number of lanes installed since the inception of this study is 1999. The sites installed had two and more lanes, and are located throughout Texas.

REFERENCES

- [1] "Evaluation of Alternative Axle Sensor Technologies," Saïd Majdi and Wiley Cunagin. Research Report 2038-1F, Texas Transportation Institute, November 1988.

APPENDIX

Specifications for the Installation of Automatic Vehicle Classification Sites

ITEM NO.	DOCUMENT NAME / OR DESCRIPTION	PROCESS SPECIFICATION NO.	MATERIAL SPECIFICATION NO.	USED ON DOCUMENT	
				DOCUMENT NAME / DESCRIPTION	DOCUMENT NUMBER
PROCESS SPECIFICATIONS					
1.	INSTALLATION PROCEDURE "ROADTRAX" - SERIES P TRAFFIC SENSORS	P0991/01 Rev. A 2pp.	TMP-0991/AVCS-01 4pp.	MASTER SPECIFICATIONS LIST	MS0991/01 Rev. A
2.	INSTALLATION PROCEDURE INDUCTIVE LOOP DETECTORS	P0991/02 Rev. A 3pp.	TMP-0991/AVCS-03 TMP-0991/AVCS-04 TMP-0991/AVCS-05 TMP-0991/AVCS-06 TMP-0991/AVCS-07 TMP-0991/AVCS-08 TMP-0991/AVCS-09 TMP-0991/AVCS-10 TMP-0991/AVCS-11	MASTER SPECIFICATIONS LIST	MS0991/01 Rev. A
3.	TRAFFIC CONTROL INSTRUCTIONS AND PROCEDURES	P0991/03 Rev. A 4pp.	NOT APPLICABLE	MASTER SPECIFICATIONS LIST	MS0991/01 Rev. A
4.	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.	TMP-0991/AVCS-02	MASTER SPECIFICATIONS LIST	MS0991/01 Rev. A
5.	MIXING INSTRUCTIONS FOR FLEXANE LIQUID URETHANES (FLEXANE 80)	P0991/05 2pp.	TMP-0991/AVCS-010	MASTER SPECIFICATIONS LIST	MS0991/01
6.	MIXING INSTRUCTIONS FOR E-BOND EPOXY GROUT (G-10)	P0991/06 Rev. A 2pp.	TMP-0991/AVCS-05	MASTER SPECIFICATIONS LIST	MS0991/01 Rev. A
MATERIAL SPECIFICATIONS					
7.	PIEZOELECTRIC FILM AXLE SENSORS (KATOCHEN SENSORS, INC.)	See SPEC. @ RIGHT	TMP-0991/AVCS-01 4pp.	INSTALLATION PROCEDURE FOR "ROADTRAX" - SERIES P TRAFFIC SENSORS	P0991/01 Rev. A 2pp.
8.	DETECTOR (CONTROL) CABINET (SOUTHERN MANUFACTURING CO.)	See Spec. @ RIGHT	TMP-0991/AVCS-02 3pp.	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.
NOTE: ASSY. REQUIRES FOLLOWING ITEMS - *EXERCISE SOURCING OPTION					
8A.	CAST ALUM. BASE HOUSINGS	* PELCO #PB-5300	TMP-0991/AVCS-02	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.
8B.	SLIP FITTER HUBS	* PELCO #SE-3104	TMP-0991/AVCS-02	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.
8C.	ALUMINIUM MOUNTING POLES	* PELCO #PB-5100	TMP-0991/AVCS-02	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.
9.	3M DETECTOR LOOP SEALANT (CONSOLIDATED TRAFFIC CONTROLS INCORPORATED)	See SPEC. @ RIGHT	TMP-0991/AVCS-03 3pp.	INSTALLATION PROCEDURE FOR INDUCTIVE LOOP DETECTORS	P0991/02 Rev. A 3pp.
9A.	REFERENCE: MATERIAL SPEC.	3M-PRDT. DATA SHIT	-DLS		
		12pp.			
DWR.	<i>E. D. [Signature]</i>	9/17/91			
CKD.	<i>V. [Signature]</i>	9/17/91			
APPD.					
REV.	DATE	CHANGE OR ADDITION	CHG'D. BY		
A	5/1/92	Major Changes (See [Signature])	[Signature]		
SHEET 1 OF 2					
MS0991/01					
		Revision	A	MASTER SPECIFICATIONS LIST	
		5/1/92			

ITEM NO.	DOCUMENT NAME / OR DESCRIPTION	PROCESS SPECIFICATION NO.	MATERIAL SPECIFICATION NO.	USED ON DOCUMENT DOCUMENT NAME / DESCRIPTION	USED ON DOCUMENT DOCUMENT NUMBER
MATERIAL SPECIFICATIONS - CONTINUED FROM PAGE 1					
9B.	REFERENCE: MATERIAL SAFETY DATA SHEETS (MSDS)	3M-MSDS #07-53/798			
10.	LOOP WIRE FOR INDUCTIVE LOOP DETECTOR (BELDEN/COOPER INDUSTRIES) c/o STEBLING ELECTRONIC	See SPEC @ RIGHT	TMP-0991/AVCS-04 2pp	INSTALLATION PROCEDURE FOR INDUCTIVE LOOP DETECTORS	P0991/02 Rev. A 3pp.
11.	E-BOND EPOXY GROUT (G-100) (E-BOND EPOXIES, INC.)	See SPEC @ RIGHT	TMP-0991/AVCS-05 4pp.	INSTALLATION PROCEDURE FOR "ROADTRAX" SERIES P TRAFFIC SENSORS	P0991/01 Rev. A 2pp.
11A.	REFERENCE: MATERIAL SPECS.	E-BOND-PRDT. DATA SHEET. 5pp.			
11B.	REFERENCE: MATERIAL SAFETY DATA SHEETS (MSDS)	MSDS-COMPONENT A (RESIN) 3pp.			
11C.	REFERENCE: MATERIAL SAFETY DATA SHEETS (MSDS)	MSDS-COMPONENT B (HARDENER) 3pp.			
12.	PVC PIPE (CONDUIT) (CARLON, OR EQUIVALENT) c/o HARD ELECTRIC	See SPEC. @ RIGHT	TMP-0991/AVCS-06 4pp.	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.
13.	WEIGHT SCALE TAPE (POLYGUARD PRODUCTS, INC.)	See SPEC. @ RIGHT	TMP-0991/AVCS-07	INSTALLATION PROCEDURE FOR "ROADTRAX" SERIES P TRAFFIC SENSORS	P0991/01 Rev. A 2pp.
14.	READY-MIX CONCRETE (SAKRETE, OR EQUIVALENT) "AS AVAILABLE", IN THE FIELD	See SPEC. @ RIGHT	TMP-0991/AVCS-08 1p.	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.
15.	STEEL REINFORCEMENT BARS A.S.T.M. A-615, GRADES 40 & 60 "AS AVAILABLE", IN THE FIELD	See SPEC. @ RIGHT	TMP-0991/AVCS-09 2pp.	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.
16.	FLEXANE LIQUID URETHANE (FLEXANE 80) c/o BRIGGS-WEAVER	See SPEC. @ RIGHT	TMP-0991/AVCS-010	INSTALLATION PROCEDURE FOR "ROADTRAX" SERIES P TRAFFIC SENSORS	P0991/01 Rev. A 2pp.
16A.	REFERENCE: MATERIAL SPECS.	ITW/DEVCON-PRDT. DATA SHEET. pp.			
16B.	REFERENCE: MATERIAL SAFETY DATA SHEETS (MSDS)	MSDS-FLEXANE pp.			
17.	MATRIX WELDMENTS (ANCHOR BOLT ASSEMBLY) c/o ELECTRICAL & CONSTRUCTION PRODUCTS (ECP)	See SPEC. @ RIGHT	TMP-0991/AVCS-011	INSTALLATION PROCEDURE FOR DETECTOR (CONTROL) CABINET	P0991/04 Rev. A 4pp.

DWG.	<i>[Signature]</i>	9/17/91
CKD.	<i>[Signature]</i>	9/17/91
APPD.		
REV.	DATE	CHANGE OR ADDITION CHG'D. BY
A	5/1/92	Major Changes (See <i>[Signature]</i>)

PROCESS SPECIFICATION INSTALLATION PROCEDURE ROADTRAX SERIES P TRAFFIC SENSORS

Introduction

Each sensor consists of a one-inch square cross-section aluminum U-shaped channel that contains the piezo-film strip surrounded by an elastomer. The sensor is approximately six feet (75 inches) in length and comes with 100 feet of coaxial cable.

The sensor shall be installed in the road with the top part (rubber) positioned 1/8 inch (plus or minus 1/16 inch) below the pavement surface in the right wheel path. In order to accomplish this, a channel is cut in the pavement using a "plunge saw" (ganged saw blades) to cut the slot. The measurements for the channel are 1.85 inches \pm 0.10 inches in width, 1.625 inches (minimum) in depth, and 77 inches in length. This channel shall be perpendicular to traffic. Epoxy grout (the pourable mixture of resin plus hardener) is poured into the excavated sensor slot. The sensor is immediately pushed gently downward into the epoxy grout before curing begins, extruding the epoxy from each of the four sides. The excess epoxy grout is troweled to a smooth surface surrounding the sensor. The sensor shall not be bent to conform to the pavement cross-section. No other material besides epoxy shall be used to backfill the sensor slot. A slot is cut from the end of the channel to the edge of the road for one lead-in cable. No more than one cable shall be placed in each slot. Adequate epoxy cure time shall be observed before allowing traffic to pass over the installed sensor.

Installation Procedure

The following is a step-by-step description of the installation procedure.

1. Trace the channel starting at the outside edge of the lane (right wheel path). Make sure channel is perpendicular to traffic.
2. Mark the channel with a chalk line to indicate the saw cuts. See Figure 1.
3. Mark the lead-in cable slot with a chalk line starting at the center of the channel end closest to the control box location and ending at the edge of pavement.
4. Spray all chalk lines with a clear coating (clear lacquer) to prevent chalk from being blown away.
5. Make 1/4-inch width saw cuts such as inductance loops and sensor cable slot. The sensor cable slot must be cut prior to installing the sensor.
6. For the sensor channel, cut the pavement with a concrete "plunge saw" to a depth of 1.625 inches minimum and width 1.85 inches \pm 0.10 inches with the ganged saw blades. See Figure 2. The cable slot will have been pre-cut to 1/4 inch wide and one inch deep. See Figure 1. **THE SENSOR SLOT PROCEDURE SHALL NOT USE A JACK HAMMER.**
7. Use air compressor to blow all dust, water, and debris from the channel.

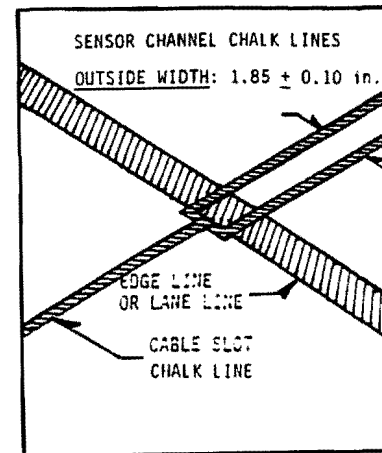


FIGURE 1

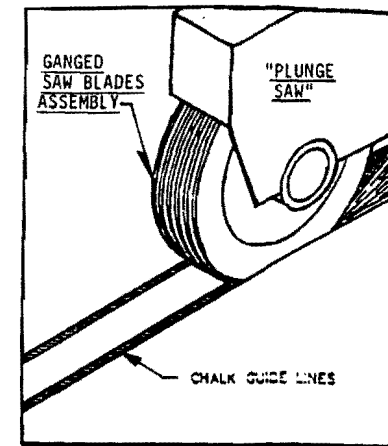


FIGURE 2

REV. A
5/1/92
E. J. HARRIS

PROCESS SPECIFICATION

#P0991/01

SHEET 1 of 2

**Installation
Procedure
for
Piezo-Film
Axle Sensors**

8. The TxDOT Inspector shall record the sensor serial number and test it using a rubber mallet before it is placed in the pavement slot. The sensor shall be supported along its full length, then struck twice with the rubber mallet. The resulting signal will be recorded on a strip chart recorder.
9. Following testing and approval by the TxDOT Inspector, the contractor shall cover the entire length of the sensor along the top with duct tape.
10. Mix the epoxy¹ and hardener until a uniform color is obtained and then pour into the prepared sensor channel. See Figure 3. Position sensor in channel by applying downward force to sink the sensor into the poured epoxy grout. The sensor shall be positioned 1/8 inch (\pm 1/16 inch) below the road surface in the right wheel path. The sensor shall not rest on the bottom or the sides of the channel. An aluminum jig may be used to maintain this position as desired. Smooth the epoxy using a trowel, and discard any excess epoxy. See Figure 4.
11. Place cable into pre-cut slot and seat with a blunt tool, then seal with loop sealant.² See Figure 5.
12. When epoxy has hardened, the duct tape is removed and (optional) jig tabs are broken off.
13. Add three or more layers of scale tape (e.g. Polyguard) to build up sensor to match pavement level. Each strip of tape is two inches wide except the final (top) layer which is four inches wide.
14. When lane is reopened to traffic, the TxDOT Inspector uses a strip chart recorder to test the sensor. One contractor truck pulling a trailer shall be made available for driving across the sensor.

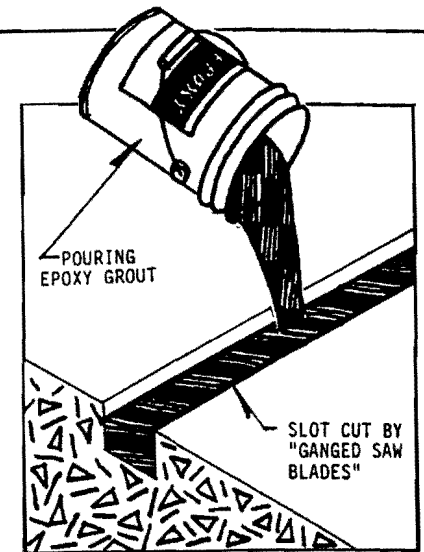


FIGURE 3

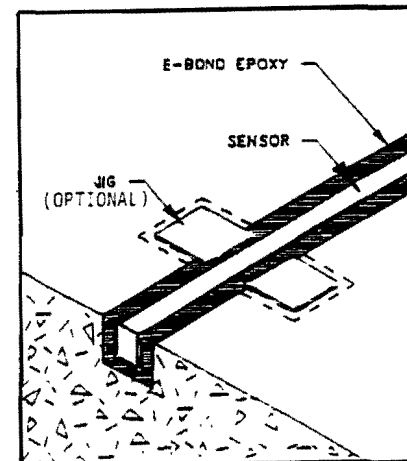


FIGURE 4

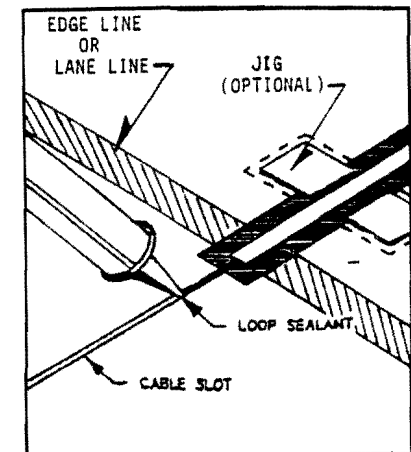


FIGURE 5

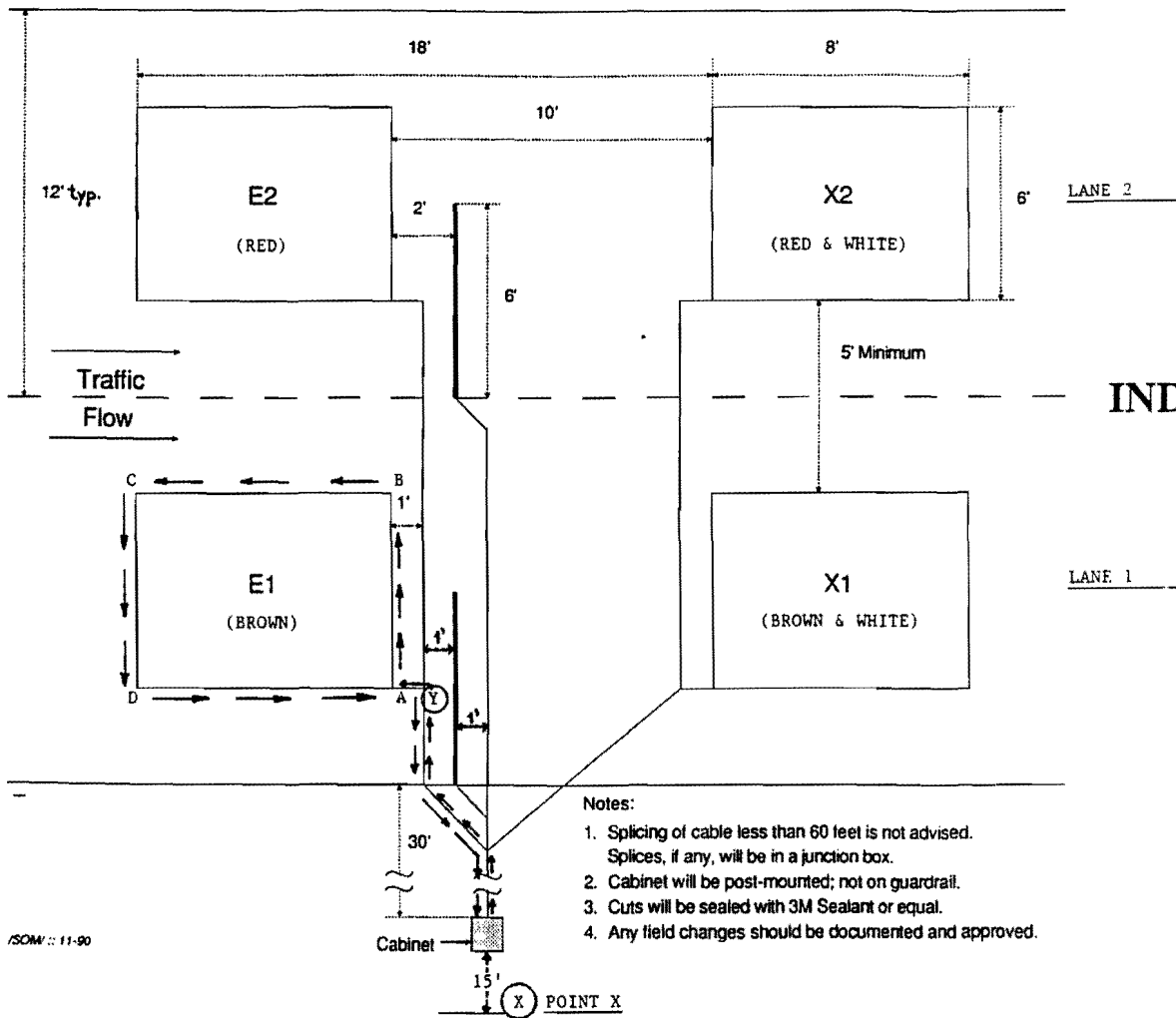
¹ E-Bond Epoxies, Inc. P.O. Box 23069, 501 NE 33rd St., Fort Lauderdale, FL 33307

² Consolidated Traffic Controls, Inc., P.O. Box 3461, Arlington, TX 76010-3461

PROCESS SPECIFICATION
INSTALLATION PROCEDURE
INDUCTIVE LOOP DETECTORS

1. Wire colors by lane are: Lane 1: brown; Lane 2: red; Lane 3: orange; Lane 4: yellow. Upstream (entry) loops use solid colors and downstream (exit) loops use a white stripe with the same colors stated above. For example, the lane 1 entry loop uses a solid brown and the exit loop uses a brown/white stripe.
2. Loop dimensions shall be 6-feet by 8-feet with the 8 foot dimension being parallel to the centerline of the roadway. The loops shall be centered in the lane with a minimum distance of 5 feet between adjacent loops. For narrow roadways where the 5-foot minimum cannot be maintained when the loop is centered in the lane, the 6-foot width shall be reduced.
3. The saw cuts for a two-lane and one side of a four-lane installation shall be as shown by Figures 1 and 2. Lateral tolerances for saw cuts on the loops shall be a maximum of $\pm 1/2$ inch from the center of the chalk line. The TxDOT inspector will inspect the chalk lines and saw cuts to insure adherence to these tolerances.
4. Each saw cut shall be a minimum of one inch in depth to insure adequate cover over loop wires by 3M loop sealant. Wires shall be pushed downward (seated) with a blunt object so as to keep them in the bottom of the cuts.
5. Begin marking and cutting lanes in the lane(s) farthest from the cabinet. For a two-lane roadway, begin in lane 2. Make all saw cuts, run all wires within that lane, and seal all cuts before moving on to lane 1. The process is similar for a four-lane roadway which uses two cabinets -- begin with lane 2. For a four-lane roadway with only one cabinet, do lanes 3 and 4 simultaneously, then do lanes 1 and 2 simultaneously.
6. Procedure for installing wire in each loop: for each lane, begin 15 feet beyond the cabinet (point X on Figure 1) rolling wire off the spool. As one person walks along the saw cuts with the spool, another follows behind to secure the wires in the cuts. This following person shall carefully seat each wire in the cuts using a blunt object so as not to cut the insulation on the wiring. From point X, proceed to point Y, then A to B to C to D and back to A in that order. This forms one complete counterclockwise turn of wire. Complete two more turns, returning then to point Y and to point X. Repeat the process for other loops at the appropriate time.
7. Seal each loop with 3M loop sealant. Hold a slight downward pressure against the wires in the loops by the tube nozzle as sealant is applied, encapsulating the wires. Fill the saw cuts completely so that sealant is flush with (but not above) the roadway surface. Smooth top surface of sealant.
8. Once all wires from all loops and piezoelectric sensors have been installed and sealed, they should be cut to the same length and taped together for pulling through the conduit to the cabinet. After all wires have been pulled into the cabinet, they should be cut so as to allow a minimum of 4 feet extending into the cabinet.
9. At the edge of the roadway, saw cuts shall be deep enough so that all wiring has a minimum of one inch cover for protection. The TxDOT inspector shall judge the adequacy of this depth. Once wires are pulled through the conduit, a polyurethane foam plug and loop sealant shall be applied at the interface between the pavement edge and end of the conduit to encapsulate the wires and waterproof this area as much as possible.

