Diamond Plate Safety Mat
Technical Manual

IMPORTANT

This manual must accompany the product throughout its working life. Those persons responsible for the product must ensure that all persons involved in the installation, commissioning, operation, maintenance and servicing of the product have access to all the information contained in this manual.

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1. PRODUCT DESCRIPTION

The **TAPESWITCH Diamond Plate Safety Mat (DPM)** is a pressure-sensitive safety device designed to protect operators working at or near dangerous machinery.

The DPM is designed to meet and exceed the requirements of BS EN1760-1: 1998. It is important for the user to select a safety interface that complies with annex B of BS EN954-1: 1996. That will establish a complete safety machine interface system. In addition, the category rating will then be at the level of the attached controller to a maximum category level of 3.

When correctly installed at and interfaced to a machine, the DPM will: (a) detect a person present in the dangerous area and prevent dangerous motion from occurring. (b) Detect a person entering the dangerous area and cause dangerous motion to cease before the person can reach the dangerous parts. (c) A combination of (a) and (b). The area covered by the DPM depends on which of the functions (a), (b) or (c) is to be performed.

2. PRODUCT CONSTRUCTION

The active area of the DPM is made of a heavy gauge 6061 T6 aluminum deck plate(s) covering a special sensing mat. The inactive border of the DPM is made of an extruded aluminum section featuring a standard ramped edge design, effectively eliminating any trip hazard. An optional square edge section is available for situations where the DPM butts up to the machine, wall, etc. (Use caution when selecting the square edge border, as the square edge, exposed to foot traffic constitutes a trip hazard.) The border incorporates a flexible PVC dust seal to prevent a failure due to a build up of dirt or swarf under the sensor.

The DPM is constructed with an internal fail-safe switch sensor. This sensor is a normally-open, pressure-sensitive device that uses a top and bottom conductor kept apart by an insulating spacer. When pressure is applied to the DPM surface, the sensor's top and bottom conductors make contact; when the pressure is removed, the conductors separate again.

The lead wire is a stainless steel, shielded 22 AWG, 5-conductor cable. The standard length is 6 feet. Other lengths, up to a maximum length of 100 feet are available as an option. The standard lead location for single mat systems is SLS – short side, left, single lead, seven inches from the outside edge. Large Diamond Plate Mat systems requiring multiple sensing mats typically have multiple lead exits from the assembly.

Although a single square or rectangular DPM having a maximum total sensing area of 32 sq. ft, and an active area width no greater than 48 inch, is preferred for ease of handling and installation, many shape and size configurations are possible. Consult Tapeswitch engineering for a feasibility assessment.

The DPM has an inactive zone comprised of the aluminum edge extrusion which surrounds the outer edges. This inactive zone is nominally 3 ½ inches wide per side or 7 inches greater than the overall dimensions of the active area. Refer to *Figure One*. This should be considered when specifying the size of DPM for a particular application.

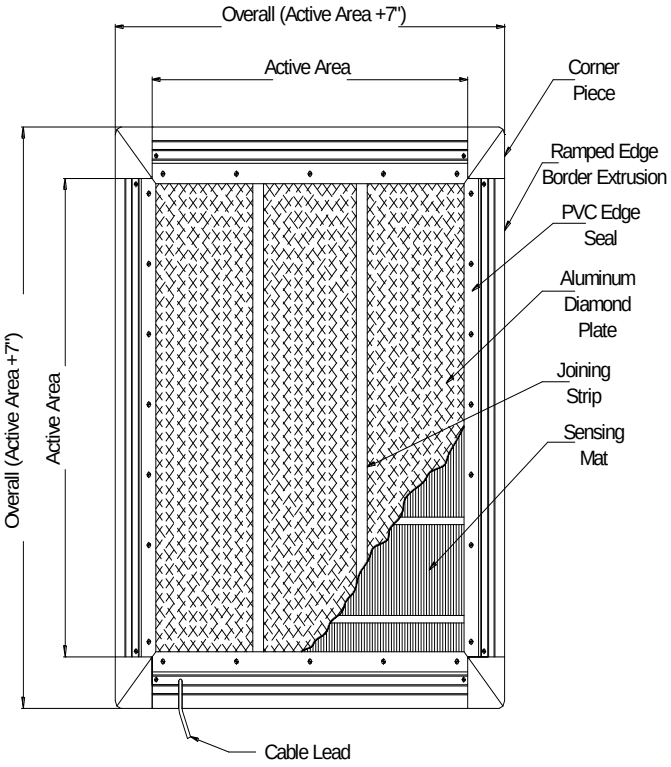


Figure One

3. DETERMINE MINIMUM MAT SIZE

The dimensions of the sensors and their layout must be such that access to the machine is not possible without stepping on the DPM. The dimensions of the dangerous area depend upon each application. The parameters to be considered include:

- Speed of walk or arm movement.
- Arm length.
- Length of stride.
- Response time of system.
- Position of inactive zones.
- Over travel of dangerous parts after stop signal is generated.

