



MMC INTERNATIONAL CORP

OPERATING AND MAINTENANCE INSTRUCTIONS

INTRINSICALLY SAFE TRIPLE FUNCTION GAUGING TAPE

FOR

CLOSED (GAS-TIGHT) APPLICATIONS

**LIQUID MEASURE OF ULLAGE, OIL/WATER INTERFACE
AND TEMPERATURE**

MODEL D-2401-2

TECHNICAL APPROVED BY:

CSA/ATEX FOR CLASS I, DIVISION I, GROUPS C & D

AND

LLOYD'S REGISTER, BUREAU VERITAS "MED" APPROVED

**IN ACCORDANCE WITH IMO RESOLUTION MEPC.5 (XIII)
FOR OIL/WATER DETECTION**

**MMC INTERNATIONAL CORP.
60 INIP DRIVE
INWOOD, NEW YORK 11096**

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NOTICE TO ALL EQUIPMENT USERS

The triple functions of this sensor are to detect cargo surface level, **Ullage**, the **Interface** between two immiscible products such as oil and water, and cargo **Temperature**.

The normal order of the gauging device, response to the products “Ullage level”, is a steady horn tone. The normal response to an “Interface level”, (i.e., between a non-conducting and an electrically conducting product such as a petroleum product and water, is a “**steady**” tone changing to a “**beeping**” tone at the interface level.

A special note to our chemical customers, is the fact that some chemical cargoes may be inherently conductive.

Therefore, at the surface of a conductive product’s Ullage level, a “**beeping**” tone will be the normal response.

As a further note to the above, the change in detection of a non-conductive product Ullage level as a steady tone to that of a conductive product’s ullage “beeping” tone, it is not to conclude that the sensor is malfunctioning.

Best Regards,

MMC International Corp.

User instructions (in compliance with ATEX 94/9/EC Directive, Annex II, 1.0.6)

The following instructions apply to the Flexidip Portable Gauging Tape Type D-2401-2** covered by certificate number BAS 02ATEX1274X. The information contained herein shall be included with every batch of products sold, either as a separate sheet or incorporated as a discrete section in an instruction manual.

**WARNING: USE ONLY DURACELL/PROCELL MN1604 BATTERY REPLACEMENT.
DO NOT REPLACE BATTERY WHERE AN EXPLOSIVE GAS ATMOSPHERE MAY BE PRESENT.**

**BE AWARE OF POTENTIAL ELECTROSTATIC CHARGING HAZARD AFTER LOADING
DISTILLED PETROLEUM.**

THIS DEVICE MUST BE GROUNDED.

Instructions for safe selection, installation, use, maintenance, and repair

- 1 The equipment may be used in zones 0, 1, or 2 with flammable gases.
- 2 The equipment may be used in the presence of flammable gases and vapors with apparatus groups IIC or IIB or IIA and with temperature classes T1 or T2 or T3 or T4.
- 3 The equipment is certified for use in ambient temperatures in the range of -20°C to $+40^{\circ}\text{C}$ and should not be used outside this range.
- 4 The equipment is to be installed by suitably trained personnel in accordance with the applicable code of practice (typically IEC EN 60079-14).
- 5 The equipment does not require assembly or dismantling.
- 6 With regard to safety it is not necessary to check for correct operation.
- 7 No user adjustment is required.
- 8 Regular periodic inspection of the equipment should be performed by suitably trained personnel in accordance with the applicable code of practice to ensure it is maintained in a satisfactory condition.
- 9 The equipment is not intended to be repaired by the user. Repair of the equipment is to be carried out by the manufacturer, or their approved agents, in accordance with the applicable code of practice.
- 10 The equipment contains no other customer-replaceable parts.
- 11 The apparatus shall not be subjected to a prolific charge generating mechanism (such as might occur in pneumatic transfer of powders or charge spraying in a powder coating process).
- 12 If the equipment is likely to come into contact with aggressive substances, e.g., acidic liquids or gases that may attack metals or solvents that may affect polymeric materials, then it is the responsibility of the user to take suitable precautions that prevent it from being adversely affected thus ensuring that the type of protection is not compromised.