REV. A 5/1/92 S. J. [Signature]	PROCESS SPECIFICATION SHEET 1 of 3 #PO991/02
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INDUCTIVE LOOP INSTALLATION

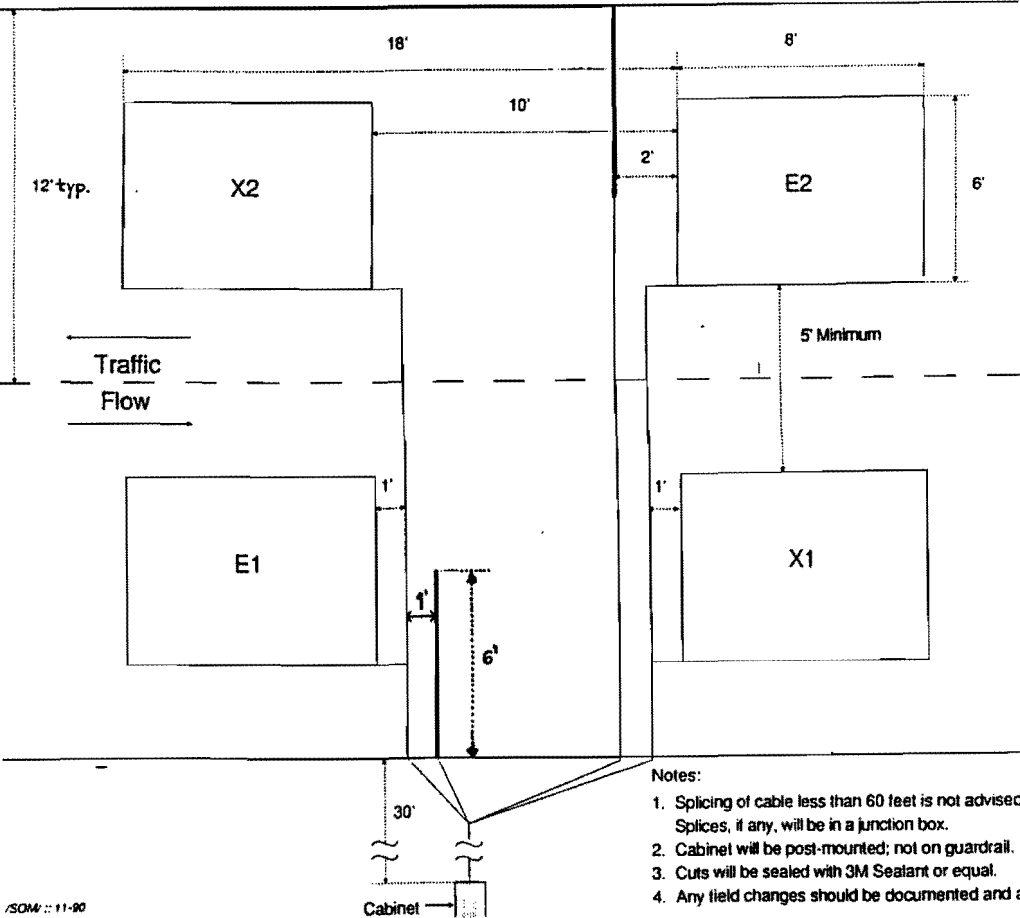
Notes:

1. Splicing of cable less than 60 feet is not advised. Splices, if any, will be in a junction box.
2. Cabinet will be post-mounted; not on guardrail.
3. Cuts will be sealed with 3M Sealant or equal.
4. Any field changes should be documented and approved.

ISOM 11-90

FIGURE 1

INDUCTIVE LOOP INSTALLATION



- Notes:
1. Splicing of cable less than 60 feet is not advised. Splices, if any, will be in a junction box.
 2. Cabinet will be post-mounted; not on guardrail.
 3. Cuts will be sealed with 3M Sealant or equal.
 4. Any field changes should be documented and approved.

SOM :: 11-90

FIGURE 2

REV. A	PROCESS SPECIFICATION
5/1/92	#PO991/02 SHEET 3 OF 3
C. Brown	

PROCESS SPECIFICATION

Traffic Control

1. Safety is the primary concern when working on the roadway. If either the TxDOT Inspector or the Contractor's Foreman feels that a situation is unduly hazardous, then the work shall cease until a suitable improvement is found.
2. The contractor shall provide traffic control devices which are in good working order and shall apply them in a manner which is consistent with the Texas Manual on Uniform Traffic Control Devices, (TMUTCD) appropriate Barricade and Construction Standards, or other documents appropriate to this work. If at any time traffic control devices become ineffective, they shall immediately be replaced or otherwise corrected as needed. This includes warning signs which are blown over by the wind or by trucks passing near them. If the Contractor's Foreman or any of his crew, or a traffic control contractor if one is employed, fail to correct a deficiency as soon as it is made known, the TxDOT Inspector shall shut the job down immediately and the irresponsible personnel shall be subject to termination.
3. Typical drawings for two and four-lane traffic control are attached from the Texas Manual on Uniform Traffic Control Devices. These are Figures 4, 5, and 6. **NOTE:** These are **examples only** and should not necessarily be construed as appropriate for direct application to a field situation. It is the responsibility of the contractor to instruct his field personnel regarding changes which occur in the TMUTCD. The Contractor's Foreman shall be qualified to design and install a complete traffic control plan based on both formal training and substantial field experience in installing traffic control.
4. No work shall be done on the roadway without proper traffic control. For this type work, 28-inch traffic cones, 48-inch by 48-inch black on orange warning signs, flaggers, arrow board(s), and other appropriate devices prescribed by the TMUTCD shall be provided. All contractor personnel shall wear an approved orange vest and orange baseball cap. The only exception to the orange cap is an approved (American National Standards Institute, ANSI Z89.1 Class A,B,C) hard hat. The vests and head gear shall be kept reasonably clean so as to maintain their color and appearance. Vests shall remain fastened at all times to provide the appropriate appearance and conspicuity. The contractor shall provide replacement safety gear to meet this requirement or as directed by TxDOT.
5. Lane closures shall generally begin by installing the first upstream warning sign and proceeding toward the downstream end of the project. The vehicle used to place traffic control devices on the roadway shall have an arrow board attached and flashing so as to be in full view of approaching motorists. The installation of traffic control is often the most hazardous aspect of a lane closure, so the contractor should use even greater precautions for protection of work force personnel and the motoring public.
6. The Contractor's Foreman and the person(s) he leaves in charge when he is away from the job site shall be both formally trained in traffic control and have demonstrated through field experience the capability of installing and maintaining adequate traffic control. The formal training requirement shall be met through successful completion of a short course such as "Safe Handling of Traffic in Construction and Maintenance Areas," taught by the Texas Engineering Extension Service. The contractor shall identify the person in charge of traffic control before beginning work. This person shall be responsible for insuring that flaggers are properly trained regarding flagging procedures contained in the TMUTCD.
7. For two-lane roadway installations and repairs, flaggers shall be in place on the roadway before the lane closure begins. One flagger shall be maintained on a continuous basis for each direction for the duration of the lane closures. Each flagger shall be relieved after a maximum of two hours.
8. All contractor vehicles shall be parked completely off the roadway or behind a proper lane closure. These vehicles shall all be parked on the same side of the roadway. Entry and exit from the traffic stream within the workzone shall be done with extreme caution.
9. The TxDOT Inspector and Contractor Foreman shall discuss any obvious deviations from the Contractor (P.E.)-provided traffic control plan/s and/or any/all obviously "unsafe" behaviors/practices and effect corrective action/s. TX DOT officials may intervene in specific situations to "stop the work" or "stop the (allegedly) improper procedure/practice" and may even "dictate the specific remedy".

TRAFFIC CONTROL INSTRUCTIONS and PROCEDURES

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5/1/92

PROCESS SPECIFICATION
#D0001/02 SHEET 1 of 4

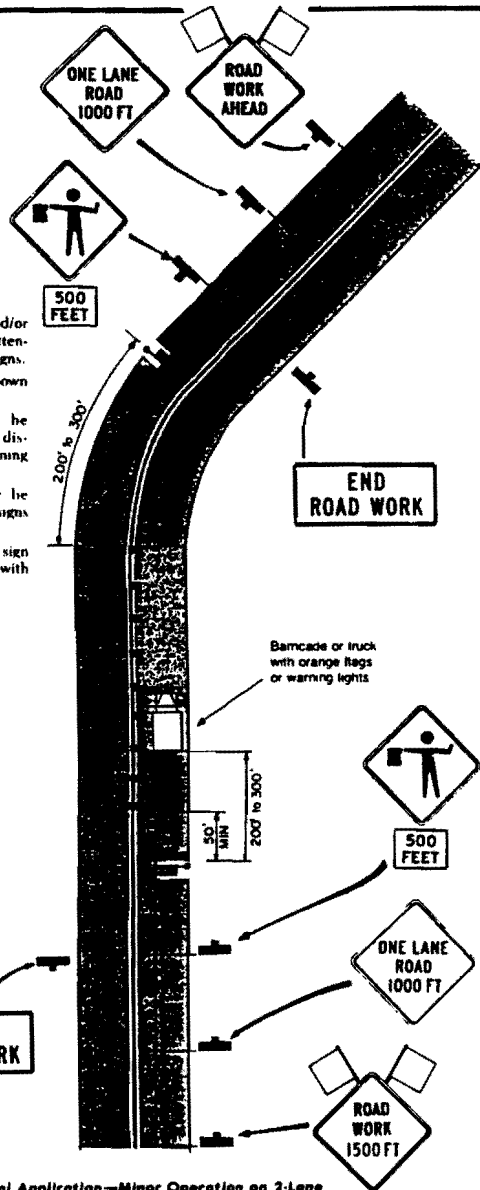
FIGURE 4

NOTES

1. Flashing warning lights and/or flags may be used to call attention to the advance warning signs.
2. All distances and spacings shown are approximate.
3. The word AHEAD may be substituted for the actual distances on the advance warning signs where applicable.
4. The word UTILITY may be substituted for ROAD in all signs where applicable.
5. Appropriate advisory speed sign may be used in conjunction with warning signs.

Posted Speed or 85% Speed (MPH)	X Min. Distance (feet)
30 or less	80
35	120
40	160
45	240
50	320
55	500

KEY:
 Flagger
 Channelizing devices



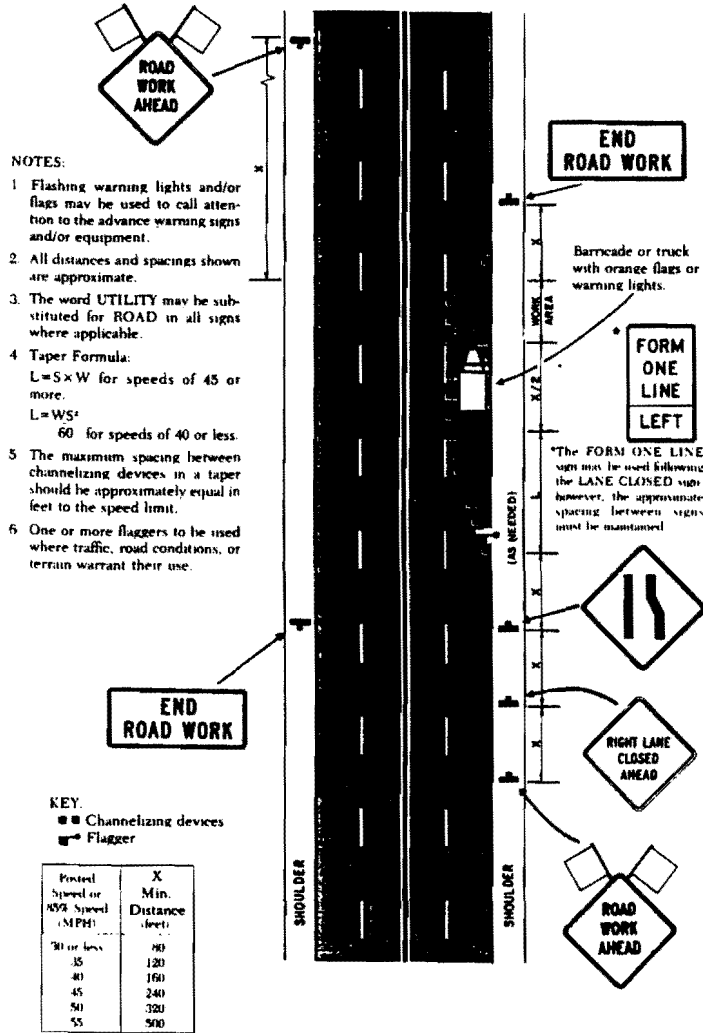
Typical Application—Minor Operation on 2-Lane Roadway Where One Lane is Closed and Flagging is Provided.

TRAFFIC CONTROL
 INSTRUCTIONS
 and PROCEDURES

SOURCE:
 TEXAS MANUAL ON UNIFORM
 TRAFFIC CONTROL DEVICES (TMUTCD)

REV. A	PROCESS SPECIFICATION
5/14/92	#P0991/03
	SHEET 2 of 4

FIGURE 6

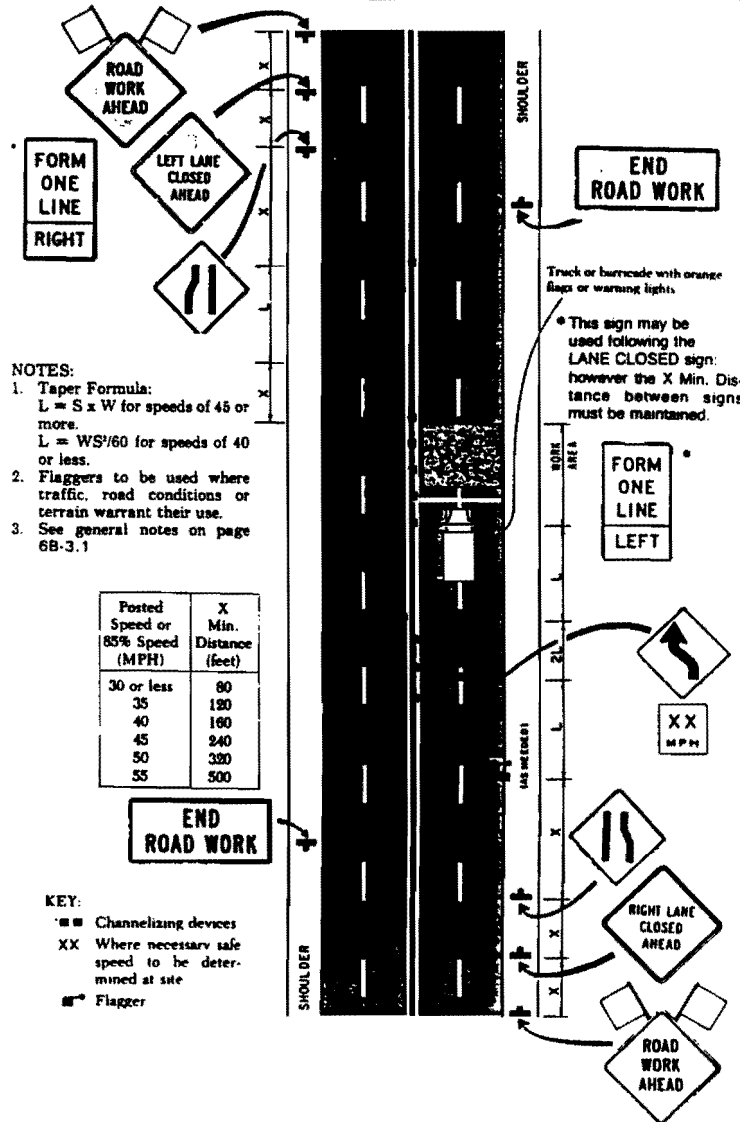


Typical Application—Minor Operation on Undivided 4-Lane Roadway Where One Lane is Closed.

TRAFFIC CONTROL
INSTRUCTIONS
and PROCEDURES

SOURCE:
TEXAS MANUAL ON UNIFORM
TRAFFIC CONTROL DEVICES (TMUTCD)

FIGURE 5



NOTES:

1. Taper Formula:
 $L = S \times W$ for speeds of 45 or more.
 $L = WS^2/60$ for speeds of 40 or less.
2. Flaggers to be used where traffic, road conditions or terrain warrant their use.
3. See general notes on page 6B-3.1

Posted Speed or 85% Speed (MPH)	X Min. Distance (feet)
30 or less	80
35	120
40	160
45	240
50	320
55	500

END ROAD WORK

KEY:

- Channelizing devices
- XX Where necessary safe speed to be determined at site
- ☒ Flagger

Typical Application Minor—Operation on 4-Lane Undivided Roadway Where Half the Roadway is Closed

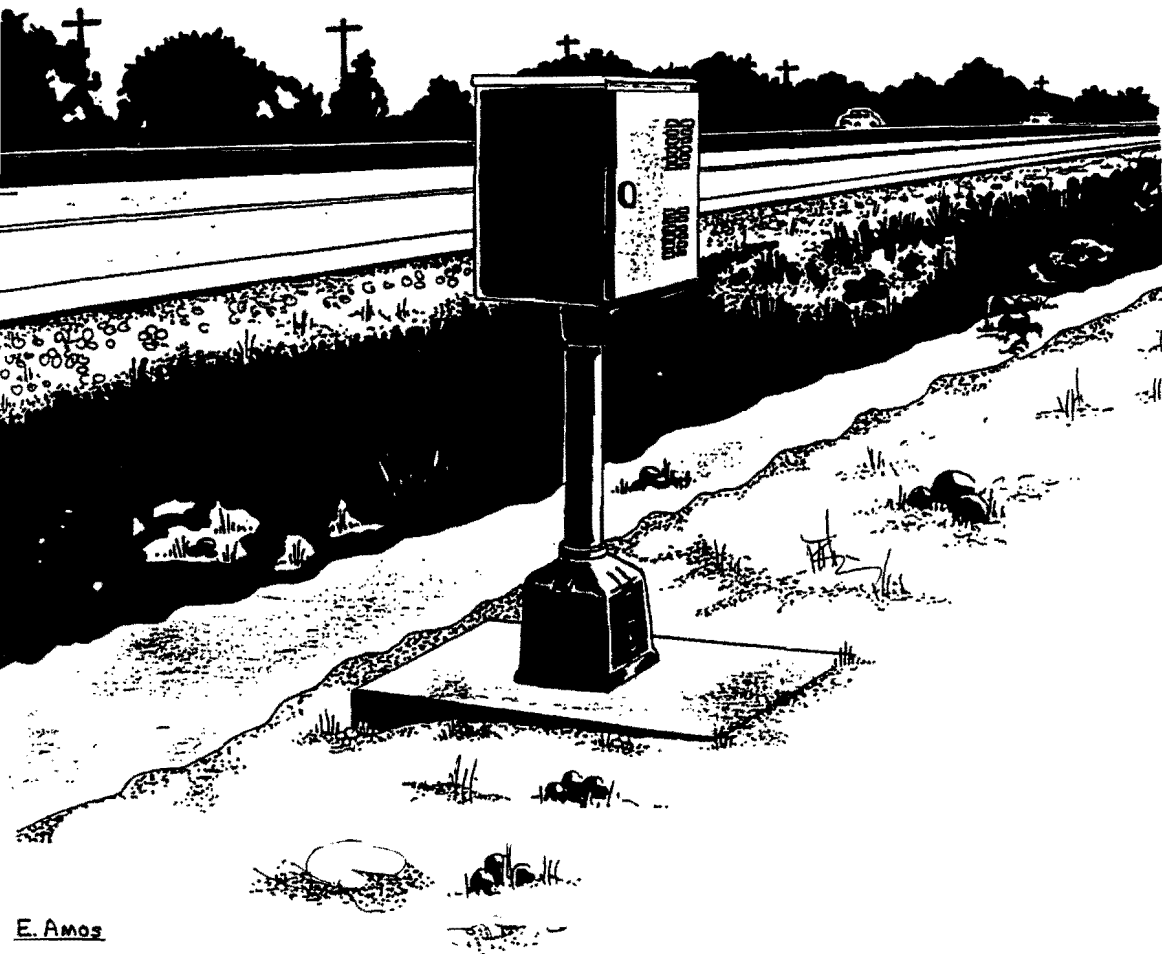
TRAFFIC CONTROL INSTRUCTIONS and PROCEDURES