In order to determine the position of the front edge of the active zone, it is necessary to consider the stopping performance of the machine.

Any machine, regardless of the efficiency of its braking system, will take a certain time to come to rest after a stop signal is generated. From the instant a person's foot touches the mat to the instant that dangerous motion actually ceases is called the overall system response time.

The overall system response time, T, is given by the following calculation:

T = t1 + t2

Where **t1** (milliseconds) = The maximum response time of the safety device between the actuation of the sensor and the generation of a stop signal = 30 ms.

and **t2** (milliseconds) = The response time of the machine between receiving a stop signal from a safety device and the dangerous parts coming to rest.

The dangerous parts will obviously continue to move during this time. The DPM must therefore be dimensioned such that the nearest point at which a person could first touch the mat is at a minimum distance from the dangerous parts before they have stopped.

This must take into account the worst case conditions illustrated in *Figure Two* where a person could be a full stride onto the DPM before the DPM is actuated. This means that a certain distance from the front edge of the DPM and the nearest dangerous parts must be maintained.

This distance is the "minimum separation distance". All possible directions of approach must be considered. The minimum separation distance, **S** (mm), can be calculated using the following formula:

S = (1600 x T) + 1200

S (millimeters) is the minimum active distance required.

The overall system response time, **T**, should be measured several times and the highest value recorded, plus a suitable allowance for brake deterioration, should be used in the calculation of the minimum separation distance.

To determine the overall size needed, use this simple formula below: Active area + 7 inch = overall length or width.

Note: 7 inch is for ramped edge on both sides
Square edge border is 1-7/8 inches wide

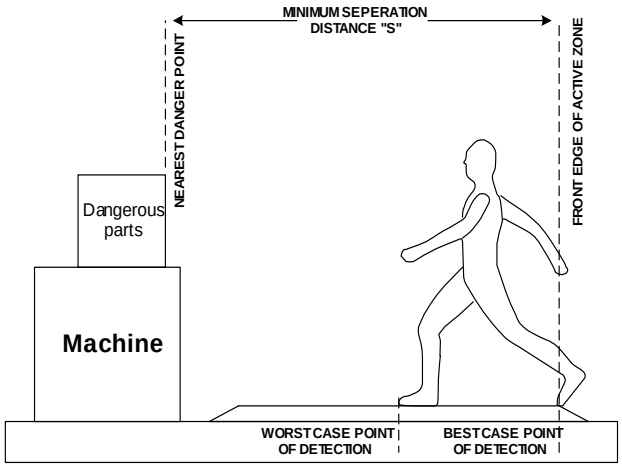


Figure Two

For additional assistance in determining the size, layout or mounting of the DPM, call Tapeswitch Corporation at **1-800-234-8273.**

WARNING: *The Tapeswitch Diamond Plate Safety Mat is designed to protect operators working at or near dangerous machines. It can only perform that function if it is correctly fitted and interfaced to a suitable machine. Every effort has been made in the production of this manual to provide comprehensive and accurate information. It is the responsibility of the user to ensure that all persons involved in the installation of the product have the knowledge, training, and experience necessary, and that they are fully conversant with all laws, rules, regulations, and codes of practice pertaining to their task.*

4. INSTALLATION

The DPM must be fixed permanently in position to prevent accidental displacement due to vehicle or personnel traffic. The DPM is designed to provide simple, fast, and easy mounting provisions for the installer. The basic construction provides the necessary means for affixing the DPM in the desired location.

The DPM is manufactured to the size and shape requirements of the customer. It is fully pre-assembled and tested at the factory, and is shipped either fully assembled, or disassembled, depending on normal freight handling requirements. Re-assembly and installation is fast and easy.