SECTION I

1. GENERAL

1.0 SPECIFICATIONS:

Display Readable Temperature Range	°F = -40° to 199.9°*
*Reading Limit Due to 3-1/3 Digit LCD Display on °F Range	°C = -40° to 150.0°
Guaranteed Temperature Calibration Range (0°C to 88°C)	32°F to 190°F
Accuracy Over Calibration Range	±0.5°F (±0.2°C)
Accuracy Linear Measurements	±1/8" (±2.0 MM), Plus ±0.1% of Total Tape Length, worst case
Minimum Detectable Tank Bottom Liquid Level	3/8" (10MM)
Minimum Detectable Floating Product Level	1/8" (3MM)
Batteries for Intrinsically Safe Operation Only (supplied)	Duracell MN1604
Battery Drain (Temperature Mode)	1.3 ma (In Air) 2.6 ma (In Fluid)
Display	3-1/2 Digit Liquid Crystal Display 1/2" Character Height
Operating Temperature Limit of Liquid Crystal Display,	-40°F to 176°F -40°C to 80°
Storage Temperature Limits	-67°F to 185°F -55°C to 85°C
Available Tape Length, *Single Face Scales	50 FT (15 Meters) 65 FT (20 Meters) 75 FT (25 Meters) 100 FT (30 Meters) *100 FT (10ths & 100ths) 35M, 40M
Hazardous Environments	Certified Intrinsically Safe BASEEFA/SIRA, Gas Groups C & D

1.1 LINEAR ACCURACY SPECIFICATIONS:

MMC PORTABLE ELECTRONIC GAUGING TAPE STANDARD PRODUCTION LINEAR MEASUREMENT ACCURACY

Applicable Equipment:	MMC Models D-2401-2 (Trimode), D-2401-2UI (Ullage/Interface)
Tape Lengths:	50FT., 65FT., 75FT., 100FT. and 15M, 20M, 25M, 30M, 35M, 40M.
Basic Gauging Tape Style:	Steel, 0.375 wide x 0.006 thick, yellow or white faced, black & red graduation markings. Manufactured in accordance with API Chapter MPMS 3.1A industrial guideline.
System Linear Accuracy:	English Reading, $\pm 1/8"$ of reading Metric Reading, $\pm 2\text{MM}$ of reading plus $\pm 0.01\%$ of total tape length.

GENERAL STATEMENT OF LINEAR ACCURACY

MMC warrants that the above listed, newly produced equipment models, incorporating the listed basic gauging tape style and lengths, will perform to the stated system accuracy.

Certification of accuracy for new equipment is available at an extra cost. Certification costs to standards of accuracy more precise than the stated system accuracy will be quoted upon request.