SOURCE:

TEXAS MANUAL ON UNIFORM

TRAFFIC CONTROL DEVICES (TMUTCD)

REV. A	PROCESS SPECIFICATION
5/1/92	SHEET 3 of 4
CHANG	#P0991/03



PROCESS SPECIFICATION

INSTALLATION PROCEDURE

FOR

DETECTOR (CONTROL) CABINET

- ENTRENCHMENT SCHEME
- CONCRETE FOUNDATION

REV. A
5/1/92
C. Amos

PROCESS SPECIFICATION

#P0991/04

SHEET 1 of 4

PROCESS SPECIFICATION
INSTALLATION PROCEDURE
DETECTOR (CONTROL) CABINET

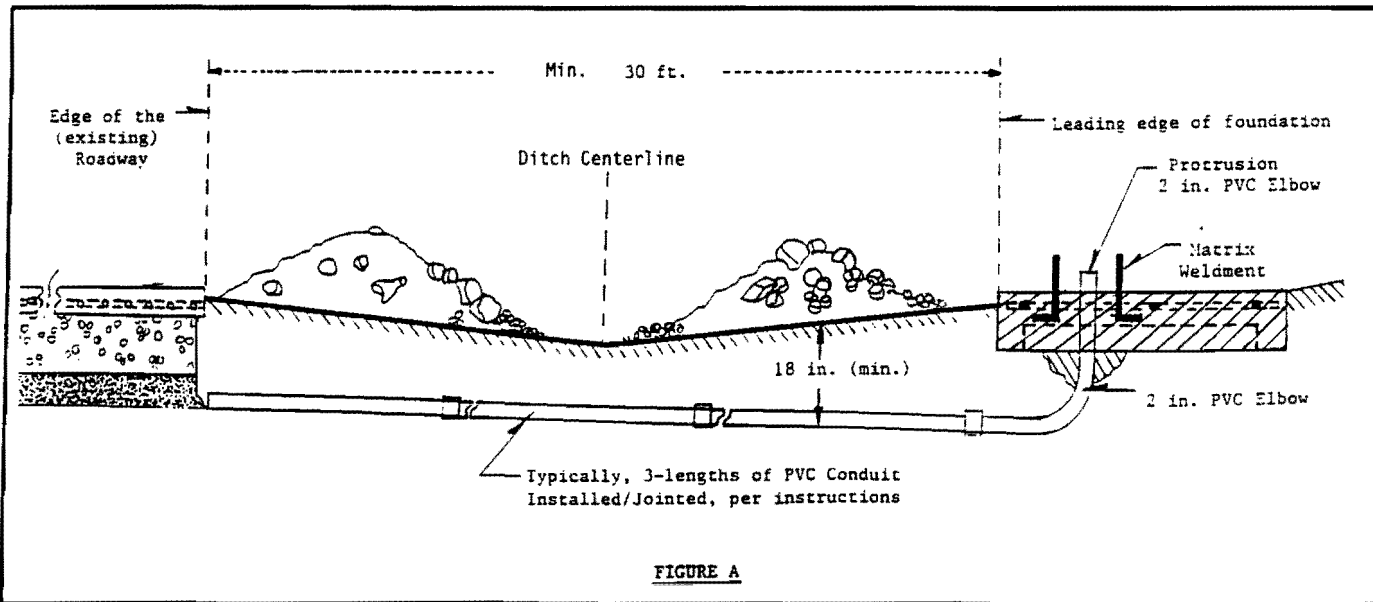
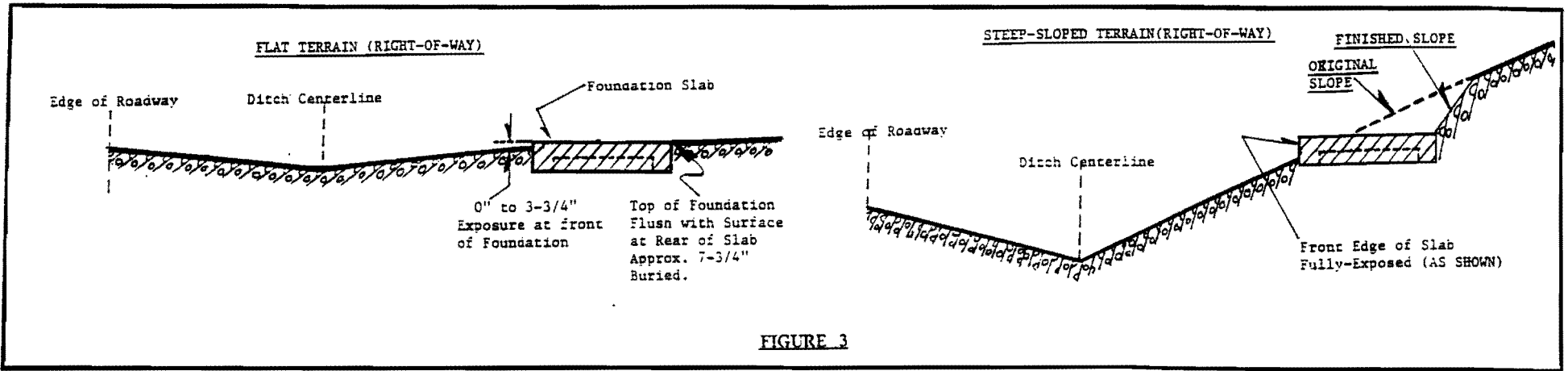
1. All cabinet foundations shall be located by one of the following criteria:
 - a) installed as marked by TxDOT stake near right-of-way (ROW), or
 - b) if not marked, at 30 feet from travel lane to nearest edge of slab, or
 - c) as far as possible from edge of roadway but not outside ROW, or
 - d) in some special circumstances, as approved by TxDOT Inspector who has contacted the local TxDOT District office for approval. Such change shall be recorded as a Field Change that is initiated by both TxDOT Inspector and the Contractor's Foreman.
2. Pouring of foundations shall be done immediately upon arrival at each job site to allow time for the concrete to cure while the remainder of the work at the site is being completed. All concrete shall cure for a minimum of 24 hours before installing the cabinet, and longer when the ambient temperature drops below 50 degrees F at night.
3. All concrete slabs shall be poured using standard sacked cement containing pea gravel to one-inch size rock combined with sand and portland cement to attain 3,000 psi test in 28 days.
4. Reinforcing steel shall be 3/8 inch diameter, placed in the wet cement so as not to touch the ground. Placement of the steel shall be according to Figures A and B.
5. The trench shall be dug its entire length to minimum dimensions of 6 inches wide by 18 inches deep as indicated in Figure A.
6. All conduit shall be two-inch diameter schedule 40 (gray) PVC pipe. Pipe may have either preformed joint end or straight end. If straight, pipe connectors shall be used. All connections shall be glued with PVC cement.
7. The conduit proximal to the road shall be sealed with a polyurethane foam plug and loop sealant. The conduit distal end shall penetrate the slab using a PVC cemented long radius "ell" and terminated such that the terminal pipe rests 4 inches above the finished slab surface.
8. The location of the concrete slab, the ground excavation for the slab, and the slab form placement shall be verified by the TxDOT Inspector. The front of the slab shall be located at the position of the TxDOT stake or as indicated by the TxDOT Inspector.
9. The slab shall generally be positioned so that the back of the cabinet is facing toward the roadway with the two-foot dimension of the slab parallel with the roadway. In no case shall the foundation be built partially or completely on earth fill without the approval of the TxDOT Inspector. Placing the foundation on a slope requires excavation of the high side so that the opposite side of the foundation is at existing/natural ground level. Whether on flat or sloping terrain, the 4 inch by 4 inch beam (footer) along the bottom of the foundation shall be below the existing ground level around its entire perimeter as shown in Figure 3. A 2-inch by 4-inch timber form shall be laid out so that the 4-inch (nominal) dimension is vertical, forming a slab of this thickness above the excavated flat ground and will measure two feet by three feet in the horizontal plane. The excavation shall be flat from front to back and side to side. The beam will extend below the bottom of the slab level four inches as shown in Figures A, B, and C to provide stability.
10. The anchor bolt weldment and 3/8 inch reinforcing steel shall be installed as shown in Figure B. The bolt weldment shall be positioned such that it will be seven inches behind the front edge of the form and centered from side to side within the form. The weldment shall be elevated to provide 2 1/2 inches of threads above the finished concrete slab. The bolt threads shall be protected with duct tape during pouring of cement.
11. The quantity of cement shall be 4 to 5 bags per slab. The two inch by four inch forms shall be filled to the top, finished smooth, and allowed to remain undisturbed for 10 to 15 minutes, then curb troweled.
12. The contractor shall mix the water to form cement in the proportions provided for by the manufacturer, usually printed on the bag. This water/cement ratio is usually four quarts of water per bag of cement. Only the TxDOT Inspector can approve additional water and he will stipulate how much additional water will be allowed in one-quart increments. If too much water is added for a given amount of cement, the contractor shall add more bag mix to attain the correct consistency. He shall not pour off water from the top of the cement-water mixture. More cement must be added to correct the consistency.
13. The TxDOT Inspector shall inspect the slab and approve the installation of the cabinet when sufficient concrete cure time has elapsed. Begin installation of cabinet components. Bolt the aluminum base to the slab. Insert the threaded end of the pipe into the base and tighten until snug. Bolt the collar to the bottom of the cabinet. Install the cabinet with collar assembly onto the pipe, making sure it is aligned with the roadway and that it is level. Tighten set bolts to the pipe to secure the cabinet in this position.

REV. A
5/1/92
<i>[Signature]</i>

PROCESS SPECIFICATION

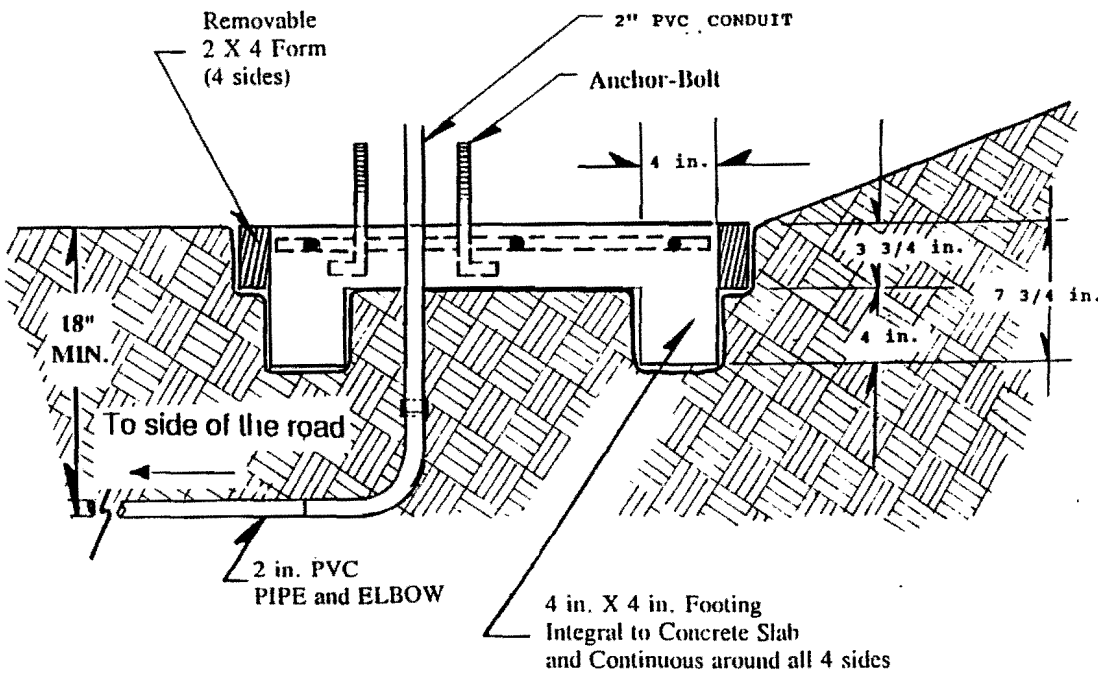
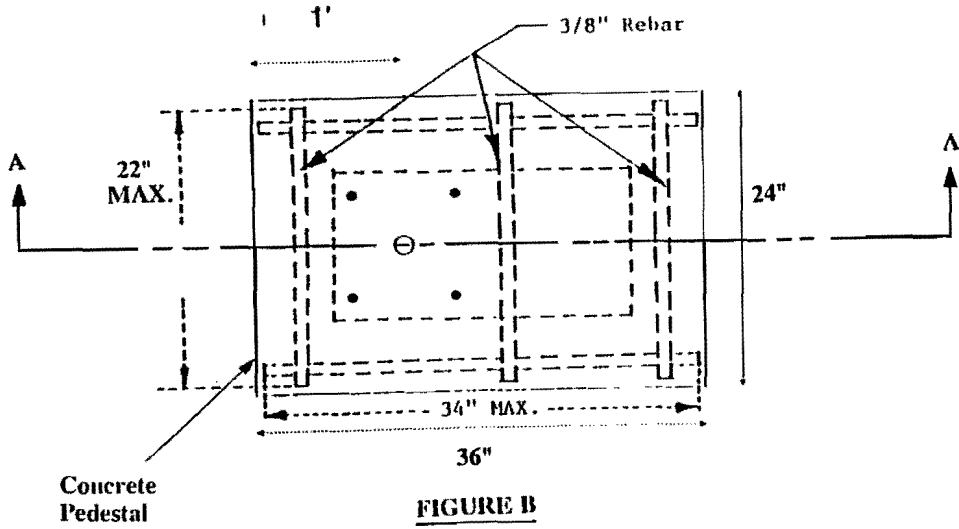
#P0991/04

SHEET 2 of 4



ILLUSTRATION

EXCAVATION/FORMING/REINFORCEMENT/AND POURING OF CONCRETE SLAB



SECTION A-A'

FIGURE C

ILLUSTRATION TO CLARIFY FOOTING DETAIL OF SLAB DESIGN

NOTE
 CONCRETE TO BE POURED AND MATRIX SET SUCH THAT IN FINAL SLAB FORMATION THERE SHALL BE NO EXPOSED STEEL AND NO STEEL IN CONTACT WITH THE GROUND.

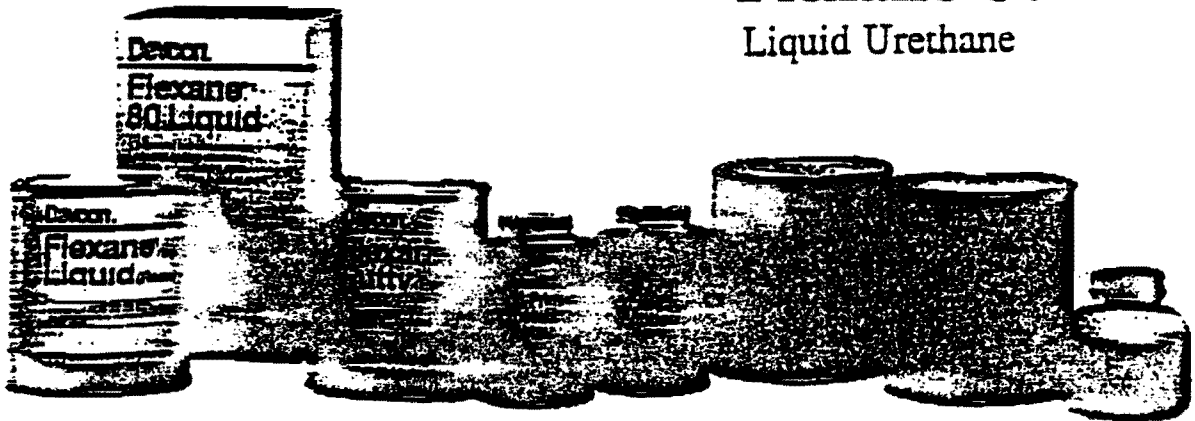
REV. A
 5/11/92
 ST/192
 #P0991/04
 PROCESS SPECIFICATION
 SHEET 4 OF 4

PROCESS SPECIFICATION

MIXING INSTRUCTIONS

FLEXANE LIQUID URATHANES

Flexane 80
Liquid Urethane



MIXING INSTRUCTIONS

Flexane

1. Pour liquid Flexane resin and curing agent into plastic mixing container provided in the shipping box. Stir the mixture vigorously for two minutes. Be sure to mix along bottom and sides of can.
2. Wipe spatula clean; mix again for two additional minutes. Flexane is now ready to use. Its cure time in moderate to high temperature ranges is 30 minutes (Flexane 80).
3. The sensor slot and pavement surface beside the sensor shall be clean, dry, and free of debris. Approximately 3.5 pounds of Flexane is required for each lane if the sensor is placed 1/8 inch below the pavement surface.
4. Upon sufficient curing of Flexane, cover with Polyguard, and the sensor is ready for traffic and testing with a strip chart recorder.

PROCESS SPECIFICATION

MIXING INSTRUCTIONS

E-BOND EPOXY



**PRODUCTS
OF CHEMISTRY
AND RESEARCH**

E-BOND EPOXIES, INC.

P.O. Box 23069 501 N.E. 33 rd. Street
Ft. Lauderdale, Fl. 33307

(305) 566-6555 FAX: 305-566-6663

REV. A	PROCESS SPECIFICATION
5/1/92	SHEET 1 of 2
<i>P. Hines</i>	#PO991/06 C-19/A

MIXING INSTRUCTIONS

E-Bond Epoxy

1. The pavement slot for the piezoelectric sensor shall be prepared using a "plunge saw" (ganged saw blade), cutting a slot which is 1.85 inches \pm 0.10 inches in width. The slot shall be cut to the proper dimensions, be reasonably dry (no standing water), and be completely free of loose debris.
2. Epoxy resin shall be prewarmed at least 30 minutes prior to time for its use. This can be done by placing full unopened cans inside the Sullair compressor hood next to the exhaust manifold.
3. Mix prewarmed resin making sure to keep mixing element deep in the resin to avoid introducing air into the resin.
4. Slowly add the contents of the premeasured curing agent container, being careful not to splash onto skin or into eyes. Contractor personnel who handle this mixture shall wear gloves.
5. Continue to mix for 2 to 3 minutes so as to increase the temperature of the mix and thus reduce the cure time. As the mix begins to thicken, the person doing the mixing must immediately prepare to pour the mix. Note: For mixing in higher ambient temperatures, less time is typically required while in colder temperatures more time might be required.
6. The resin and curing agent are shipped in premeasured quantities for purposes of mixing one can of curing agent per can of resin. Regardless of seasonal or other impacts on cure time, the contractor shall not add additional curing agent without prior approval from TTI.
7. Pour mixture into prepared sensor slot for immediate placement of sensor as described in Traffic Sensor Installation Procedure Specification PO991/01.