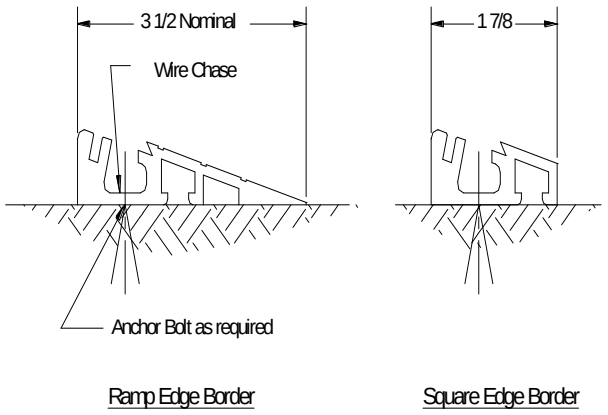


Figure Three

1. The surface on which the DPM is mounted must be sound, flat, and rigid. In most cases, a flexible floor surface will not be suitable. The DPM can tolerate gentle irregularities, but may become actuated by ridges, bumps, bows, or dips that exceed 1/8" over any 4-foot-minimum span. **Where the surface is rough, cracked or breaking up, it should be corrected using appropriate sealing and leveling compounds. If you think that flatness may be an issue in your application, please contact Tapeswitch for technical assistance.**

2. Remove contents from packaging. Basic contents should include:

a. Aluminum framing
b. Aluminum corner pieces
c. Diamond Plate sections
d. Black sensing mat(s)
e. "H" joining strips (gray)
f. Yellow retaining strips
g. Installation hardware

3. Position the black sensing mat(s) in the proper locations with cable leads in correct orientation. (See *Illustration 1*)

4. Install aluminum frame around sensing mat, routing cables through provided openings. Use provided #8-32UNC flat head machine screws to attach corner connectors. (See *Illustrations 2 & 3*)

5. Check frame squareness and permanently anchor frame to the floor in designated area (cable way) under the yellow retaining strips as required. Anchor hardware is not provided by Tapeswitch. (See *Figure 3)*.

6. ***Note: This step may be omitted for Diamond Plate Mats that are shipped fully assembled***. Install diamond plate as follows (See *Illustrations 4, 5 and 6*):

a. Place one plate on sensing mat inside frame at one side.

b. Temporarily support one end slightly (½ inch – ¾ inch).

c. Use silicone spray or soapy water to lightly lubricate routed edge of diamond plate and slide gray "H" joining strip onto routed edge of diamond plate.

d. Lubricate and slide next diamond plate into position.

As an alternative method for items c and d above, see the instructions and illustration on the following page.

e. Transfer temporary support to this plate and repeat steps a, b, and c until all plates are in place.

7. Reinstall the yellow border retaining strips using the pre-drilled holes and the supplied #8 x 3/8 flat head sheet metal screws (See *Illustrations 7 & 8*).

8. Initial mat installation is complete.

NOTE: WARRANTY WILL BE VOIDED IF MAT IS NOT ANCHORED TO FLOOR OR MOUNTING SURFACE.

Alternate assembly method for Section 6, steps c and d.

An alternative method of assembling the aluminum plates is to use a putty knife to slide each diamond plate into the gray ”H” joining strip as shown in the image below.

5. COMMISSIONING CHECKS

The commissioning checks should be carried out by persons who are competent and who have access to all the information supplied with the machine and its safety equipment. The results of the examination should be recorded, and both the user and the employer of the person performing the examination should keep copies of this record.

The person carrying out the examination should, as a minimum, perform the following checks:

a. Check that the DPM is suitable for use in the application.

i.) Check that the level of safety integrity provided by the DPM is suitable for the level of risk presented by the machine.

ii.) Check that the environment is suitable for the use of the DPM.

b. Check that the dimensions and position of the DPM are correct, taking into account the operating mode. For this purpose it will be necessary to check the overall system response time using a device designed for this purpose.

c. Check that adequate measures have been taken to prevent access to the dangerous parts of the machine from any direction not covered by the DPM.

d. Examine the machine controls and connections to the DPM for correctness.

e. Check that the DPM is fixed in position and that no trip hazards are present within the dangerous area.

f. Except where the device is solely used as a trip device, check that it is not possible to stand in the dangerous area without actuating the DPM.

g. Check that it is not possible for the dangerous parts of the machine to be set in motion while the DPM is actuated.

h. Check that actuation of the DPM during a dangerous phase of operation (of the machine) results in the dangerous parts being arrested or in an otherwise safe condition, before any part of a person could reach them.

i. Check that after a machine has been stopped by the actuation of the DPM, it is not possible for the dangerous parts to be set in motion until the DPM has been cleared, a reset button has been operated and released, and the machine start control has been re-operated.

j. Check that the removal of power from the DPM prevents further operation of the machine. It should not be possible for the dangerous parts of the machine to be set in motion until power has been restored, a reset button has been operated and released, and the machine start control has been re-operated.

k. Check that the DPM operates over the whole active area by walking, 'heal to toe' over the whole area in two directions as shown in *Figure Four*.