1.2 SPECIAL FEATURES:

Conductive Tape Surface to Drain Off any Static Charge

Grounding Cable with Heavy Alligator Clamp

Dual-Purpose Spring-Loaded Tape Crank and Tape Position Lock

Watertight Electronics Construction with Sealed Switches

All Stainless-Steel Fasteners

Nylon Coated Aluminum Reel Housing for Lightweight Portability

Low Battery Display Indicator

High Daylight Visibility with Liquid Crystal Display

Push-Button Night Light

Rapid Multiple Temperature Measurements

Easily Renewable Tape Wiper

Manually Operated Vacuum/Pressure Relief Valve

Primary and Secondary Tape Sight Glasses

Anti-Wind Internal Spring-Loaded Stop Lever Sensor

Internal Tape/Reel Confinement Springs

Gas Tight Construction

SECTION II

2.0 INTRODUCTION:

- 2.1 The MMC Tri-Mode portable ullage, temperature and interface tape described herein incorporates extremely accurate instrumentation to provide three vital petroleum and other liquid tank measurements.
- Measurement of surface ullage level of oil or other fluids to an accuracy and repeatability of $\pm 1/8$ inch.
 - Determination of the exact location of the ullage level of the interface layer exists when an oil-water mixture is contained within the same vessel.
 - Measurement in either Degrees F or Degrees C of the temperature of the fluid within a vessel, at any or several desired ullage levels, in rapid succession. Measurement is given to the nearest 0.1 degree and is accurate to $\pm 0.5^{\circ}\text{F}$ over the calibrated temperature ranges given in the specifications listed in Section I.
- 2.2 The MMC system utilizes a sensor suspended at the end of a fluoropolymer covered gauging tape wound on a reel assembly. The plastic covered steel gauging tape contains two isolated side conductors to carry the signal and power to the electronic circuit within the sensor barrel with the steel tape, provides the ground return. The plastic surface of the tape has been treated to make it sufficiently conductive to prevent the build-up of static charges. Temperature indication is provided by a large digital liquid crystal display (LCD), housed within a sealed reel driving assembly.
- 2.3 Ullage and interface detection is provided by an audible signal obtained from a horn in the reel driving hub, when the bottom "U" gap in the sonic sensor is immersed in fluid. The audible signal heard will be a continuous tone in a non-conductive fluid such as oil, gasoline, kerosene, etc., but will change to an interrupted tone when immersed in a fluid which is electrically conductive, such as water.
- 2.4 The system is certified as intrinsically safe for electrical equipment in hazardous atmospheres by SIRA, CSA, BV, DNV.
- 2.5 The triple function temperature, interface, and ullage sensor is powered by a single 9-volt battery contained within the hub assembly. Battery drain is extremely low, (approximately 1-1/4 Milliamperes in either the ullage, interface, or the temperature mode), ensuring very long operation, without battery replacement. Low battery warning is provided at the upper left corner of the temperature display LCD, when the battery voltage has dropped to a level that would, with further operation, cause excessive errors in temperature readings.

SECTION III

3.0 THEORY OF OPERATION:

- 3.1 Drawing S-2562-1TR illustrates the main components of the closed Temperature, Ullage, and Interface system. A tape reel contains the calibrated tape. The reel crank on the driving hub is used by the operator to raise and lower the sensing head assembly which is attached to the reel via the tape. Before lowering or raising the tape, the reel brass thumb screw lock must be unlocked.
- 3.2 The sensor head assembly contains two piezo-electric crystals, a pair of interface or conductivity pins and a temperature sensor, located in one of the conductivity pins and electronic circuit board. The sensor is connected electrically to the driving hub electronics by the two wires encased in the gauging tape plastic jacket, which covers and hermetically seals these wires and centers graduated metallic gauging tape. The metallic tape is used as a ground return conductor, which when including the two wires straddling it, form a rectangular three conductor transmission cable.
- 3.3 The electronic circuits in the hub assembly are comprised of an LCD digital display which provides temperature readings when the system is in the temperature mode; an analog to digital converter, a power on-off switch, a mode switch which permits operator to select the temperature mode or ullage/interface mode, a night light switch and ancillary electronic parts all assembled on a printed circuit board. A 9-volt battery power source and audio horn are located within the tape reel hub assembly below the P.C. board of the modular hub cover assembly.
- 3.4 When the system is placed in the ullage/interface mode, and as the sensor is immersed in a non-conductive fluid such as oil, a sonic signal originated by the sensor head circuits freely crosses the sensor gap and is detected, amplified and then transmission tape to the hub electronics board, which in turn drives a horn in the turning drum assembly. A high pitched continuous audible signal is then emitted. When the sonic sensor is in air, the sonic signal does not cross the sensor gap and therefore the horn is silent.
- 3.5 When the sonic sensor is immersed in a conductive fluid, such as the water layer side of an oil/water interface, operation is as above except that the conductivity pins within the sensor gap now permit a minute current to flow between the pins. This current flow is detected by the sensor electronic circuitry with the sensor housing and suitably conditioned to cause the sonic signal to be periodically interrupted, yielding a “beeping” tone for operator identification.
- 3.6 When the system is placed in the temperature mode the ullage and interface circuits within the sensor barrel are de-energized, also disengaging the audio signals associated with the ullage/interface mode. The integrated circuit temperature sensor housed within the grounded interface pin now functions as an extremely accurate linear temperature to current transducer. As the temperature at the sensor rises, so does the temperature sensor current. By passing the temperature sensor current via the transmission tape, through the electronic component network, with the turning drum, input to an A to D converter is