REV. A	PROCESS SPECIFICATION
5/1/92	SHEET 2 of 2
<i>[Signature]</i>	#PO991/06 C-20/A



PIEZOELECTRIC-FILM AXLE SENSORS

ROADTRAX SERIES P - "REVISION D"

RULE-OF-THUMB (USAGE):

**ONE SENSOR (INSTALLED) PER EACH LANE X
NUMBER OF LANES AT A GIVEN SITE.
TYPICALLY**

- 2 LANE SITE** - (2) SENSORS TO BE INSTALLED
- 4 LANE SITE** - (4) SENSORS TO BE INSTALLED
- 6 LANE SITE** - (6) SENSORS TO BE INSTALLED
- 8 LANE SITE** - (8) SENSORS TO BE INSTALLED

SOURCE:
ATOCHEM SENSORS INC.
P.O. BOX 789
VALLEY FORGE, PA 19482
PHONE (215) 666-3500
FAX (215) 666-3509

#TMP-0991/AVCS-01
SHEET 1 of 4

ROADTRAX SERIES P *DIMENSIONS

* TO BE ORDERED/SUPPLIED AS "REVISION D" PER PETER RADICE (ATOCHEM) 9/90

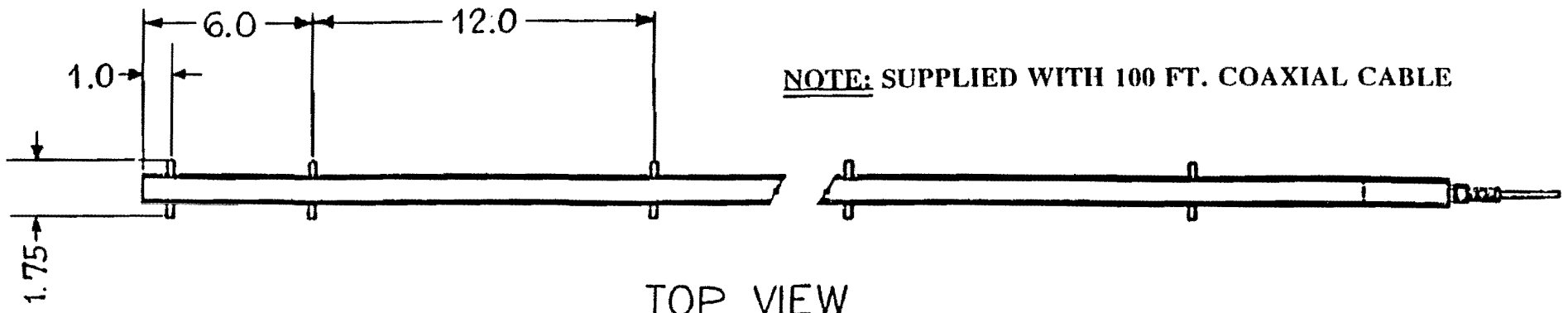
ROADTRAX SERIES P* - PRELIMINARY DATA SHEET (KYNAR PIEZO FILM BASED IN-THE-ROAD AXLE COUNTER)

Output Uniformity	± 25%
Output Level	See <u>Sheet 4 - Figure 1</u>
Operating Temperature Range	-40 to +80 °C
Temperature Sensitivity	0.5%/ °C Typical
Adjacent Lane Sensitivity	< 10% Full Scale
Corrosion Resistance	Excellent
Abrasion Resistance	< 90 (ASTM-D-1044 H-22 Wheel)
Hardness	60 Durometer (Shore A)
Cable	RG-58 C/U (MIL-C-17F)
Connector	None Typ: Call with Requirements
Hold Down Pin Material	ABS Plastic
Frame Material	Aluminum (6061)
Product Life	2 year minimum
Mounting Requirements	See <u>SHEET 4 - FIGURE 2</u>
Compression Limits (Installed)	500 psi
Dimensions	See <u>SHEET 3</u>

**ATOCHEM reserves the right to change these specifications at any time without notice.

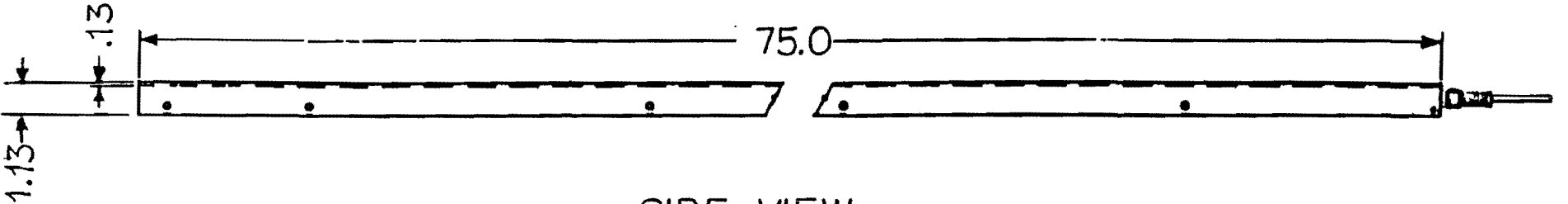
#TMP-0991/AVCS-01

SHEET 4 OF 4



TOP VIEW

NOTE:
ALL DIMENSIONS AS SHOWN ARE SPECIFIED IN INCHES



SIDE VIEW

ROADTRAX SERIES P* DIMENSIONS

TO BE ORDERED/SUPPLIED AS "REVISION D". PER PETER RADICE (ATOCHEM) 9/90.

#TMP-0991/AVCS-01
SHEET 3 OF 4

SERIES P TYPICAL OUTPUT SIGNAL

IN THE ROAD MEASUREMENTS

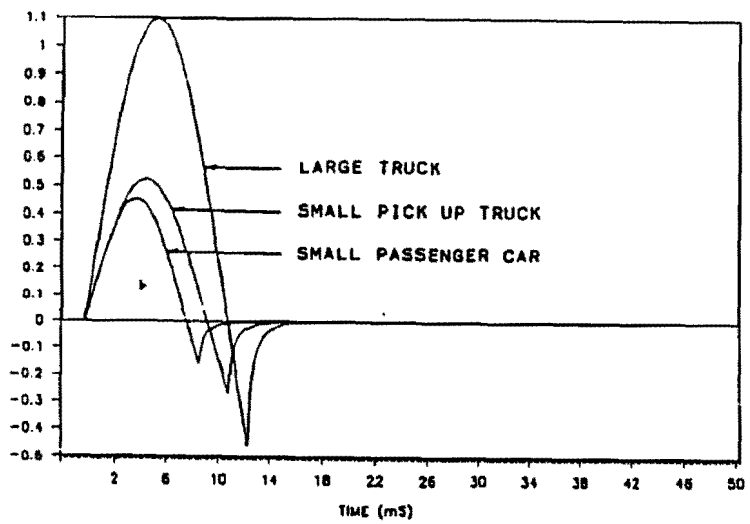


FIGURE 1

Cross Section of Installed Piezo Film Axle Sensor

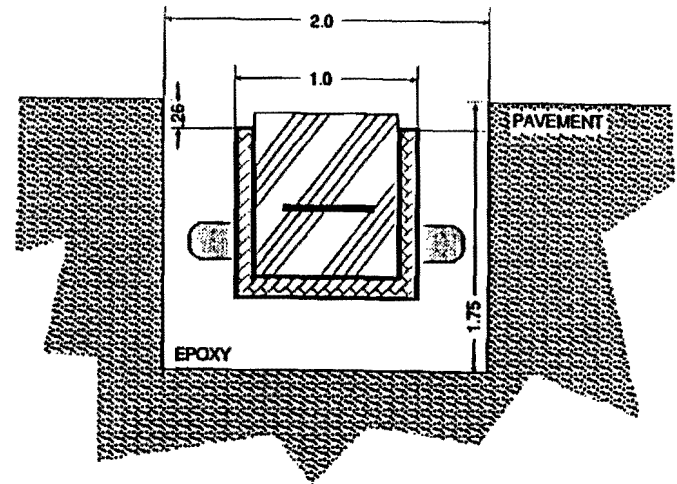
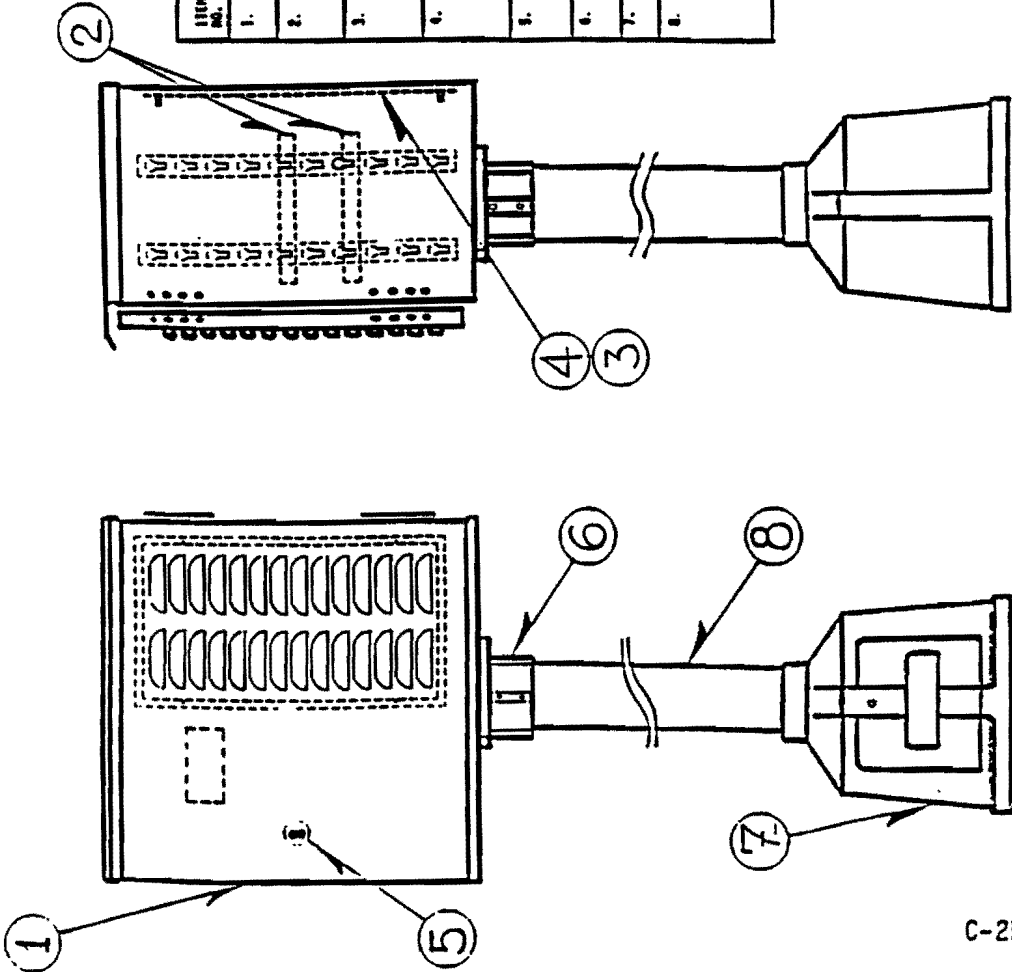


FIGURE 2

DETECTOR CABINET

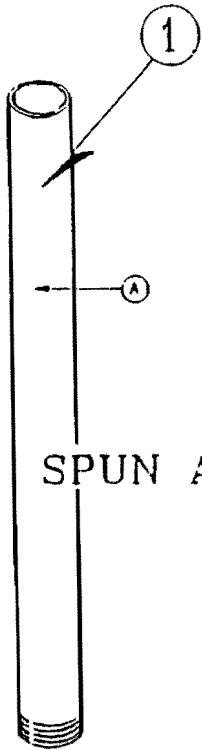


ITEM NO.	DESCRIPTION	QTY. REQ'D	RECOMMENDED SOURCE	MFR.'S DWG. OR PART NO.
1.	TRAFFIC CABINET PER ITT SPECIFICATIONS	1	SOUTHERN MFG. CO.	SOUTHERN DWG #K-162
2.	ADJUSTABLE SHELVES PER ITT SPECIFICATIONS W/MOUNTING HOLES.	2	SOUTHERN MFG. CO.	SOUTHERN DWG #K-162
3.	TERMINAL BLOCKS W/12 CONTACT POINTS (DOUBLE ROW FOR 2-32 SCREWS) TIGHTEN PER ITT SPECS.	3	SOUTHERN MFG. CO.	SOUTHERN DWG #K-162
4.	INTERNAL (RACK) PANEL PER ITT SPECS. COMPLETE WITH MOUNTING HOLES AND STAPLES SUPPLIED ASSEMBLED IN CABINET	1	SOUTHERN MFG. CO.	SOUTHERN DWG #K-162
5.	SKELTON PEE FOR POLICE TYPE (ENCLOSURE LOCK (INSTALLED ON CABINET))	1	SOUTHERN MFG. CO.	SOUTHERN DWG #K-162
6.	SLIP FITTER W/4 (4 in. 1) WITH HARDWARE	1	SOURCE A SOUTHERN MFG. CO. SOURCE B PELCO	PELCO # BR-3104
7.	CAST ALUMINUM BASE HOUSING W/ACCESS DOOR	1	SOURCE A SOUTHERN MFG. CO. SOURCE B PELCO	PELCO # PB-5300
8.	MOUNTING POLE (4 IN DIAM) 4 in. DIA. 8 in. LB. THREADED ON BOTTOM 1/2 x 1/2 x 30	1 ^{PH}	SOURCE A SOUTHERN MFG. CO. SOURCE B PELCO	PELCO # PB-5100

PH SHIPPED IN CARDBOARD TUBE TO PROTECT PIPE AND THREADS

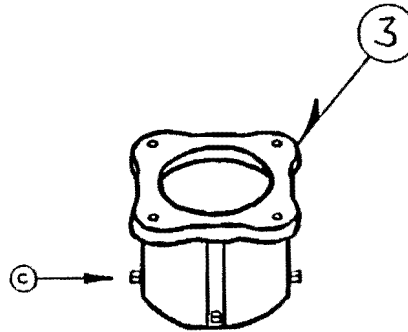
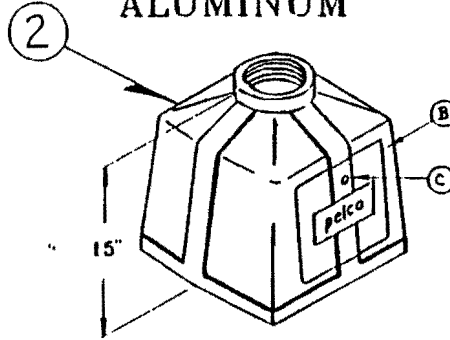
#TMP-0991/AVCS-02

SHEET 1 OF 3



SPUN ALUMINUM POLE

SQUARE BASE ASSY.
ALUMINUM



Alum. Pedestal Adaptor
for a 4.0in.O.D. pole

ITEM NO.	QTY.	DESCRIPTION/DETAIL	MFR.	PART NUMBER
1	ONE (1) PER EA. ASSY.	POLE (ALUMINUM) 4in. DIA. X 30in. LONG THREADED ONE END ONLY	PELCO	# PB-5100 W/PROTECTIVE SLEEVE
2	ONE (1) PER EA. ASSY.	CAST ALUMINUM BASE, 12 in. SQUARE X 15in. H W/METAL ACCESS DOOR	PELCO	# PB-5300 W/STAINLESS HARDWARE
3	ONE (1) PER EA. ASSY.	POLE ADAPTOR (ALUM.) SLIP FITTER HUB TYPE for 4 in. DIA. POLE	PELCO	# SE-3104 W/STAINLESS HARDWARE

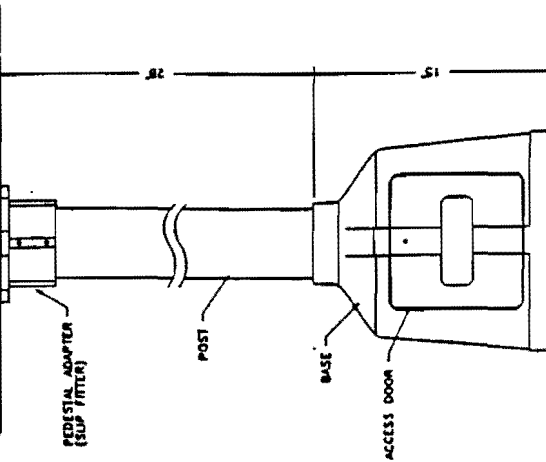
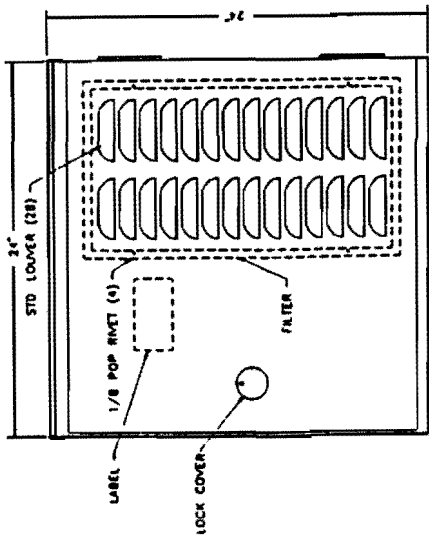
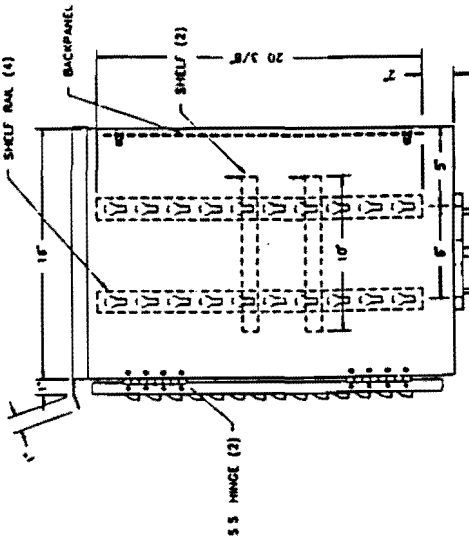
- (A) ALUMINUM POLE TO BE SHIPPED IN CARDBOARD PROTECTIVE SLEEVE TO PROTECT FINISH AND THREADS
- (B) SQUARE BASE (CAST ALUMINUM) TO BE SUPPLIED COMPLETE WITH ALUMINUM DOOR W/ S.S. SCREWS
- (C) SQUARE BASE AND PEDESTAL BOTH TO BE SHIPPED WITH STAINLESS STEEL HEX. HEAD SCREWS

POLES & BASES

#TMP-0991/AVCS-02
SHEET 2 of 3

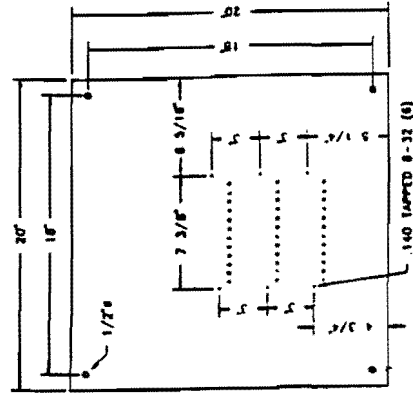
NOTES:

1. ENCLOSURE TO BE FABRICATED FROM .125 AND 2ND 5052-H32 MILL FINISH ALUMINUM TO TYPE 3A STANDARDS
2. ENCLOSURE DOOR TO HAVE SKELETON LOCK, PERMANENT FILTER LOCK COVER, LOCKWIRE, S.S. HINGES, GASKET ALL AROUND WITH RETAINER AND LABEL INSTALLED
3. ENCLOSURE TO HAVE 10" x 20" .125 ALUMINUM BACKPANEL WITH LEGEND SELF SCHEDULED PER DETAIL
4. ENCLOSURE TO HAVE STOP ROD TO HOLD DOOR AT 80 AND 120 DEGREES OTHER POSITION.
5. SUPPLY THREE (3) TERMINAL BLOCKS W/13 CONTACT POINTS EACH (DOUBLE ROW TERMINAL AND 8-32 SCREWS)
6. SUPPLY TWO (2) ADJUSTABLE SHELVES W/MOUNTING BOLTS, NUTS AND WASHERS.
7. SUPPLY ONE (1) 1/2" CAST ALUMINUM SLIP-FITTER W/HARDWARE, ONE (1) 3/8" DIA ALUMINUM POLE THREADED ON BOTTOM 1/2" x 3/8" OR EQUIVALENT-SHIPED IN CARDBOARD SLEEVE W/THREAD PROTECTION.
8. SUPPLY ONE (1) CAST ALUMINUM BASE W/ACCESS DOOR, SET OF FOUR (4) ANCHOR BOLTS 1/2" DIA x 1 1/2" LONG ON TOP.
9. ALL SHARP CORNERS AND EDGES TO BE DEBURRED.



FRONT VIEW

SIDE VIEW

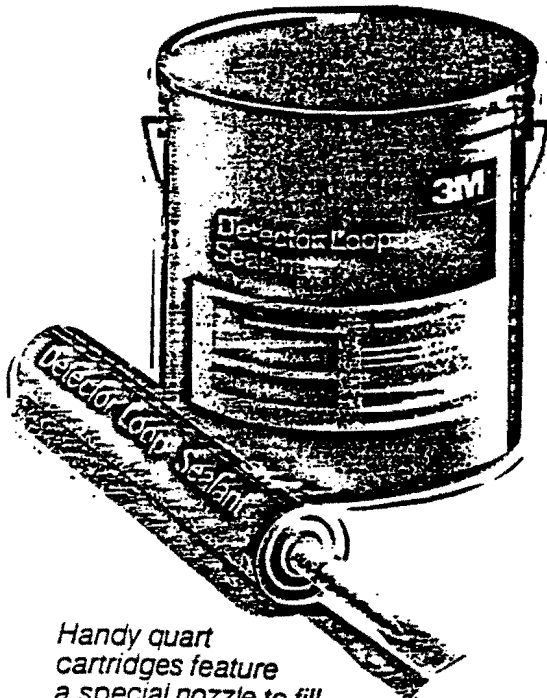


BACKPANEL

3M Detector Loop Sealant



3M BRAND DETECTOR LOOP SEALANT



Handy quart cartridges feature a special nozzle to fill sawcut from the bottom up, allowing encapsulation of the loop wires. Also available in 5-gallon pails for bulk pumping systems.