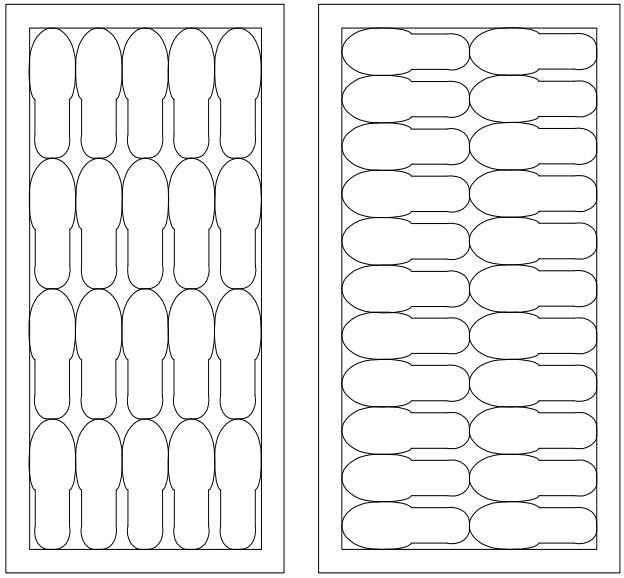


Figure Four

l. Examine the stopping performance monitor (if fitted) to ensure that it is fitted and functioning correctly. Ensure that the means by which the stopping performance can be assessed by the operator is indicating correctly.

m. Test the muting arrangements (if fitted). Ensure that the muting is only possible during non-dangerous operation and ensure that the safety level of the muting device is at or above that of the safety mat, but never below.

n. Examine brakes and clutches (if fitted) as recommended.

Operation of the DPM is straightforward. Once installed and interfaced to a machine, the DPM will be an active safety sensor. The DPM will actuate each time the active surface is stepped on.

Daily use of the DPM by one or several persons will not lead to any deterioration of sensor performance. In addition, the DPM can withstand heavy loads from the wheels of vehicles, i.e. pallet-loaders, forklifts and automobiles.

The DPM does not need any maintenance; however, the life of the DPM will be considerably increased if a basic cleaning routine is observed.

The surface of the DPM should be cleaned daily. Dust and dirt should be swept off the mat. Note: While water resistant, it should not be cleaned with pressurized water. Grease and oil on the mat can cause it to become slippery. Spills should be removed immediately or covered with sawdust and removed at the next daily cleaning.

The frequency of cleaning depends on the nature of the environment. In relatively clean environments, where the DPM is rarely exposed to water or other fluids, monthly cleaning will be sufficient. In dirtier environments, weekly cleaning may be necessary.

> **WARNING:** Servicing of DPM should only be carried out by qualified personnel. Servicing involves the exposure of terminals and devices that carry potentially lethal voltages. Only those persons with the appropriate training and experience should undertake this work. If there are any questions call Tapeswitch Corporation at **1-800-234-8273.**

IMPORTANT: After any part of the system has been replaced, the installation should be considered as new and, as such, should be re-commissioned in accordance with the instructions in this manual.

When ordering a replacement sensor, state the part number, serial number and product information code on the label of the DPM needing replacement.

6. TECHNICAL INFORMATION

1) Physical Properties:
Strength data of aluminum alloys is based on the tensile yield and shear strengths. The diamond tread plate and extrusion sections are made of 6061-T6 material, while the cast corners are made of 319.0-F alloy.

2) Active Zone:
Aluminum diamond-tread plate, non-sparking and non-magnetic. Resistant to atmospheric corrosion and many industrial corrosion agents to ASTM B632.

3) Inactive Zone:
Extruded aluminum edging joined at corners with a cast aluminum corner.

4) Sensor Switch:
Twin metallic conductors extruded with a soft PVC jacket.

5) Cable:
A 22 AWG/ 5-conductor shielded (75% stainless steel wire braid) control cable with black, red, yellow, white, green/yellow color-coded PVC insulation, inner gray PVC jacket and a flame resistant clear PVC jacket, UL and CSA AWM approved for 300 volts and 80 degrees centigrade. The nominal diameter of the cable is 0.300 inches and the maximum length is 30 meters.