caused to vary linearly with temperature. Span control (R18) is adjusted to provide a fixed reference voltage, to scale for either, to scale for either a Centigrade or Fahrenheit reading device. Coded digital output from the A to D converter to the LCD Display is used to provide accurate and fast temperature readings.

The two potentiometer controls, R13 and R18, perform as a two-point temperature calibration adjustment.

A complete temperature calibration procedure is later described in this manual. (See section VIII).

Temperature recalibration is recommended at yearly intervals. Please note that units returned for Temperature Calibration during standard or extended warranty periods are not covered by warranty statement.

- 3.7 New Addition LED to existing PCB. When the electronic probe is lowered and senses a hydrocarbon, a steady horn tone is sounded and LED illuminates. When sensing an oil-water interface, or a heavier than water non-conductive liquid, and intermittent horn tone sounds, and LED begins flashing.

SECTION IV

4.0 **REQUIRED CONDITIONS AND RECOMMENDATIONS FOR SAFE USAGE:**

The attention of the user of this apparatus is drawn to the possible hazards of ullage, interface, and temperature measurements within flammable liquids, which are known to be generators of static electricity.

Adhering to the specific safety directives of your company is the responsibility of the user. The following is a general guideline to safe usage, drawn from the advice and experience of various industry sources.

The specific safety standards or directives of your company are to be strictly adhered to, with the general guidance given here being regarded as only a supplement to existing and established operating safety procedures.

4.1 **REQUIRED CONDITIONS:**

This apparatus must be earthed (grounded) to the liquid tank containment vessel or tank, before and during introduction into the vessel. The earthed conductor must not be disconnected until the apparatus is completely withdrawn from the vessel being gauged. A suitable grounding cable is provided as part of the gauging unit. Proper grounding of this cable is the responsibility of the user.

4.2 **RECOMMENDED SAFE USAGE CONDITIONS FOR THE TRIPLE FUNCTION GAUGING TAPE:**

As the word “Closed” implies, the Tri-Mode gauging assembly shown on drawing S-256201TR has been carefully constructed to eliminate the escape of cargo vapors to the atmosphere and to minimize exposure of operating personnel to these vapors. The sealed construction utilized meets the current state and federal environmental requirements and provides the operator with a tool which greatly reduces potential occupational hazards.

To assure that the above conditions will prevail, the “Closed” Tri-Mode gauging system should be entered into a cargo tank by means of a deck station vapor valve.

4.3 **GROUNDING PRECAUTIONS:**

The “Closed” gauging tape assembly is to be hull grounded before and during its use for cargo gauging. Grounding of the gauging unit with the provided coiled grounding cable should be completed before the vapor valve is opened and any measurements conducted. The unit must remain grounded during all measurement procedures and until the sensor is fully wound back up into the case and the valve is closed.

4.3.1 The grounding of the unit and adhering to the specific company safety standards or directives, is the sole responsibility of the operator.

4.3.2 Sensor entry into tanks or vessel immediately following a tank filling or loading operation of known static accumulator type petroleum products or other such flammable liquids, **should not** be attempted until, at least a period of **30 minutes** has elapsed since the cessation of filling.