PURCHASING SPECIFICATION

Purchase as 3M Brand
DETECTOR LOOP SEALANT

#62-5794-6320-9

SUPPLIED IN 1 QUART CARTRIDGE

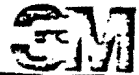
RECOMMENDED SOURCE:

CONSOLIDATED TRAFFIC CONTROLS, INC.
P. O. Box 3461
ARLINGTON, TX 76010-3461
(817) 265-3421

#TMP-0991/AVCS-03

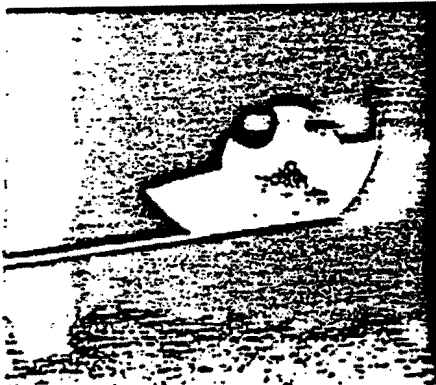
(SHEET 1 OF 3)

DETECTOR LOOP SEALANT

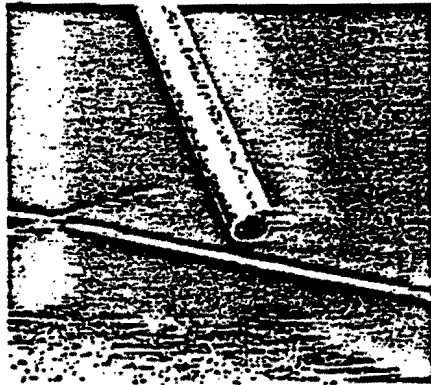


3M BRAND DETECTOR LOOP SEALANT

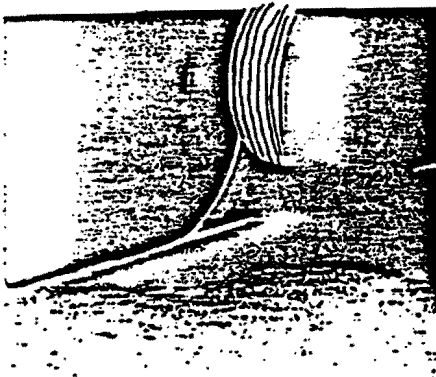
4 steps to correctly prepare the detector loop for traffic.



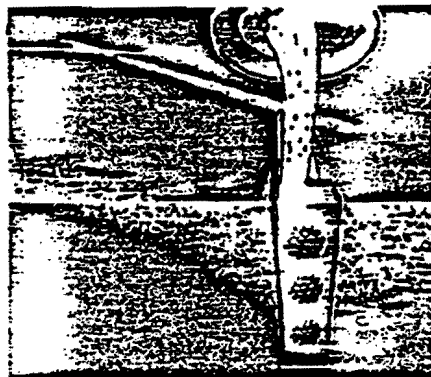
1. Cut the loop.



2. Flush out debris and blow out standing water.



3. Install loop wires.



4. Fill sawcut with 3M Detector Loop Sealant.

#TMP-0991/AVCS-03

(SHEET 2 OF 5)

CL 29

DETECTOR LOOP SEALANT



3M BRAND DETECTOR LOOP SEALANT

3M I.D. NUMBER:

62-5794-5220-2 62-5794-6320-9 62-5794-8520-2
62-5794-9520-1 62-5794-9920-3

<u>1. INGREDIENT</u>	<u>PERCENT</u>
polystyrene	20.0 - 30.0
talc	20.0 - 30.0
polypropylene triol	15.0 - 25.0
naphthol spirits	10.0 - 20.0
polypropylene glycol	1.0 - 10.0
2-ethoxyethyl acetate	1.0 - 10.0
toluene diisocyanate	1.0 - 10.0
toluene	1.0 - 10.0
amorphous silica	1.0 - 10.0
zinc oxide	1.0 - 10.0
titanium dioxide	1.0 - 10.0
carbon black	0.0 - 1.0

<u>2. PHYSICAL DATA</u>	
BOILING POINT (toluene)	232.00 F
VAPOR PRESSURE @ 68F	25.1900 mmHg
VAPOR DENSITY	3.00 Air = 1
EVAPORATION RATE	3.00 Ether = 1
SOLUBILITY IN WATER	Nil
SP. GRAVITY	1.200 Water = 1
PERCENT VOLATILE	20.00 %
VOLATILE ORGANICS	241.00 gm/l
pH	N/A
VISCOSITY	ca. 30000.0 CPS
APPEARANCE AND ODOR	Gray, thick liquid, solvent odor

3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	40.00 F
FLAMMABLE LIMITS - LEL	1.27 %
FLAMMABLE LIMITS - UEL	7.00 %
AUTOIGNITION TEMPERATURE	N/D
EXTINGUISHING MEDIA	
CO ₂ , foam, dry chemicals, water	

#TMP-0991/AVCS-03

(SHEET 3 OF 5)

C 20

DLSSPEC

PROPOSED SPECIFICATION
VEHICLE DETECTOR LOOP WIRE SEALANT

1.0 SCOPE

- 1.1 This specification describes the minimum design, installation and functional performance requirements of a flexible traffic loop wire encapsulant intended for sealing and protecting vehicle detector loop wires installed in sawcuts 1/4" to 3/8" wide and 1 1/2" to 2 1/2" deep.
- 1.2 The encapsulant is intended to provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in asphaltic and concrete pavements, while protecting the loop wire from moisture penetration, fracture and shear.

2.0 GENERAL

- 2.1 The encapsulant shall be a one-part elastomeric compound requiring no mixing, measuring or application of heat prior to or during its installation.
- 2.2 The encapsulant shall, within its stated shelf life in original undamaged packaging, cure only in the presence of moisture. The rate of cure will, therefore, depend upon temperature and relative humidity at the time of installation. Cool, dry weather will slow curing whereas warm, humid weather will accelerate curing.
- 2.3 The encapsulant shall be designed to enable vehicular traffic to pass over the properly filled sawcut immediately after installation without tracking or stringing of the material. The encapsulant shall form a surface skin allowing exposure to vehicular traffic within 30 minutes at 75°F and completely cure to a tough, rubber-like consistency in two (2) to seven (7) days after installation.

- 2.4 Properly installed and cured encapsulant shall exhibit resistance to effects of weather, vehicular abrasion, motor oils, gasoline, antifreeze solution, brake fluid, deicing chemicals and salt normally encountered, in such a manner that the performance of the vehicle detector loop wire is not adversely affected.
- 2.5 The cured encapsulant shall be temperature stable and exhibit no degradation in performance throughout the ambient temperature ranges experienced within the continental United States, Alaska, Hawaii and Puerto Rico.
- 2.6 The encapsulant shall exhibit minimal shrinkage during or after its installation, and in no manner affect the performance characteristics of the material.
- 2.7 The encapsulant shall be designed to permit clean-up of material and application equipment with non-flammable solvents such as 1,1,1 trichloroethane or Scotch-Grip Brand Solvent No. 4 (prior to curing of encapsulant). Should any encapsulant material be allowed to cure in the application nozzle, it shall be able to be pulled out as a solid plug.
- 2.8 The encapsulant shall have a minimum shelf-life in undamaged original containers when stored in a cool, dry environment as follows: 9 months after receipt when packaged in one quart cartridges. 12 months after receipt when packaged in 5-U.S. gallon pails. The 5-U.S. gallon pails shall contain 4.5 U.S. gallons of encapsulant in order to permit application by commercially available pumps.
- 2.9 The encapsulant shall be designed for roadway installation when the surface temperature is between 40 degrees F and 140 degrees F.
- 3.0 PHYSICAL PROPERTIES
- 3.1 The encapsulant shall have the following physical properties in its uncured and cured states.

3.1.1 Physical properties of the uncured (wet) encapsulant:

<u>Property</u>	<u>Requirement</u>	<u>Test Procedure</u>
A. Weight	10.1 lbs/gal +/- 0.3 lbs	A. Weight/Gallon
B. Total Solids by Weight	75 - 85%	B. Determination of Non-Volatile Content
C. Viscosity	10,000 - 85,000 CPS	C. Viscosity
D. Drying Time	Touch: 24 hrs. max. Complete: 30 hrs. max.	D. Tack-Free Time

3.1.2 Physical properties of the cured encapsulant:

<u>Property</u>	<u>Requirement</u>	<u>Test Procedure</u>
A. Hardness (Indentation)	65 - 85	E. Rex hardness
B. Tensile Strength	500 psi min.	F. Tensile and Elongation
C. Elongation	300% min.	F. Tensile and Elongation

4.0 CERTIFICATION

4.1 The supplier shall be prepared to provide a letter of certification from the manufacturer confirming the physical properties identified in paragraphs 3.1.1 and 3.1.2 of this specification.

4.2 Notification of this letter of certification, if required, shall be stated on this agency's purchase order and such certification shall accompany the material when shipped by the manufacturer.

5.0 PACKAGING

5.1 The encapsulant shall be available in the following packaging:

5.1.1 ONE-QUART CARTRIDGES: Such cartridges shall be equipped with threaded fitting to accommodate a screw-on nozzle designed for insertion in a pavement sawslot 1/4" to 3/8" in width and 1 1/2" to 2 1/2" in depth. The nozzle shall be designed to permit filling of sawslot with encapsulant from the bottom up, with minimal waste. The cartridge shall contain a puncture seal on its nozzle end. All cartridges shall be designed to permit application of encapsulant by appropriate size manual caulking gun or air-powered caulking gun. Cartridges shall be packaged twelve (12) per case with a minimum of three (3) applicator nozzles per case.

5.1.2 FIVE-GALLON PAILS: Such pails shall be DOT-37A80 open head pails and the covers shall be sealed with tubular neoprene gaskets. Such pails shall contain a minimum of 4.5 gallons of encapsulant material in order to permit pumping directly from the pail to the sawslot by commercially available pumps, requiring insertion of a follower-plate in the pail to form an appropriate seal. Encapsulant material shall be ordered in multiples of 4.5 gallons.

6.0 MEASUREMENT

6.1 Measurement for payment shall be made of each unit (cartridges or pails) of encapsulant delivered to the location(s) specified in the Invitation to Bid.

DLSTEST

TEST METHODS
VEHICLE DETECTOR LOOP WIRE SEALANT

A. WEIGHT/GALLON:

1. Equipment: The apparatus shall consist of the following parts (Refer to Fisher Catalog No. 3-247).
 - a. A smoothly finished round aluminum cup with external threads on the top edge, approximately 1 1/2" in diameter 3/4" high and holding approximately 15 cc filled to the top edge.
 - b. A snug fitting, flanged plug type lid with a concave inner surface and a 1/8" hole in the top.
 - c. An open centered cap or retaining ring with inside threads to match the cup which can be used to pull the lid in place.
2. Preparation: Each Pycnometer must be calibrated when new and periodically during use as follows:
 - a. Weigh empty to the nearest 0.01 gram.
 - b. Fill with water and weigh again.
 - c. Compute the difference and determine the factor as follows:

$$\text{FACTOR} = \frac{8.33}{\text{Wt. with water} - \text{wt. empty}}$$

3. Procedure:
 - a. Weigh the empty Pycnometer to the nearest 0.01 gram,
 - b. Fill the Pycnometer almost to the top, using care to keep air at a minimum by:
 - (1) Using a small amount of encapsulant and working it into the corners to displace air.

- (2) Slowly adding the remainder carefully displacing air as the volume is built up.
 - (3) When the cup is almost full, work the material in the cup with a spatula using an up and down motion.
 - (4) Then smooth the surface of the material in the cup leaving the edges high and the center low so that the concave shape of the lid and the encapsulant will force out surface air.
- c. Carefully position the lid in place centering the plug inside the rim of the cup.
 - d. Slide the retaining ring over the top and tighten down slowly by hand until the flange on the lid is seated on the top edge of the cup.
 - e. Remove the excess encapsulant that exudes from the hole, leaving the remaining material level with the top of the hole.
 - f. Weigh the filled Pycnometer to the nearest 0.01 gram.
 - g. Calculate the weight per gallon as follows:

$$\text{Factor X (Weight full - Weight empty) = lbs./gal.}$$

B. DETERMINATION OF NON-VOLATILE CONTENT:

1. Procedure:

- a. Accurately weigh three closed containers (2-ounce ointment cans or equivalent with covers) to the third decimal place (W1) and record the weight figures.
- b. Place approximately 3 to 5 grams of test material in one of the weighed containers, close the cover at once and weigh it immediately with accuracy to the third decimal place (W2). Repeat this procedure for the remaining two containers.

NOTE: With heavy materials, it is good practice to spread the sample over the entire bottom and sides of the container to give a large surface area.

- c. Remove the covers from each ointment can and place them on the bottom. Place the containers in an air circulating oven for 24 hours at 160 degrees F.

NOTE: Normally the air circulating oven is at the specified temperature before placing the samples in the oven.

- d. At the end of the specified time period, remove the containers from the oven, replace the covers and allow them to cool at room temperature.
- e. Weigh these containers to the third decimal place (W3) and record.
- f. Compute the percent non-volatile using the following formula:

$$\% \text{ Non-volatile} = \frac{\text{Final weight of sample}}{\text{Original weight of sample}} \times 100$$

Where:

Original weight of sample = W2 - W1

Final weight of sample = W3 - W1

- g. The percent non-volatile reported will be the average of the three samples run if the deviation between the samples is less than 0.50%. In case none of the samples fall within this deviation, new samples must be run.

C. VISCOSITY:

1. Sample Conditioning:

- a. One pint samples shall be stored as indicated on the product performance standard and in turn brought to a temperature of 77 degrees + or - 2 degrees F for testing. Stir the sample vigorously with a spatula for 1 minute immediately prior to testing and note any segregated material which cannot be dispersed.
- b. Determine the viscosity using a Brookfield RVF viscometer with a No. 6 or 7 spindle (as required) rotating at 20 rpm.

D. TACK-FREE TIME:

1. Procedure:

- a. Cast a film of undegassed encapsulant in a 1/16 inch deep open mold similar to that used for the tensile and elongation specimens referenced in test method section F. Fill the mold even with its top and place it at 77 degrees F and 50% RH. A small sheet of smooth polyethylene film (which shall be clear and colorless, with no signs of plasticizer, slip agents or other foreign substances on the surface) measuring 0.004 + or - 0.002 inch thick shall be pressed lightly with the thumb onto the encapsulant and then withdrawn. The time at which the film no longer adheres tightly to the encapsulant shall be considered the tack-free time.

E. REX HARDNESS:

1. Apparatus: Hardness shall be determined with a Rex durometer, Model 1700 Type A (with dial gauge). The durometer should be recalibrated at least once each month using the procedure in ASTM Test Method No. D-2240-64T, and the appropriate adjustments made in the readings.
2. Specimens: Specimens shall be at least 3/16 inch thick, and may be obtained by plying up portions of the tensile and elongation film (described in test method section F) after curing for 7 days at 77 + or - 2 degrees F and 50% R.H. plus 2 days at 120 degrees F. The hardness specimens shall be at least 1 inch in diameter and shall be tested with the mold side up. Specimens with bubbles or other voids, or with irregular thickness, shall be rejected.
3. Determining the Hardness: Place the plied hardness specimen on a heavy flat steel plate. The Durometer shall then be placed on the test specimen, while keeping the base of the instrument parallel to the surface of the specimen. The test pressure applied shall be just sufficient to insure firm contact of the pressure plate with the test specimen. The durometer indentation reading shall be taken as soon as the indicator hand on the dial comes to rest, or if this is not possible, at a moment when a definite change in needle speed is noted. Report the average of 5 such readings.

F. TENSILE AND ELONGATION:

1. Dilution and Degassing: Stir the encapsulant a minimum of 200 rapid strokes to insure uniformity and reduce the thixotropic gel. Weigh 100 grams of stirred sample into a one-quart can and add 30 grams of Analytical Reagent Grade Toluene. Mix until uniform. Place the can in a device suitable for subjecting it to a vacuum of 29 inches of mercury for 15 to 20 minutes. When degassing is complete, remove the sample container and immediately cast a film as described below.

NOTE: Refer to Figure #1 for a suggested degassing device.

2. Casting the Film:

- a. Prepare a mold for 6" x 8" x 40 mil alclad aluminum (or equivalent 5" x 8" metal panels) by covering one surface of the metal panel with 6" wide Teflon Tape. (e.g. 3M Brand TFE Plastic Tape No. 5491 or equivalent)
- b. Use 3M Brand EC-1202T tape or masking tape, 1/16" thick x 1/2" wide, as a "dam" around the perimeter of the mold.
- c. Pour sufficient encapsulant into the mold to fill the mold even with its top. Strike the encapsulant very carefully to level it with the top of the mold. Do not entrap air in the coating!

3. Curing the Encapsulant: Place the filled mold on a level surface at 77 degrees F and 50% R.H. After two days at these conditions, remove the encapsulant from the mold; invert the film, and continue the cure for five additional days at the same conditions. After 7 days at 77 degrees F and 50% R.H., place the film at 120 degrees F for 2 days.

4. Preparation of Dumbbells: Punch three dumbbells from the cured film using a micro die (Refer to Figure #2). The dumbbells must be free from air bubbles, craters, nicks, segregation, or any other defects. Measure and record the thickness of each dumbbell at the neck (narrow portion), using a micrometer or dial gauge accurate to + or - 1 mil. Take a total of three readings at various locations on the neck and record the median (T, inches). The maximum thickness variation along the neck should not exceed 2 mils. Place two bench marks, in ink, 1/2 inch apart on one side of each dumbbell, using care not to nick the
C-3

5. Determining the Tensile Strength and Ultimate Elongation: Place the dumbbells on an Instron or tensile testing machine having a sensitivity of 1/10 pound, and a jaw separation rate of 2" per minute. The dumbbells should be clamped near their ends (wide portions) in the jaws of the machine. Start the machine and note continuously the distance between the center of the two bench marks taking care to avoid parallax. Record the stress (S, lbs.) and elongation (L, inches) at the time of rupture. The bench mark distance may be measured just before rupture with either a pocket scale calibrated in inches or with a pair of dividers. If the dumbbell breaks at a hidden bubble or other defect, reject that test and test another dumbbell.

6. Calculation:

Calculate the ultimate tensile strength of each specimen using the following formula:

$$* \quad \frac{8 \times 5 (S)}{T} = \text{PSI}$$

Calculate and report the mean value of three specimens as tensile strength in PSI. Calculate the elongation of each specimen from the following formula:

$$* \quad L - .5 \text{ inch} \times 200 = \% \text{ elongation}$$

Calculate and report the mean value of three specimens as % elongation.