6) Sensor Mat:
Ribbed Koroseal® Mat, top and bottom.

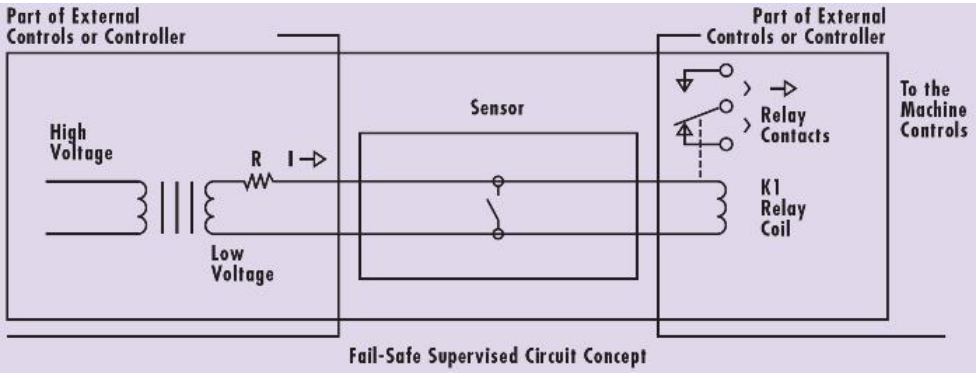
Technical Specifications

Requirement Grade		BS EN 1760-1: 1998 and BS EN951-1: 1996 Category Rating: To Maximum Category 3. See attached controller.
Power Consumption		6 VA (with PSSU Series Controller)
Response Time		<25 ms
Number of Operations		3 million typical
Actuating/Test Force		<300n (67 lbs.) with an 80mm diameter test piece.
Temperature Range	Operation	0 to 50 degrees C
	Storage	-20 to 70 degrees C
Protection Rating		IP54
Inactive Zone		3 1/2 inches wide around outer edge of sensor. (Ramped Edge)
Operating Voltage		24V DC
Weight (approx.)		6.5 lbs.ft ^{2}
Vehicle Traffic		Pallet-loaders, forklifts and automobiles, as well as to detect a person using walking aids (cane, walker, etc.).
Top Surface Material		Aluminum plate aluminum alloy 6061 T6.

UNDERSTANDING THE FAIL-SAFE CONCEPT

Principle of Safety

The fail-safe concept monitors the sensor status at all times. In the event of a failure, the fail-safe concept will simulate a protected position. The “protected” position is when the sensor is activated (closed) and the “normal” or “run” position is when the sensor is not activated (open).



- Normal Conditions – constant current flow (I) holding relay coil (K1) energized
- Loss of Power – no current flow (I) and relay coil (K1) is de-energized
- Actuation of Sensor – relay coil (K1) is shorted and de-energized
- Failure of Sensor in the closed position – relay coil (K1) is shorted and de-energized
- Failure of Sensor in the open position – (broken wire, switch or conductor) interrupts current flow (I) and relay coil (K1) is de-energized
- Resistor R – limits current flow through the sensor when actuated

Fail-Safe (4 wire system)