- 4.3.3 Clean oil distillates are, in general, known to be accumulators of static electricity due to their low conductivity (i.e., less than 100 Pica Siemens/Meter) and therefore may require relaxation periods of longer than 30 minutes before gauging is attempted.
- 4.3.4 The foregoing does not consider the use of anti-static additives to clean oils, as generally easing the need for proper precaution, unless actual and specific product testing has shown the product to have conductivity levels which eliminate the danger of static electric charging.
- 4.3.5 Sensor entry into tanks or vessels that have been water washed and which previously contained, or still partially contain petroleum products is not recommended unless a sounding pipe is provided, and approved for such use, or at least a period of five hours has elapsed since completion of the working operation.

SECTION V

5.0 GAUGING TAPE OPERATION:

5.1 TANK ENTRY:

- 5.1.1. The closed tape is installed into a vapor control valve in the same was as a restricted Flexi-Dip model. However, since the closed unit is sealed, an air cushion may occur, preventing the “Closed” tape from easily seating into the valve. BY depressing the vacuum/pressure relief valve located on the top of the “closed” unit, the back pressure is release, allowing the unit to properly seat. The securing collar on the storage tube barrel is then tightened on the valve.
- 5.1.2 In addition, the vacuum/pressure relief valve can be used to determine the pressure within the case. Unscrewing the valve actuator cap exposes the actual valve. This valve is similar to an ordinary bicycle tire valve and has its own attached to the valve by means of the exposed threaded valve stem. After pressure readings are complete, screw that valve actuator cap back onto the valve.

5.2 PRODUCT GAUGING OPERATION:

- 5.2.1 The tape sensor, lowered and raised by unwinding and rewinding the tape crank/reel lock assembly, is located on the reel driving hub, which is spring-loaded (perpendicular to the hub faceplate), the sensor can be freely lowered by turning the reel hub clockwise

To lock the reel at a desired tank depth, pull the knurled knob up and out of its hub socket and rotate it downward against the case. The reel is not locked. To unlock the reel, reverse the above procedure.

5.3 DETERMINING CARGO LIQUID LEVEL:

Upon sonically determining the liquid level, (previously described), the gauging tape scale is read through the primary gauging sight port, located on the bottom side of the gauging assembly directly above the tape wiper housing. With a vapor valve properly installed, the tape reading will be corrected to the “zero” ullage reference pane.

After completing a reading, re-wind the tape to its stowed position, being careful to engage the spring-loaded tape wiper.

5.4 USE OF THE SECONDARY TAPE SIGHT PORT:

- 5.4.1 A secondary tape sight port is provided for two main purposes. This port is located at the top of the unit, just below the carrying handle. With the carrying handle rotated to the case cover side, the secondary port may be viewed directly.
- 5.4.2 When lowering or raising the tape, the motion of the gauging tape should be observed through the secondary port. Viewing the tape through the secondary port gives the operator an immediate sense of tape direction, and approximate pay-out location of the sensor. When using a closed unity, as opposed to a restricted or open mode, a sense of tape direction may not be obvious to new operators.

Therefore, the use of the secondary sight port becomes an important part of normal operations.

- 5.4.3 When tape motion is stopped, the tape reading seen in the “secondary” sight port is exactly 300MM above “zero” ullage reference level.

CAUTION:

If the gauging tape reading seen at the secondary sight port is to be used as a recorded ullage, 300MM must be subtracted from reading to correct the “zero” ullage reference plane.

- 5.4.4 In addition to the above functions, the secondary port provides an easy means of determining oil-water interface layer measurements. Ince interface measurements are only concerned with relative differences, the previously mentioned 300MM corrective subtraction becomes unnecessary.

5.5 TAPE OVER-WIND AND OTHER CONSIDERATIONS:

The closed gauging tape is provided with an automatic anti-wind mechanism. The purpose of this mechanism is to prevent the operator from re-winding the tape, after having fully payed-out the tape length, in an opposite fold over sense. When a tape is fully extended, a hard stop to further tape reel rotation will occur. Do not force this stop, as tape damage may result. When a tape travel stop is encountered, please observe the tape re-wind level for the proper re-wind direction.