* Note S = Stress in pounds
 T = Thickness in inches
 L = Length in inches

Figure #1

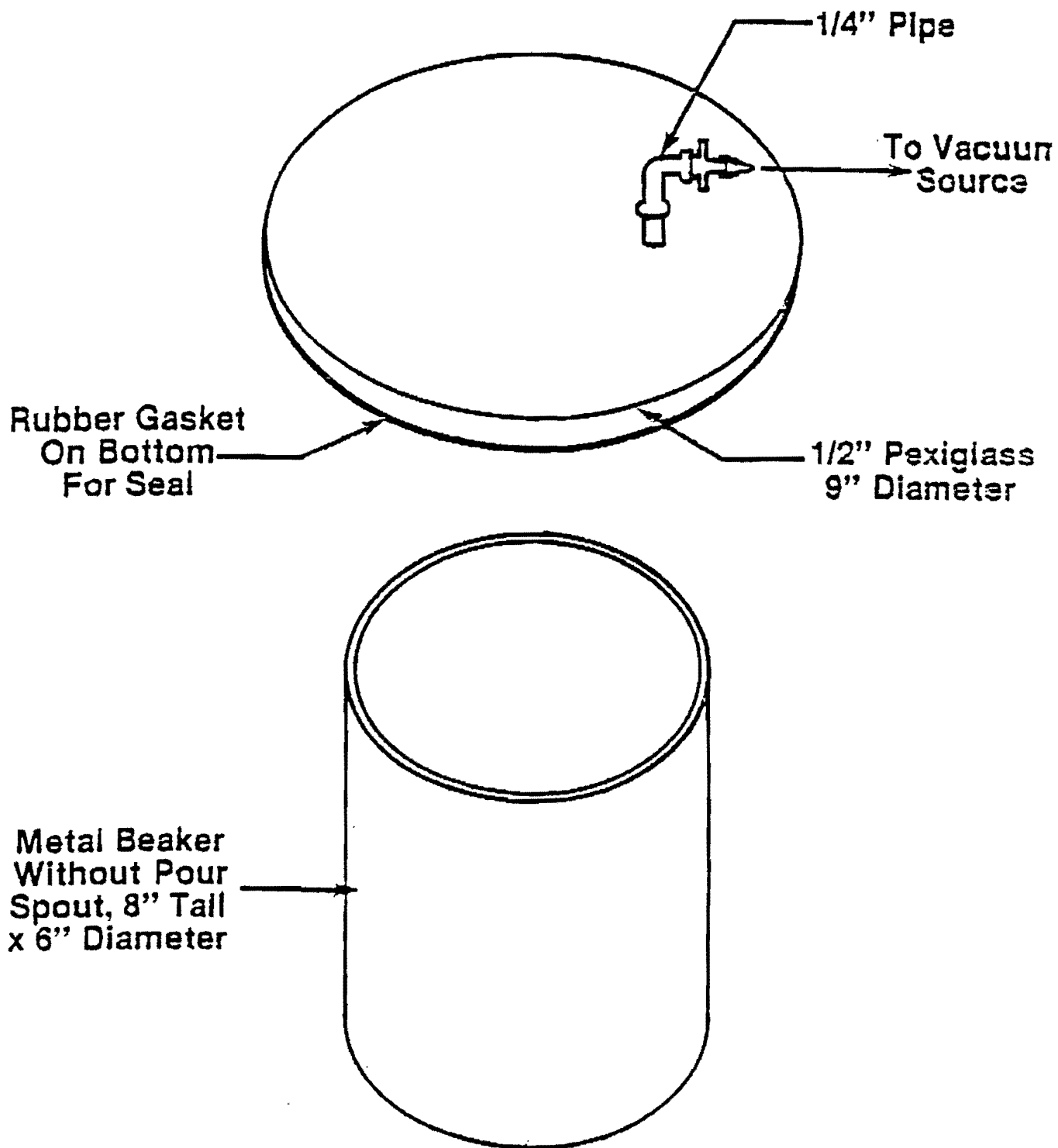
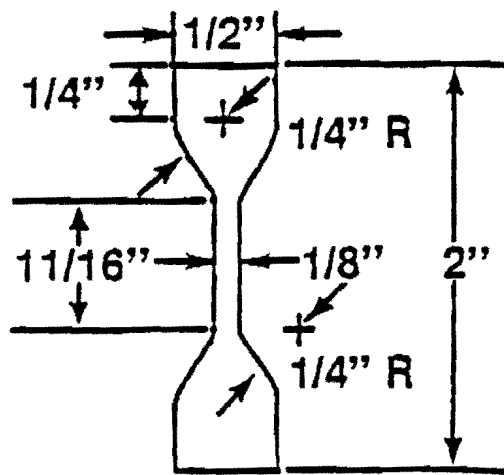


Figure #2



Cutting Edge Of Micro Dumbbell Die
(Actual Size)

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07-53
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Duns No.: 00-617-3082

MATERIAL SAFETY
 DATA SHEET



DIVISION: SAFETY AND SECURITY

TRADE NAME:

3M Brand Detector Loop Sealant

3M I.D. NUMBER: 62-5794-5220-2 62-5794-6320-9 62-5794-8520-2 62-5794-9520-1
 62-5794-9920-3

ISSUED: JANUARY 27, 1989

SUPERSEDES: NOVEMBER 29, 1988

DOCUMENT: 10-5297-6

1. INGREDIENT	C.A.S. NO.	PERCENT	EXPOSURE		LIMITS	
			VALUE	UNIT	TYPE	AUTH
polystyrene	9003-53-6	20.0 - 30.0	NONE	NONE	NONE	NONE
talc	14807-96-6	20.0 - 30.0	2	mg/m3	TWA	ACGIH
polypropylene triol	25791-96-2	15.0 - 25.0	NONE	NONE	NONE	NONE
naphthol spirits	64742-48-9	10.0 - 20.0	300	ppm	TWA	CMRG
polypropylene glycol	25322-69-4	1.0 - 10.0	NONE	NONE	NONE	NONE
2-ethoxyethyl acetate	111-15-9	1.0 - 10.0	5	ppm	TWA	ACGIH
toluene diisocyanate	26471-62-5	1.0 - 10.0	0.005	ppm	TWA	3M
toluene	108-88-3	1.0 - 10.0	100	ppm	TWA	ACGIH
amorphous silica	7631-86-9	1.0 - 10.0	3	mg/m3	TWA	ACGIH
zinc oxide	1314-13-2	1.0 - 10.0	10	mg/m3	TWA	ACGIH
titanium dioxide	13463-67-7	1.0 - 10.0	10	mg/m3	TWA	ACGIH
carbon black	1333-86-4	0.0 - 1.0	3.5	mg/m3	TWA	ACGIH

SOURCE OF EXPOSURE LIMIT DATA:

- ACGIH: American Conference of Governmental Industrial Hygienists
- 3M: 3M Medical Department Guideline
- CMRG: Chemical Manufacture Recommended Guidelines
- NONE: None Established

THIS PRODUCT CONTAINS THE FOLLOWING TOXIC CHEMICAL OR CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 AND 40 CFR PART 372:

- 2-ethoxyethyl acetate
- toluene
- zinc oxide

2. PHYSICAL DATA

BOILING POINT:..... 232.00 F
 (toluene)
 VAPOR PRESSURE:..... 25.1900 mmHg
 @ 68F
 VAPOR DENSITY: 3.00 Air = 1
 EVAPORATION RATE:..... 3.00 Ether = 1
 SOLUBILITY IN WATER: Nil
 SP. GRAVITY:..... 1.200 Water = 1
 PERCENT VOLATILE: 20.00 %
 VOLATILE ORGANICS: 241.00 gm/l
 pH: N/A
 VISCOSITY: ca. 30000.0 CPS
 APPEARANCE AND ODOR: Gray, thick liquid, solvent odor

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3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:..... 40.00 F
FLAMMABLE LIMITS - LEL: 1.27 %
FLAMMABLE LIMITS - UEL: 7.00 %
AUTOIGNITION TEMPERATURE: ... N/D

EXTINGUISHING MEDIA:

CO₂, foam, dry chemicals, water

SPECIAL FIRE FIGHTING PROCEDURES:

Fire fighters should be equipped with self-contained breathing apparatus when fighting fires involving this material.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Flammable. Overheated, closed containers adjacent to fire could explode due to pressure buildup.

NFPA-HAZARD-CODES: HEALTH 3 FIRE 3 REACTIVITY 1

UNUSUAL REACTION HAZARD: None

4. REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY - MATERIALS TO AVOID:

Reacts with water (liquid and atmospheric), amines and alcohols -- not a hazard.

HAZARDOUS POLYMERIZATION: Will Not Occur

HAZARDOUS DECOMPOSITION PRODUCTS:

CO, CO₂ and nitrogen oxides when subjected to excessive heat or flame. Thermal decomposition of polyurethane or polyisocyanurate foams at temperatures below their ignition points may generate isocyanate vapors and other irritating volatile products.

5. ENVIRONMENTAL INFORMATION

SPILL RESPONSE:

Observe precautions in all sections. Extinguish all ignition sources in the immediate work area and ventilate area. Only properly protected personnel should remain in the immediate area. Contain spill and cover with absorbent material such as sawdust or oil absorbent. Place in a U.S. Dept. of Transportation approved open top metal container. Remove to well ventilated area and treat with dilute ammonia solution (such as 90% water, 8% concentrated NH₄OH and 2% liquid detergent). Leave ventilated 24 hours. Wash down spill area with dilute ammonia solution to neutralize remaining residue of isocyanate.

RECOMMENDED DISPOSAL:

UNCURED PRODUCT: Incinerate absorbed or bulk product after mixing with flammable material in a licensed hazardous waste facility. Disposal should be in accordance with applicable regulations. U.S. EPA Hazardous Waste No.: D001 (Ignitable). **CURED PRODUCT:** Fully cured material may be disposed in a sanitary landfill. Disposal should be in accordance with applicable regulations.

ENVIRONMENTAL DATA:

Volatile Organic Compound (VOC): Maximum VOC = 241 grams/liter.
Maximum VOC minus Water minus Exempt Solvents = 241 grams/liter.

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5. ENVIRONMENTAL INFORMATION (continued)

SARA HAZARD CLASS:
 FIRE HAZARD: Yes PRESSURE: No REACTIVITY: No ACUTE: Yes CHRONIC: Yes

6. SUGGESTED FIRST AID

EYE CONTACT:
 Flush eyes with large amounts of water for at least 10 minutes. Call a physician.

SKIN CONTACT:
 Thoroughly wash affected area with soap and water.

INHALATION:
 Remove person to fresh air. Call a physician.

IF SWALLOWED:
 Do not induce vomiting. Immediately call a physician or poison control center.

OTHER FIRST AID:
 NONE

7. PRECAUTIONARY INFORMATION

Keep product and its vapor away from heat, sparks, flame and other sources of ignition. The vapors released from this product can be ignited easily. Do not breathe vapor. Use only in areas with sufficient ventilation to maintain isocyanate vapor concentrations below the recommended exposure limits. If ventilation is not adequate, use a supplied-air respirator approved for isocyanates. Local exhaust ventilation is recommended for confined areas and indoor use. Avoid eye and skin contact; wear chemical goggles or safety glasses, and impervious gloves and protective clothing when handling product. Remove contaminated clothing and laundry before reuse. Do not eat, drink or smoke during use of product. Wash thoroughly after handling product. Keep container tightly closed when not in use. Keep out of the reach of children.

ADDITIONAL EXPOSURE LIMITS

INGREDIENTS	EXPOSURE LIMITS		AUTH	
	VALUE	UNIT	TYPE	
talc	2	mg/m3	TWA	ACGIH
naphthol spirits	1900	mg/m3	TWA	CMRG
2-ethoxyethyl acetate	27	mg/m3	TWA	ACGIH
2-ethoxyethyl acetate	100	ppm	TWA	OSHA
2-ethoxyethyl acetate	540	mg/m3	TWA	OSHA
toluene diisocyanate	0.02	ppm	STEL	3M
toluene	375	mg/m3	TWA	ACGIH
toluene	150	ppm	STEL	ACGIH
toluene	560	mg/m3	STEL	ACGIH
toluene	300	NONE	NONE	OSHA
toluene	200	ppm	TWA	OSHA

Abbreviations: N/D - Not Determined N/A - Not Applicable

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7. PRECAUTIONARY INFORMATION (continued)

ADDITIONAL EXPOSURE LIMITS

INGREDIENTS	EXPOSURE		LIMITS	
	VALUE	UNIT	TYPE	AUTH
toluene	500	ppm	STEL	OSHA
amorphous silica	6	mg/m ³	TWA	ACGIH
amorphous silica	20	mppcf	TWA	OSHA
titanium dioxide	15	mg/m ³	TWA	OSHA
carbon black	3.5	mg/m ³	TWA	OSHA

SOURCE OF EXPOSURE LIMIT DATA:

- ACGIH: American Conference of Governmental Industrial Hygienists
- OSHA: Occupational Safety and Health Administration
- 3M: 3M Medical Department Guideline
- CMRG: Chemical Manufacture Recommended Guidelines

8. HEALTH HAZARD DATA

EYE CONTACT: Liquid causes eye irritation on contact. Vapors may cause eye irritation.

SKIN CONTACT: May cause skin irritation.

INHALATION: Vapor overexposure may cause respiratory system irritation and temporary nervous system impairment (light-headedness). Exposure to toluene diisocyanate (TDI) vapors may cause respiratory system irritation, breathing difficulty, and asthma-like respiratory response in certain individuals at very low vapor concentrations. Symptoms of overexposure may include tightness of chest, difficult breathing, lung congestion and edema, nausea, vomiting, headache, dizziness, fatigue, and on extreme overexposure, unconsciousness. Repeated or extreme overexposure to toluene vapor may cause nervous system damage. A lifetime inhalation study in mice and rats found no increase in cancer from TDI exposure. IARC has concluded that there is inadequate evidence for the carcinogenicity of TDI in humans. NTP, in its 4th annual report (Sept., 1986), designates TDI as a substance that may "...reasonably be anticipated to be carcinogenic" based on studies in which TDI was fed to lab animals. The results of this feeding study are of questionable relevance to the normal handling and use of this product.

INGESTION: May cause digestive system irritation. Symptoms may include nausea and vomiting.

NOTE: 2-ethoxyethyl acetate may cause birth defects, male reproductive disorders, and blood disorders on excessive exposure based on animal studies. However, 2-ethoxyethyl acetate is present in such small quantities that the effects listed would not be expected with normal use of this product.

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SECTION CHANGE DATES

ENVIRON. DATA SECTION CHANGED SINCE NOVEMBER 29, 1988 ISSUE

Abbreviations: N/D - Not Determined N/A - Not Applicable

The information on this Data Sheet represents our current data and best opinion as to the proper use in handling of this product under normal conditions. Any use of the product which is not in conformance with this Data Sheet or which involves using the product in combination with any

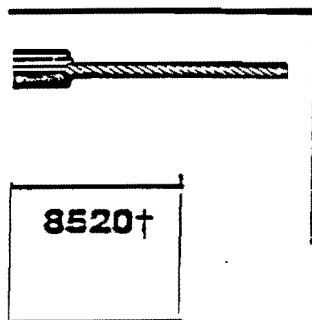
Hook-Up Wire

Hook-Up Wire

Type MW-MIL-W-76B-PVC 1000V, 80°C

Product Description

Tinned copper. PVC insulated. medium wall. The extruded PVC insulation is flame and ozone resistant and inert to most chemicals, oils, and solvents.



Color Codes

1 Brown	11 Tan	21 White/Gray
2 Red	12 Pink	22 White/Violet
3 Orange	13 Dark Blue	23 White/Black/Red
4 Yellow	14 White/Black	24 White/Black/Green
5 Green	15 White/Red	25 White/Black/Yellow
6 Light Blue —	16 White/Green	26 White/Black/Blue
7 Violet (purple)	17 White/Yellow	27 White/Black/Brown
8 Gray (stare)	18 White/Blue	28 White/Black/Orange
9 White	19 White/Brown	29 White/Black/Gray
10 Black	20 White/Orange	30 White/Black/Violet
		189 Green/Yellow



BELDEN

(SHEET 1 OF 2)

#TMP-0991/AVCS-04

HOOK-UP WIRE

MATERIAL SPECIFICATION #TMP 0991/AVCS-04 HOOK-UP WIRE

REQUIREMENTS:

1. 14 Guage Stranded Color Wire (1000 feet per roll)

Required Colors:

<u>Solid Colors:</u>	Catalogue No.
Brown	#8520-1000-1
Red	#8520-1000-2
Orange	#8520-1000-3
Yellow	#8520-1000-4
Green	#8520-1000-5
Blue	#8520-1000-6

Color on White:

Brown	#8520-1000-19
Red	#8520-1000-15
Orange	#8520-1000-20
Yellow	#8520-1000-17
Green	#8520-1000-16
Blue	#8520-1000-18

RECOMMENDED SOURCE:

Sterling Electronics

2. Belden Coax Cable #8401
(1000 feet per roll)

(SHEET 2 OF 2)

#TMP-0991/AVCS-04

MASTER SPECIFICATIONS LIST

GENERAL SPECIFICATIONS

PROCESS SPECIFICATIONS

MATERIALS SPECIFICATIONS

For
Installation of sites for Automatic Vehicle Classification

Study No. 2-10-92-1901

TTI MASTER SPECIFICATIONS LIST	# MS0991/01
TTI PROCESS SPECIFICATION	# P0991/01
TTI PROCESS SPECIFICATION	# P0991/02
TTI PROCESS SPECIFICATION	# P0991/03
TTI PROCESS SPECIFICATION	# P0991/04
TTI PROCESS SPECIFICATION	# P0991/05
TTI PROCESS SPECIFICATION	# P0991/06
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-01
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-02
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-03
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-04
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-05
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-06
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-07
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-08
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-09
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-10
TTI MATERIAL SPECIFICATION	# TMP-0991/AVCS-11

E-BOND EPOXY GROUT

G-100

This Specification covers EPOXY GROUT to be used for the implacement of traffic axle sensors having rigid housings into the roadway surface of either flexible or rigid pavements.

TO BE PURCHASED AS:

SIZE 2 - (17.1 LBS. UNIT) APPROX. 240 CU. IN.

COMPONENT A - RESIN COMPONENT

Packaged 16.5 lbs. of resin component in two gallon containers, with pry-off lids and bails.

COMPONENT B - HARDENER COMPONENT

Packaged 300 grams of hardener component in round pint cans, with multiple friction lids. The containers shall be packed with a maximum of 12 containers per carton for shipment.

SOURCE:

E-BOND EPOXIES, INC. (305) 566-6555

P.O. Box 23069

Fort Lauderdale, FL 33307-3069

(SHEET 1 OF 4)

#TMP-0991/AVCS-05

S P E C I F I C A T I O N S

G-100 EPOXY GROUT

1. SCOPE AND CLASSIFICATION

1.1 Scope This specification covers epoxy grout to be used for the placement of traffic axle sensors having rigid housings into the roadway surface of either flexible or rigid pavements.

2. REQUIREMENTS

2.1 General This material must be 100% solid self-leveling grout. It must have the ability to cure at temperatures as low as 50 degrees F.

2.2 Properties

MIXING RATIO	Part		Part
	A		B
By weight	25	to	1
By volume	13	to	1
SPECIFIC GRAVITY	2.075 +/- .05		1.020 +/- .05
POT LIFE at 75 degrees F. (208 grams)	- 30 to 40 minutes		
TACK FREE TIME at 75 degrees F.	- 3 1/2 hours		

2.3 Mixed System (7 Days @ 75 degrees F.)

COLOR		neutral to light amber
COMPRESSIVE STRENGTH	ASTM-D 695	8000 PSI
WATER ABSORPTION	ASTM-D 570	.50% Maximum
VOLATILE CONTOUR	ASTM-D 1259	1.5% Maximum
SHORE D HARDNESS	ASTM-D 2240	Minimum of 84

(PAGE 2 OF 4)

#TMP-0991/AVCS-05

3. PACKAGING

3.1 Size 1 ((11 1/2 pound unit) Approximately 160 cubic inches))

COMPONENT A - Resin Component

Packaged 11.0 lbs. of resin component in one gallon containers with multiple friction lids and bails. The containers shall be packed four per carton.

COMPONENT B - Hardener Component

Two hundred twenty (220) grams of hardener component in round 3 ounce specimen bottles with metal screw caps. The caps shall be fitted with vinylite liners with pulp board backing. A maximum of 24 bottles shall be packed per carton for shipment.

3.2 Size 2 ((17.1 unit) Approximately 240 cubic inches))

COMPONENT A - Resin Component

Packaged 16.5 lbs. of resin component in two gallon containers with pry off lids and bails.

COMPONENT B - Hardener Component

Packaged 300 grams of hardener component in round pint cans with multiple friction lids. The containers shall be packed a maximum of 12 per carton for shipment.

3.3 Size 3 ((26 Pound unit) Approximately 375 cubic inches))

COMPONENT A - Resin Component

Packaged 25.0 lbs. of resin component in two gallon containers with pry off lids and bails.

COMPONENT B - Hardener Component

Package 1 pound of hardener component in round pint cans with multiple friction lids. The containers shall be packed in a maximum of 12 per carton for shipment.

3.4 Size 4 ((46 pound unit) Approximately 650 cubic inches))

COMPONENT A - Resin Component

Packaged 44.0 lbs. of resin component in a five gallon pail with bail and lug cover.

COMPONENT B - Hardener Component

Packaged 880 grams of hardener component in round quart cans with multiple friction lids. The containers shall be packed a maximum of 4 per carton for shipment.

4. LABELING

4.1 Part A - Resin Component

Each finished container and case shall be plainly labeled with the words "EPOXY GROUT - G100", PART A, the Batch Number, the manufacturers name and address, and the prescribed health warnings and precautions. It shall also contain the mixing ratio and the words "Caution: Do not attempt to thin epoxy grout with any type of solvent. Use toluene for cleanup of equipment. Do not store at temperatures below 60 degrees F. or above 100 degrees F.

4.2 Part B - Hardener Component

Each finished container and case shall be plainly labeled with the words "EPOXY GROUT - G100", PART B, the Batch Number, the manufacturers name and address, and the prescribed health warnings and precautions.

JRR:cm/91-GASH001-41

(SHEET 4 OF 4)

#TMP-0991/AVCS-05

C-53



PRODUCT DATA SHEET

E-BOND G-100
EPOXY GROUT
100 SOLIDS HIGH STRENGTH
FOR INDUSTRIAL USE ONLY

Product No.

DESCRIPTION

E-BOND G-100 pourable epoxy grout was particularly designed for use in the placement of traffic counters and sensors in pavement surfaces.

Simple ready to use formulation contains all the necessary filler ingredients.

Simply add the curing agent, thoroughly mix and blend and pour in designated area.

Produces a high strength epoxy grout, self-leveling type.

May be used for patching and placement of anchor bolts, dowels and pins in concrete surfaces.

Low temperature cures as low as 50°F.*

PHYSICAL PROPERTIES

TYPE:
SELF LEVELING EPOXY GROUT

MIXING RATIO: 13 A to 1 B by volume
25 A to 1 B by weight

COLOR: Part A Resin STRAW
Part B Hardener AMBER
Ad-mix AMBER

POT LIFE 30 - 40 Mins. @ 75°F.
TACK FREE TIME: 3 1/2-4 Hrs. @ 75°F.
FINAL CURE (75°F. Ultimate Strength)
ASTM D-695 Modified 5 Days

PHYSICAL PROPERTIES after cure of
14 days at 75°F. and 50% R.H.