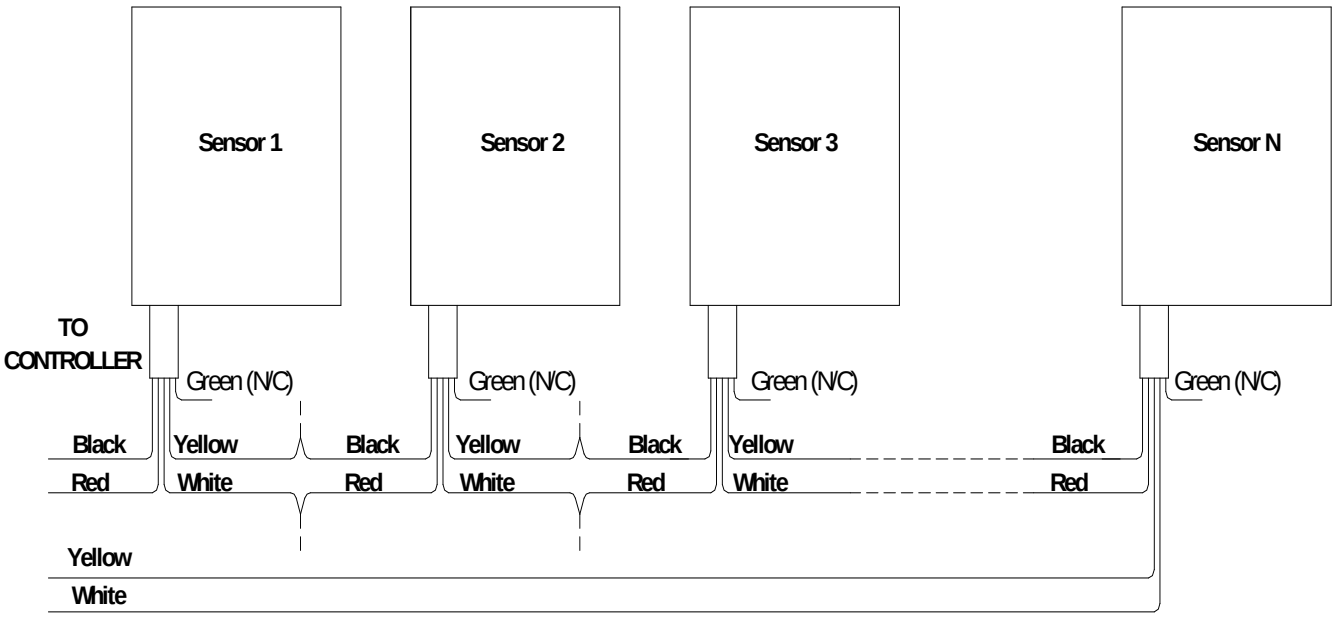
Fail-Safe is a shorthand term used to mean Fail to a Safe condition. In machinery with known hazards, the system is fail-safe when any failure leaves the machinery in a safe condition. The 4-wire fail-safe concept is illustrated in the figure above. A small current is constantly flowing through the sensor at all times, holding the relay coil energized at all times. The machine controls, interrupt, or stop circuitry is connected to the contacts of this relay. If the sensor is actuated, the relay coil will be shorted, causing the relay to deenergize. A resistor in series provides current limiting from overdrawing the power supply and limits the current through the sensor in the actuated position. If the sensor fails in the closed position the relay will be shorted and cannot be energized until the failure is corrected. If the sensor fails in the open position, the current path for the relay coil no longer exists and the relay coil cannot be energized until the current path is restored and the failure corrected.

In addition to the safety aspects achieved with Fail-Safe, it also provides:

- Isolation of the machine controls and sensor(s)
- Isolation of high amperage and high voltage machine switching from the low voltage sensors
- Conversion of a normally-open switch to required normally closed machine controls

Multiple-Sensor Electrical Connections

When a DPM system has multiple mats, they must be connected in series, so that the all the mats function as a single sensor. It is recommended that the actual point of connection be made at a location which is free from abuse and environmentally protected (i.e. junction box, control panel, etc.) Refer to **Figure Five** for multiple-mat electrical connections.



*** N/C: No Connection**

Figure Five

Illustration 1

Illustration 2

Illustration 3

Illustration 4

Illustration 5

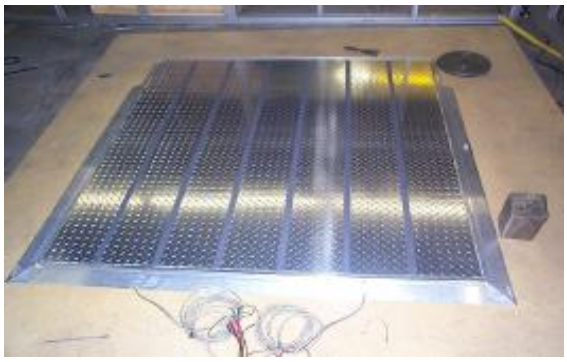


Illustration 6

Illustration 7

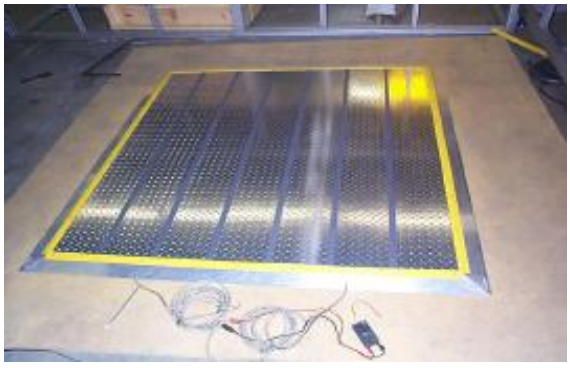


Illustration 8