EPOXY GROUT

COMPRESSIVE STRENGTH ASTM D-695
8,000 psi min.

WATER ABSORPTION ASTM D-570
0.30%

PACKAGING

Available in 11 1/2 lb. and
26 lb. units. Larger units
upon request.

COVERAGE:

11 1/2 lb. unit
Approximately 160 cubic inch
26 lb. unit
Approximately 375 cubic inch

TEMPERATURE*

E-BOND G-100 Epoxy Grout is a
pourable consistency when the
product temperature is 70°F.
or higher.

LOWER TEMPERATURES will
thicken the product
substantially resulting in
much slower cures and set
time (open time for traffic).

HIGHER TEMPERATURES will
slightly thin the product
making it more pourable with
much less working time and a
much faster set time.



E-BOND EPOXIES, INC.

P. O. Box 22069 • 501 N.E. 33rd STREET • FORT LAUDERDALE 33307

*TEMPERATURE (CONTINUED)

E-BOND G-100 Epoxy Grout will cure at temperatures as low as 50°F. providing temperature of the substrate will be 50°F. and rising during the next 24-hours. At substrate temperatures below 65°F., the epoxy should be stored at least 24-hours prior to use at 80°F. or higher.

CURE SCHEDULES AT DIFFERENT TEMPERATURE RANGES

It is important that the "user" maintain the temperature of the product when considering applications in cooler substrate temperatures. The product temperature should always be a minimum of 77°F. When working in cooler substrate temperatures; for example 60°F. and lower it is suggested that the product temperature be brought up to 80°F. or 85°F.

<u>SUBSTRATE TEMPERATURE, DEGREE F.</u>	<u>HOURS TO OPEN TO TRAFFIC</u>
100°F.	1 1/2
80°F.	1 3/4
70°F.	2
60°F.	6 - 8
50°F.	12 - 14

All of the above figures are approximate and will act as a guide based on substrate temperature.

WORKING TIME IN THE CONTAINER @ 77°F.

A 11 lb. and 26 lb. unit were selected for this test. Components of both units were conditioned at 77°F. Resin and hardener for individual units were thoroughly mixed and blended and allowed to remain in the unit until the product was deemed unusable.

11 lb. unit	19 to 20 minutes
26 lb. unit	15 to 18 minutes
1 quart unit	25 minutes

The above test was based on all of the material remaining in the individual containers that was supplied until the product was unusable. If a portion of the material had been used it is anticipated that the working time in the container would be longer.

EXOTHERM HEAT PRODUCED BY REACTION OF THIS PRODUCT

This test was produced to determine the amount of heat that is created by the reaction of the epoxy resin/hardener pre-conditioned to 80°F.

It is anticipated that it would be difficult for this heat to dissipate when it is locked between the sensor and the concrete wall.

Two (2) tests were performed utilizing a 4" X 4" cube and a 1" X 1" cube. Both cubes were contained in an insulated container. The epoxy resin hardener was pre-conditioned to 80°F.

Products were properly mixed and cast into the individual cubes. A thermocouple was placed in the direct center of the cubes to determine maximum exotherm.

The maximum exotherm in a 4" cube was 210°F. The 1" X 1" cube was 120°F.

If the substrate temperature of the sensor and the road was in excess of 80°F. this exotherm could be slightly higher. If the substrate temperature of the sensor and the road was below 80°F. this maximum/exotherm would be slightly lower.

The conclusion reached from this test is that the epoxy should not be cast greater than 1-1/2" thick per pour. For application requiring greater thickness the epoxy should be layered. (SEE APPLICATION INTRUCTIONS)

HOW TO USE

SURFACE PREPARATION: Surface must be clean and sound. Surface should be dry and free of standing water. Removed dust/laitance, grease, curing compounds, impregnations, waxes, foreign particles, disintergrated materials. All foreign materials that would adversely effect the bond of the epoxy must be removed.

PREPARATION WORK: CONCRETE - Sandblast or use other approved mechanical methods.

STEEL - Sandblast to white-metal finish

MIXING: Slowly add Component "B" (hardener) to the Component "A" (resin) and mix very thoroughly. Take special precautions to ensure thorough mixing of the sides and bottoms. If less than the entire unit is needed the two components may be mixed in the following ratio.

HOW TO USE - CONTINUED

13-parts of Resin Component by volume to 1-part of Hardener Component by volume or 25-parts of Resin Component by weight to 1-part of Hardener Component by weight.

When using in smaller quantities mix very thoroughly and allow material to remain in the mixing container from 3 to 5 minutes prior to use.

CAUTION

Do not attempt to thin E-BOND G-100 Epoxy Grout with any type of solvent. The use of toluene or other thinners are recommended for clean-up of equipment. Do not store at temperatures below 60°F. or above 100°.

APPLICATION

Ensure that all surfaces are properly cleaned and dry. Slowly pour the grout and pack well around the traffic counters and sensors as detailed by counter or sensor manufacturer.

For the placement of bolts, rebar, dowels, etc. in concrete pour material in the hole to approximately 3/4" full and slowly press the bolt and dowel up and down to remove all air to ensure full compaction of the epoxy grout to concrete and steel.

For patching of spalled areas, pour and permit the grout to self level.

An application of 1-1/2" thick could produce a maximum/exotherm heat of 120°F. to 130°F. under the sensor.

For applications greater than 1-1/2" thick it is suggested that the product be layered.

For example on a 2" thickness, cast the first thickness approximately 1" thick. Allow to cure to a semi-hard or hard condition. The surface temperature should not be greater than 100°F. prior to casting the second thickness. It is recommended that both application be completed within 8-hours.

Consult technical service for additional information.

CAUTION

COMPONENT "A" - Irritant: Prolonged contact to skin may cause irritation. Avoid eye contact.

COMPONENT "B" - Irritant: Contact with skin may cause severe burns. Avoid eye contact. Product is a strong sensitizer. Use of safety goggles and chemical-resistant gloves recommended. Remove contaminated clothing. Avoid breathing vapors. Use adequate ventilation.

FIRST AID: In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for 15 minutes: For respiratory problems, remove person to fresh air (contact physician immediately). Wash clothing before re-use.

CLEAN UP: Collect with absorbent material, flush with water. Dispose of in accordance with local disposal regulations. Uncured material can be removed with approved solvent. Cured material can only be removed mechanically.

***** KEEP OUT OF REACH OF CHILDREN
***** NOT FOR INTERNAL CONSUMPTION
***** FOR INDUSTRIAL USE ONLY

CONSULT MATERIAL SAFETY DATA SHEET FOR ADDITIONAL INFORMATION

DISCLAIMER OF WARRANTIES AND LIMITATION: E-BOND EPOXIES, INC. ("Seller") warrants that if any good supplied prove defective in workmanship or material, that Seller shall replace them or refund their purchase price. THIS WARRANTY IS MADE IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND/OR FITNESS WHICH HEREBY DISCLAIMED. IT IS UNDERSTOOD AND AGREED THAT BUYER'S SOLE REMEDY, AND THEREFORE SELLER'S LIABILITY, WHETHER IN CONTRACT, TORT, UNDER ANY WARRANTY, IN NEGLIGENCE, OR OTHERWISE SHALL BE LIMITED TO THE RETURN OF THE PURCHASE PRICE PAID BY PURCHASER OR REPLACEMENT OF ANY DEFECTIVE GOODS SOLD BY SELLER AND UNDER NO CIRCUMSTANCES SHALL SELLER BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES. THE PRICE STATED FOR THE GOODS IS A CONSIDERATION IN LIMITING SELLER'S LIABILITY. Before application, the User shall determine the suitability of the product for his intended use and User assumes all risks and liabilities whatsoever in connection therewith. The terms of this paragraph may not be orally modified. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF.

MATERIAL SAFETY DATA SHEET

E-BOND EPOXIES, INC. FT. LAUDERDALE, FLORIDA 33307
P. O. BOX 23069 (501 N.E. 33RD STREET) EMERGENCY PHONE: (305) 566-6555

I. PRODUCT NAME: E-BOND G-100 EPOXY GROUT DATE: 10/10/90
COMPONENT "A" RESIN

II. HAZARDOUS INGREDIENTS

BISPHENOL A DIGLYCIDYL ETHER RESIN
CAS #25068-38-6

PEL & TLV NOT ESTABLISHED

N-BUTYL GLYCIDYL ETHER
CAS #2426-08-6

PEL 50 ACGIH TLV 25 270 MG/m3

III. PHYSICAL DATA

BOILING POINT: 200° F SPECIFIC GRAVITY: 2.08 + .02
VAP PRESS: (MMHG) N/A MELTING POINT: N/A
VAP DENSITY: Greater than 1 EVAPORATION RATE: N/A

SOLUBILITY IN WATER: Negligible

APPEARANCE & ODOR: Beige Liquid, Slight Odor

IV. FIRE & EXPLOSION DATA

FLASH POINT: 173° F METHOD USED: Closed Cup
FLAMMABLE LIMITS: LEL: N/A UEL: N/A

EXTINGUISHING MEDIA: Water Fog, Alcohol Foam, CO2, Dry Chemical.

FIRE & EXPLOSION HAZARDS:

Decomposition and Combustion products may be toxic. Use full protecting clothing (See Section VIII). Use water to cool fire-exposed container.

FIRE FIGHTING EQUIPMENT:

Use a positive pressure, self-contained breathing apparatus.

V. REACTIVITY DATA

STABILITY: UNSTABLE: STABLE: X

CONDITIONS TO AVOID: Elevated temperatures, strong oxidizing & reducing agents, acids, strong oxidants & epoxy resins under uncontrolled conditions.

INCOMPATIBILITY: Acids, Base and Amine Compounds under uncontrolled conditions.

HAZARDOUS POLYMERIZATION: Will not occur.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: Carbon Monoxide and Carbon Dioxide, and Aldehydes.

VI. HEALTH HAZARDS

INHALATION: Inhalation of vapors could cause headaches, nausea, dizziness and respiratory tract irritation.

SKIN: Product is moderately irritating to the skin. May cause skin irritation and/or sensitization after repeated contact.

EYE CONTACT: May cause eye irritation. Repeated contact of eyes may cause severe eye injury. Damage may be irreversible.

INGESTION: Expected to be slightly toxic by this route.

SIGNS & SYMPTOMS OF EXPOSURE: A skin sensitizer. Mild skin and eye irritant.

CARCINOGENICITY: NOT ESTABLISHED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Pre-existing eye, skin and respiratory disorders may be aggravated by exposure to this product. Pre-existing skin or respiratory allergies may increase the chance of developing increase allergy symptoms from exposure to this product.

EMERGENCY AND FIRST AID PROCEDURES: Flush eyes with plenty of water for 15 minutes while holding eye lids open. Get medical attention. Remove contaminated clothing/shoes and wipe excess from skin. Flush skin with water, wash with soap and water. If irritation occurs GET MEDICAL ATTENTION. Wash clothing before re-use.

INHALATION: Remove victim to fresh air and provide oxygen if breathing is difficult, give artificial respiration if not breathing. GET MEDICAL ATTENTION.

INGESTION: Do not induce vomiting. If vomiting occurs spontaneously keep head below hips to prevent aspiration and liquid into lungs. GET MEDICAL ATTENTION.

PRODUCT NAME: E-BOND G-100 EPOXY GROUT - COMPONENT "A" RESIN
PAGE TWO

VII. PRECAUTIONS FOR SAFE HANDLING & USE

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED.

Absorb into sand or other absorbent material. Shovel into closed container for disposal. Wear protective equipment specified below. Flush contaminated area with water.

WASTE DISPOSAL METHOD: Place in appropriate disposable facility in compliance with Local, State and Federal Protection Agency regulations. Keep out of surface waters. Sewers and water ways entering or leading to surface waters. Notify authorities of when any exposure to the general public or environment occurs and/or is likely to occur. DO NOT HEAT OR CUT EMPTY CONTAINERS WITH ELECTRIC OR GAS TORCH.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Avoid contact with skin, avoid breathing vapor, mist or spray. Store in closed, cool and dry areas. Provide good ventilation, wash after handling, for Industrial Use Only. Keep away from heat and open flame.

VIII. CONTROL MEASURES

VENTILATION:

Good mechanical ventilation and local exhaust. Control airborne concentration below exposure limits.

PROTECTIVE GLOVES: Wear Impervious gloves.

EYE PROTECTION:

Wear splash proof chemical goggles. Eye wash fountain should be available.

RESPIRATORY PROTECTION:

Use NIOSH APPROVED RESPIRATOR for organic vapors if required.

OTHER PROTECTIVE EQUIPMENT: Wear protective equipment to prevent exposure and personal contact. Use of BARRIER CREAM is recommended.

WORK/HYGIENIC PRACTICE: Use good caution and personal cleanliness. Avoid contact with eyes, skin and clothing. Avoid breathing vapors, mists, or sprays. Use only with adequate ventilation contaminated clothing to be washed before re-use.

D.O.T. CLASS: COMBUSTIBLE LIQUID CLASS 3B (Not applicable for packaging having a rate of compacity of 100 gallons or less).

UN NUMBER: UN 1993

HAZARDOUS INGREDIENT(S): N/A

D.O.T. LABELS: NONE

C-61

PRODUCT NAME: E-BOND G-100 EPOXY GROUT - COMPONENT "A" RESIN
PAGE THREE

MATERIAL SAFETY DATA SHEET

E-BOND EPOXIES, INC. FORT LAUDERDALE, FLORIDA 33307
P. O. BOX 23069 (501 N.E. 33RD STREET) EMERGENCY PHONE: (305) 566-6555

I. PRODUCT NAME: DATE: 2/20/87

E-BOND G-100 EPOXY GROUT
COMPONENT "B" HARDENER

II. HAZARDOUS INGREDIENTS

*POLYETHYLENE POLYAMINE & MODIFIED
POLYETHYLENE POLYAMINE ADDUCT WITH
FATTY ACID

*A MIXTURE OF
DIETHYLENE TRIAMINE
CAS #111-40-0

TLV 1 ppm(Skin) PEL NOT ESTABLISHED

TRIETHYLENETETRAMINE
CAS #112-24-3

PEL & TLV NOT ESTABLISHED

TETRAETHYLENE PENTAMINE
CAS #112-57-2

PEL & TLV NOT ESTABLISHED

III. PHYSICAL DATA

BOILING POINT: 300°F. SPECIFIC GRAVITY: .97 to .99
VAP PRESS:(MMHG) LESS THAN 1 MELTING POINT: N/A
VAP DENSITY: Greater than 1 EVAPORATION RATE: N/A
SOLUBILITY IN WATER: Partially Soluble

APPEARANCE & ODOR: Clear Amber Liquid, Ammonia Amine Odor

IV. FIRE & EXPLOSION DATA

FLASH POINT: 200°F. METHOD USED: Setaflash
FLAMMABLE LIMITS: LEL: N/E UEL: N/E

EXTINGUISHING MEDIA: Water Fog, Alcohol-Foam, Co2, Dry Chemical

FIRE & EXPLOSION HAZARDS: Decomposition and Combustion products may be
toxic. Carbon Monoxide, Carbon Dioxide & Oxides of Nitrogen may be
produced in fires. Use full protecting clothing (See Section VIII). Use
water to cool fire-exposed container.

FIRE FIGHTING EQUIPMENT: Use a positive pressure, self-contained
breathing apparatus.

V. R E A C T I V I T Y D A T A

STABILITY: UNSTABLE: STABLE: X

CONDITIONS TO AVOID: Elevated temperatures, strong oxidizing & reducing agents, acids, strong oxidants & epoxy resins under uncontrolled conditions.

INCOMPABILITY: Acids, Base and Amine Compounds under uncontrolled conditions.

HAZARDOUS POLYMERIZATION: Will not occur.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: Ammonia, Carbon Monoxide Oxides of Nitrogen and Carbon Dioxide gases may be formed.

VI. H E A L T H H A Z A R D S

INHALATION: Inhalation of vapors could cause headaches, nausea, dizziness and respiratory tract irritation.

SKIN: Product is moderately irritating to the skin. May cause skin irritation and/or sensitization after repeated contact.

EYE CONTACT: May cause eye irritation. Repeated contact of eyes, may cause severe eye injury. Damage may be irreversible.

INGESTION: Expected to be slightly toxic by this route.

SIGNS & SYMPTOMS OF EXPOSURE: A skin sensitizer. Milk skin and eye irritant.

CARCINOGENICITY: NOT ESTABLISHED

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:

Pre-existing eye, skin, and respiratory disorders may be aggravated by exposure of this product. Pre-existing skin or respiratory allergys may increase the chance of developing increase allergy symptoms from exposure to this product.

EMERGENCY AND FIRST AID PROCEDURES: Flush eyes with plenty of water for 15-minutes while holding eye lids open. Get medical attention. Remove contaminated clothing/shoes and wipe excess from skin. Flush skin with water, wash with soap and water. If irritation occurs GET MEDICAL ATTENTION. Wash clothing before re-use.

INHALATION: Remove victim to fresh air and provide oxygen if breathing is difficult, give artificial respiration if not breathing. GET MEDICAL ATTENTION.

INGESTION: Do not induce vomiting. If vomiting occurs spontaneously keep head below hips to prevent aspiration and liquid into lungs. GET MEDICAL ATTENTION.

PRODUCT NAME: E-BOND G-100 COMPONENT "B" HARDENER
PAGE TWO

VII. PRECAUTIONS FOR SAFE HANDLING & USE

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED.

Absorb into sand or other absorbent material. Shovel into a clean container for disposal. Wear protective equipment specified below. Dilute contaminated area with water.

WASTE DISPOSAL METHOD: Place in appropriate disposable facility in compliance with Local, State and Federal Protection Agency regulations. Keep out of surface waters. Sewers and water ways entering or leading to surface waters. Notify authorities of when any exposure to the general public or environment occurs and/or is likely to occur.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Avoid contact with skin. Avoid breathing vapor, mist or spray. Store in closed, cool and dry area. Provide good ventilation, wash after handling, for Industrial Use Only. Keep away from heat and open flame.

VIII. CONTROL MEASURES

VENTILATION:

Good mechanical ventilation and local exhaust. Control airborne concentration below exposure limits.

PROTECTIVE GLOVES: Wear impervious gloves.

EYE PROTECTION:

Wear splash proof chemical goggles. Eye wash fountain should be available.

RESPIRATORY PROTECTION:

Use NIOSH APPROVED RESPIRATOR for organic vapors if required.

OTHER PROTECTIVE EQUIPMENT: Wear protective equipment to prevent exposure and personal contact. Use of BARRIER CREAM is recommended.

WORKING/HYGIENIC PRACTICE: Use good caution and personal cleanliness. Avoid contact with eyes, skin and clothing. Avoid breathing vapors, mists, or sprays. Use only with adequate ventilation. Contaminated clothing to be washed before re-use.

D.O.T. CLASS: CORROSIVE LIQUID, N.O.S.

UN NUMBER: 1760

HAZARDOUS INGREDIENT(S): (ALIPHATIC AMINE)

D.O.T. LABELS: CORROSIVE LIQUID, N.O.S.

PRODUCT NAME: E-BOND G-100 HARDENER
PAGE THREE EPOXY GROUT COMPONENT B

JRR/smp/90/(E030U01-XXXII)

"THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH. NO WARRANTY, EXPRESSED OR IMPLIED, IS GIVEN REGARDING ACCURACY OF THESE DATA AND RESULTS OBTAINED FROM USE THEREOF. CONSULT E-BOND EPOXIES, INC, FOR FURTHER INFORMATION."

PVC PIPE
SPECIFICATIONS

PVC PIPE 2 IN. DIA.
SCHEDULE 40

PVC 90° ELBOWS 2 IN. DIA.
SCHEDULE 40

PVC COUPLINGS 2 IN. DIA.
SCHEDULE 40

**SCHEDULE 40 ELBOWS –
STANDARD RADIUS**

RIGID NON-METALLIC ELBOWS (PVC), FOR ABOVE SCHEDULE 40

SIZE: 2 INCH DIAMETER (NOMINAL) WITH BELLED END (ONE END ONLY)

SUPPLIED AS: CARLON #UA9AJ, OR EQUIVALENT

RECOMMENDED SOURCE:

WARD ELECTRIC

DEALERS ELECTRIC

CENTRAL ELECTRIC

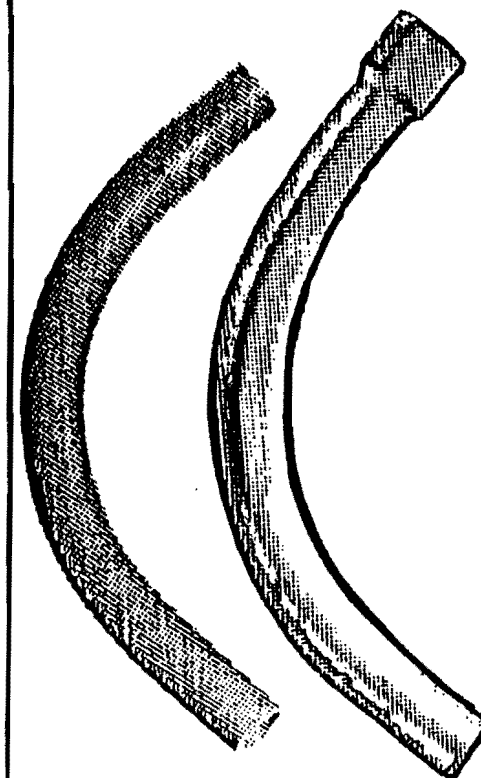
WESCO

GESCO

Plain End Part No.	Belled End Part No.	Size	Plain End Pkg. Qty.	Belled End Pkg. Qty.
UA9AD	—	½"	50	—
UA9AE	—	¾"	25	—
UA9AF	—	1"	25	—
UA9AG	UA9AGB	1½"	20	20
UA9AH	UA9AHB	1½"	25	25
UA9AJ	UA9AJB	2"	20	15
UA9AK	UA9AKB	2½"	10	10
UA9AL	UA9ALB	3"	30	25/5
UA9AM	UA9AMB	3½"	25	20/5
UA9AN	UA9ANB	4"	25	20/5
UA9AP	UA9APB	5"	8	8/2
UA9AR	UA9ARB	6"	8	8/2

Item

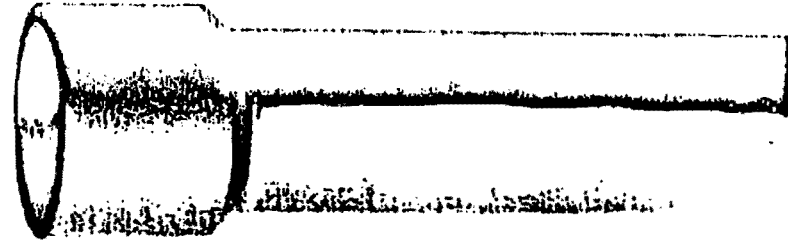
90°
Elbow



#TMP-0991/AVCS-06

SHEET 2 of 4

RIGID NON-METALLIC CONDUIT



RIGID NON-METALLIC CONDUIT (PVC) SCHEDULE 40

2 INCH DIAMETER (NOMINAL)

2.375 O.D. APPROX.

2.067 I.D. APPROX.

0.154 WALL APPROX.

SUPPLIED IN 10 FT. LENGTHS

SUPPLIED AS: CARLON #49011, OR EQUIVALENT

RECOMMENDED SOURCE:

WARD ELECTRIC

DEALERS ELECTRIC

CENTRAL ELECTRIC

WESCO

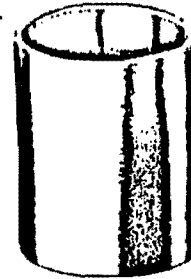
GESCO

PLUS 40 Heavy Wall

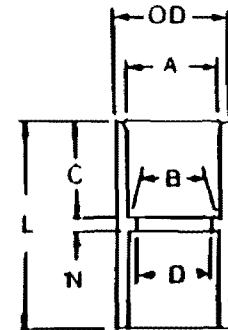
Nom. Size	Cat. No.	O.D.	I.D.	Wall	Wt. Per 100 Feet	Feet Per Bundle
1/2	49005	.840	.622	.109	17	100
3/4	49007	1.050	.824	.113	23	100
1	49008	1.315	1.049	.133	34	100
1 1/4	49009	1.660	1.380	.140	46	50
1 1/2	49010	1.900	1.610	.145	55	50
2	49011	2.375	2.067	.154	73	50
2 1/2	49012	2.875	2.469	.203	125	10
3	49013	3.500	3.066	.216	164	10
3 1/2	49014	4.000	3.548	.226	198	10
4	49015	4.500	4.026	.237	234	10
5	49016	5.563	5.047	.258	318	10
6	49017	6.625	6.065	.280	412	10

Rigid non-metallic conduit is normally supplied in standard 10' lengths, with one belled end per length. For specific requirements, it may be produced in lengths shorter or longer than 10', with or without belled ends.

STANDARD COUPLINGS



Socket type for joining non-metallic conduit.



RIGID NON-METALIC STANDARD COUPLINGS (PVC) SCHEDULE 40

SIZE: 2 INCH DIAMETER (NOMINAL)

SUPPLIED AS: CARLON #E940J, OR EQUIVALENT

RECOMMENDED SOURCE:

WARD ELECTRIC

DEALERS ELECTRIC

CENTRAL ELECTRIC

WESCO

GESCO

Part No.	Size	A	B	D	OD	C	N	L	Ctn. Qty.
E940D	1/2	.852	.836	.758	1 1/64	11/16	1/8	1 1/2	150
E940E	3/4	1.064	1.046	.948	1 5/16	1/4	1/8	1 5/8	100
E940F	1	1.330	1.310	1.210	1 5/8	15/16	1/4	2	50
E940G	1 1/4	1.677	1.655	1.535	1 63/64	1	1/8	2 1/8	30
E940H	1 1/2	1.918	1.894	1.755	2 15/64	1 1/8	1/8	2 3/8	25
E940J	2	2.393	2.369	2.190	2 17/64	1 3/16	1/8	2 1/2	30
E940K	2 1/2	2.890	2.868	2.688	3 1/16	1 5/8	1/4	3 1/16	20
E940L	3	3.515	3.492	3.375	3 11/32	1 3/4	1/16	3 13/32	25
E940M	3 1/2	4.015	3.992	3.780	4 1/2	1 7/8	1/4	3 5/8	20
E940N	4	4.515	4.491	4.265	5 3/32	2	1/4	3 3/4	15
E940P	5	5.593	5.553	5.097	6 1/4	1 5/16	3/12	4 1/16	8
E940R	6	6.658	6.614	6.115	7 1/2	2 1/16	1 1/4	4 5/8	5



POLYGUARD PRODUCTS - WEIGHT SCALE TAPE

DESCRIPTION

POLYGUARD Weight Scale Tape comprises a rubberized asphalt waterproofing element and a polypropylene mesh laminated to the outer surface. The total laminated thickness is sixty-five mils (0.065 inch). The tape is wound on a disposable release-treated strip sheet to prevent blocking in the roll.

APPLICATIONS

POLYGUARD Weight Scale Tape is applied to pavement surfaces in order to secure, on a temporary basis, weight scales, or traffic counter hoses.

No other use of these materials is to be made without prior approval of POLYGUARD as to service and method of application.

TECHNICAL DATA

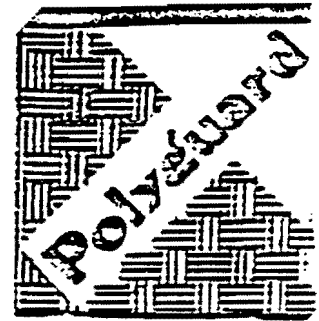
<u>PROPERTY</u>	<u>TYPICAL MEASUREMENT</u>	<u>TEST METHOD</u>
Total Thickness	65 mils (0.065 in.)	
Tensile Strength - Mesh	50 lbs./in.	ASTM D 382 Modified (1 in. opening)
Puncture Resistance - Mesh	200 lbs.	ASTM E 154
Pliability - 1/4" Mandrel	No cracks in mesh or rubberized asphalt	ASTM D 146 180°F. Bend @ 15°F.
Permeance (perm)	0.1 maximum	ASTM E 96 Method B (modified)

SOURCE

POLYGUARD Products, Inc.
Ennis, Texas 75120-0755
(214) 875-8421

PURCHASED AS:

**POYLGUARD WEIGHT SCALE TAPE
4 in. WIDE X 200FT. LONG ROLLS
3 ROLLS/PER CARTON
80 LBS./PER CARTON**



PRECAUTIONS:

Polyguard Weight Scale Tape should be applied only to pavement which is clean, dry, smooth, and free of debris. Temperature should be over 45° F.

If tape is being applied at under 50° F., primer may be required. Contact Polyguard for primer recommendations.

This material is offered for sale by POLYGUARD PRODUCTS, INC., only for the expressed purpose as described in this literature for purposes other than taught therein by POLYGUARD PRODUCTS, INC. shall be the responsibility of the purchaser and POLYGUARD PRODUCTS, INC. does not warrant nor will be responsible for any misuse of these products. POLYGUARD PRODUCTS, INC. will replace, F.O.B. Ennis, TX., materials not meeting our manufacturers' specifications, one year from date of sale.

Polyguard products as described herein are for industrial use only. The application of these products should be performed by workmen who are skilled in the application of materials described herein in accordance with manufacturers' specifications.

MATERIAL SAFETY DATA:

All Material Safety Data Sheets and precautionary labels should be read and understood by all user supervisory personnel and employees before using. Consult POLYGUARD PRODUCTS, INC., Material Safety Data Sheets and OSHA regulations for additional safety and health information for the products described herein. Purchaser is responsible for complying with all applicable federal, state, or local laws and regulations covering use of the product including waste disposal.

This is not a Material Safety Data Sheet and is not to be used as such. POLYGUARD has prepared separate Material Safety Data Sheets on each product.

MAINTENANCE:

Not required.

TECHNICAL SERVICE:

Assistance and information is available from any POLYGUARD distributor or dealer, or contact us at our Ennis, TX., office.

SOURCE:

**POLYGUARD PRODUCTS, INC.
Ennis, Texas 75120-0755
(214) 875-8421**

READY-TO-USE CEMENT MIXES



MATERIAL SPECIFICATION

#TMP 0991/AVCS-08
READY MIX CONCRETE

AVAILABLE AS:

SAKRETE
REDI-MIX
HANDI-MIX

REQUIREMENTS:

80 lbs. BAG mixed with a ratio of 4 quarts of water per bag (typically), unless otherwise specified by the manufacturer, or as directed by the TTI Inspector/s assigned to this project.

The manufacturer's instructions, or the TTI Inspector can stipulate the acceptable water content. Where additional water is stipulated, it shall be added in one (1) quart increments.

If too much water has been added for a given amount of cement, the contractor shall add more bag mix to attain the correct consistency. It shall not be permissible to pour off excess water from the top of the cement/water mixture. More cement must be added to correct the consistency.

Amount of Cement Per Installation Site

(Typically) four (4) to five (5) bags per cabinet (slab) foundation.

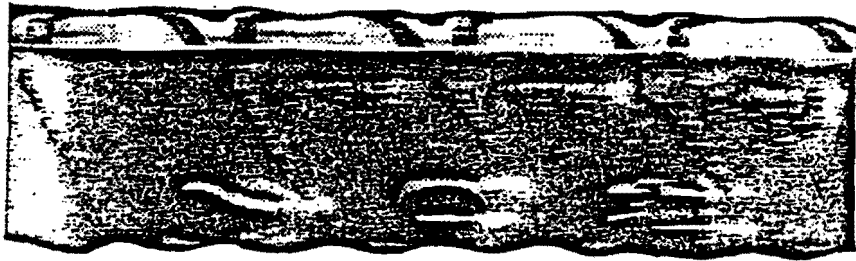
RECOMMENDED SOURCE

As available in the field

REINFORCING BARS

Standard Round Concrete

A.S.T.M. A-615 Grades 40 and 60



New bar Nos. based on number of $\frac{1}{8}$ inches included in nominal diameter of bar. Bars numbered 9, 10, 11 are equivalent in weight and nominal cross-sectional area to old type 1, $1\frac{1}{8}$, $1\frac{1}{4}$ inch square bars.

Bar Sizes		Nominal Dimensions			Weight Pounds per Foot
New No.	Old In.	Diameter Inches	Cross- Sectional Area Sq. In.	Perimeter Inches	
3	$\frac{3}{8}$	.375	.11	1.178	.376
4	$\frac{1}{2}$	.500	.20	1.571	.668
5	$\frac{5}{8}$	.625	.31	1.963	1.043
6	$\frac{3}{4}$	.759	.44	2.356	1.502
7	$\frac{7}{8}$	.875	.60	2.749	2.044
8	1	1.000	.79	3.142	2.670
9	1	1.128	1.00	3.544	3.400
10	$1\frac{1}{8}$	1.270	1.27	3.990	4.303
11	$1\frac{1}{4}$	1.410	1.56	4.430	5.313
14-S		1.693	2.25	5.320	7.650
18-S		2.257	4.00	7.090	13.600

NOTE:
See SHEET 2, following,
for specific ORDERING
and SOURCING information!

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#TMP-0991/AVCS-09

(SHEET 1 of 2)

MATERIAL SPECIFICATION #TMP 0991/AVCS-09 REBAR

REQUIREMENTS:

3/8" rebar

13' per box placed as per installation instructions:

2 - 3' sections

2 - 2' sections

3 - 1' sections

Available in 10' or 20' sections. Purchase of either length depends on hauling capabilities of Subcontractor.

RECOMMENDED SOURCE:

As available in the field.

C-73

#TMP-0991/AVCS-09
(SHEET 2 of 2)

Flexane 80 Liquid Urethane



Flexane 80 LIQUID URETHANES

FLEXANE 80 LIQUID

Offers a longer working time of approximately 30 minutes and a more flexible cured hardness of 87 Shore A.

STOCK NO.

15800

UNIT SIZE

1 lb.

RECOMMENDED SOURCE:

BRIGGS-WEAVER, INC.
P.O. Box 24500
Houston, TX 77229-4500
(713) 672-1100

Typical Physical Properties, Flexane® Urethanes (7 days, room temperature)

	Flexane 80 Liquid
Mix Ratio Resin: Curing Agent, ratio % by wt.	77:23
Specific volume, ml/lb.	26.5
Coverage/lb. @ 1/8" thick in sq. in.	106
Viscosity with hardener (cps)	10000
Pot life of 1 lb. in minutes at 75°F	30
Dormant time (hours)	10
Operating temperature maximum °F	Dry: 180
	Wet: 120
Cured hardness, Shore A	87
Tensile strength, psi ASTM D 412	2100
Cure shrinkage, %/in. ASTM D 2566	0.0018
Dielectric strength ASTM D 148	350
Tear resistance, psi ASTM D 624	250

Solvent loss allowance

(SHEET 1 OF 1)

#TMP-0991/AVCS-10

C-74

PEDESTAL MOUNTING MATRIX for DETECTOR CABINET

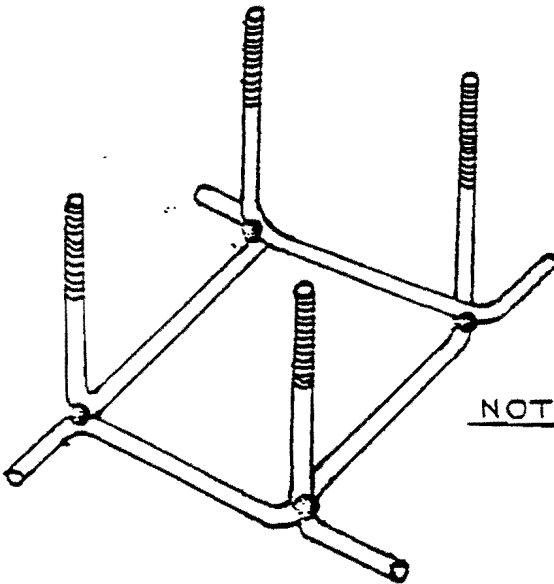
MATRIX WELDMENT

Formed and bent to shape, from Four (4) each of Item #1
of ECP Drawing #ECP-12-01-90 (3/4-10x18x3 Low Carbon Steel
Anchor Bolts) and Welded, as shown below.

SEE - ECP DRAWING No. ECP-12-01-90 (ATTACHED)!!!

SOURCE:

ECP
ELECTRICAL & CONSTRUCTION PRODUCTS
1707 Hydro Drive
Austin, Texas 78728
(512) 251-7139



NOTE:

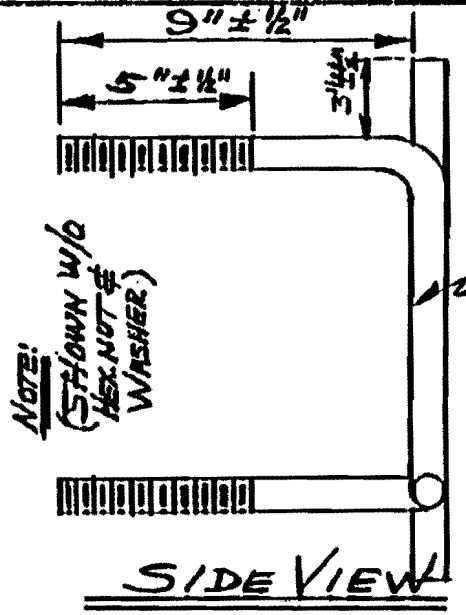
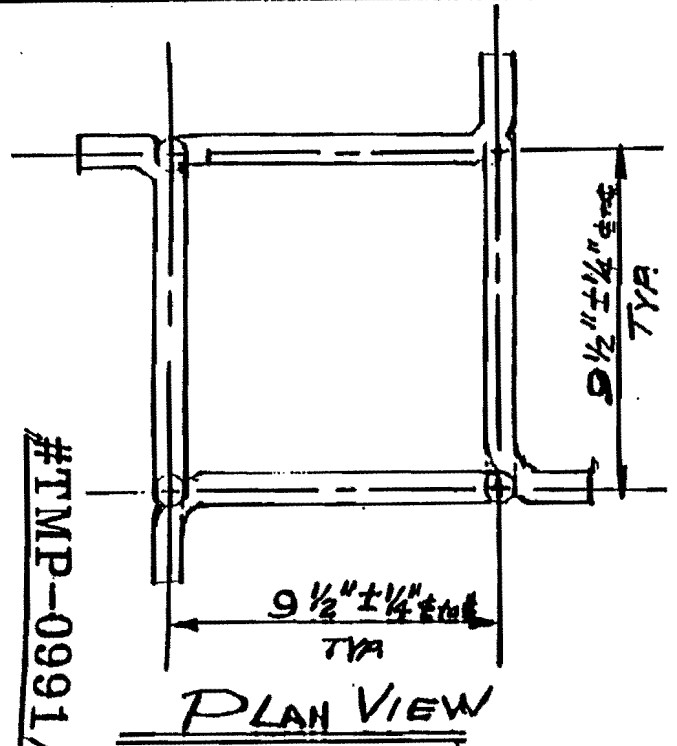
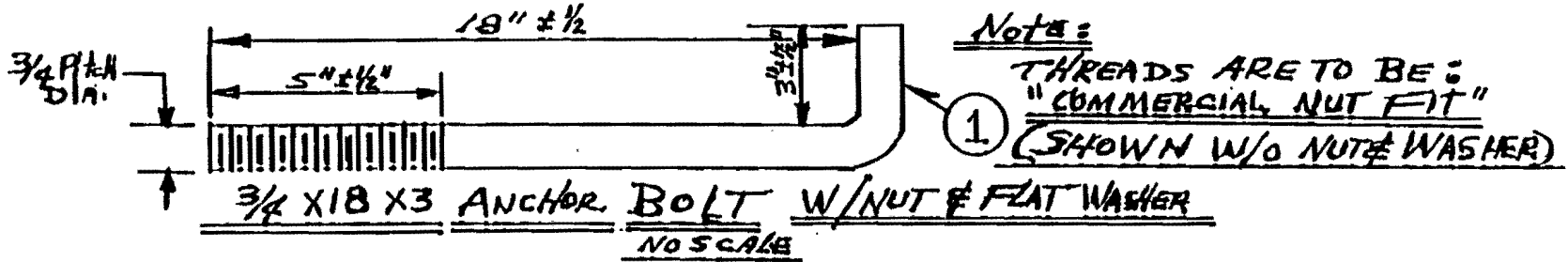
ONE (1) EACH REQUIRED,
PER EACH INSTALLATION!

NOT TO SCALE

C-75

#TMP-0991/AVCS-011

SHEET 1 of 2



Note:
 THIS MATRICE IS MFG. FROM $\frac{3}{4}$ -10 X 18 X 3 ANCHOR BOLT AS SHOWN ABOVE. (4 REQ'D.)
 ANCHOR BOLTS ARE LOW CARBON STEEL, H.D.G.*
 WASHERS & HEX. NUTS ARE STEEL, H.D.G.

NO SCALE * HOT-DIPPED, GALVANIZED

<u>PEDESTAL MOUNTING MATRICE</u> <u>FOR - TRAFFIC CABINET</u>		
SCALE	DRAWN BY	
NONE	T. ZC.	
	REVISED	
ELECTRICAL & CONSTRUCTION PRODUCTS (512) 251-2444		
1707 HYDRO DR. - AUSTIN, TX 78728		
FAX (512) 251-3136		
DATE	APPROVED BY	DRAWING NUMBER
12/1/90	TOM CLARK	ECP 12-01-90

#TMP-0991/AVCS-011
 SHEET 2 OF 2