Internally, spring band fingers have been positioned around the tape take-up reel, to prevent the tape from coming out of the reel. However, in the event that the assembly is inadvertently dropped a good distance with a tape not fully rewound, the gauging case cover should be removed for an internal inspection.

5.6 SIGHT PORT GLASS CLEANING:

Occasionally, sight glass cleaning may become necessary. With reference to drawings A-2562-146 and A-2562-147, cleaning may be easily accomplished. Cleaning may be most easily accomplished by unscrewing the entire assembly and washing in a suitable detergent.

CAUTION!

To maintain the sealed integrity of the gauging assembly, be sure that the case seal “O” ring, Part No. 5 is in place upon re-installation of sight ports.

SECTION VI

6.0 OPERATION (Refer to Figure 1):

6.1 FAMILIARIZATION WITH OPERATING CONTROLS AND FEATURES ON THE TAPE REEL HUB COVER PANEL:

- 6.1.1 Turn on power by momentarily depressing the “On/Off” push-button switch (1) located at left of panel. The display should read 1XX.X* indicating that the system is in the Ullage/Interface mode.
- 6.1.2 Looking at the top left-hand corner of the LCD display, notice if the symbol “LO BAT” appears. If the symbol is displayed, the battery voltage is low, and the battery should be replaced (see Section VII Paragraph 7.5). Always replace the battery if “LO BAT” appears even though the digital display turns on. Temperature readings with a low voltage batter (below 7.0 Volts) are unreliable.
- 6.1.3 Once again, momentarily depress the power “On/Off” switch. Note that the display turns off. Always turn power off when the system is not in use to prolong battery life.

Depress the “On/Off” switch once more. Display turns on and reads 1XX.X* indicating the Ullage/Interface mode.

*NOTE: Due to an inherent digital uncertainty of the A to D converter, some digital displays, whenever is the Ullage/Interface mode, will read 00.0 instead of 1XX.X.

- 6.1.4 Now momentarily depress the “Mode” switch at the right of the panel. The display should now switch to the temperature mode as indicated by a reading on the display indicative of the temperature of the sensor tip.

Once again depress the “Mode” switch and not that the display reads 1XX.X* (Ullage/Interface Mode). Depressing the “Mode” switch alternately changes the function from temperature to Ullage/Interface and vice versa. Depressing the power “On/Off” switch alternately turns power off or on regardless of which mode was in operation. However, when power is switched on again the system will always come on in the Ullage/Interface mode.

- 6.1.5 Depress the night light switch (3) at upper center of panel when it is too dark to see the display. The display background will illuminate, and the reading should now be discernible.

6.2 ULLAGE/INTERFACE MEASUREMENTS:

- 6.2.1 If power is off, depress power “On/Off” push-button switch. The system comes on in Ullage/Interface mode (display reads 1XX.X).
- 6.2.2 If the power was on and the system is in temperature mode, depress the “Mode” switch at right of panel to alter function to Ullage/Interface.

- 6.2.3 Make sure “LO BAT” does not show at left upper corner of display.
- 6.2.4 After grounding the assembly, insert the barrel of the gauging unit into the valve. Un-lock the tape reel lock by rotating the brass lock thumbscrew counterclockwise turning position hub seat. Grasp the knurled reel crank hand and lower the sensor head tape assembly, which contains the sonic sensor, into the tank. Always exert a retraining force to prevent the sensor from descending too rapidly or free falling.

CAUTION!

Under no circumstances should the reel and tape be permitted to unwind without restraint. Permanent damage may be incurred to the sensor head or to the calibrated tape if the head is permitted to fall freely.

- 6.2.5 Lower the sensor head slowly until a steady tone is heard. If the surface of the fluids is oil or other non-conductive fluid, a continuous audible tone will be heard. If the surface of the fluid is water or other conductive fluid, the audible tone heard will be a “beeping” tone.
- 6.2.6 Define measurement by raising the sensor head until the sound just ceases. Lower until sound is just heard again, to refine ullage level.
- 6.2.7 Place gauging tape against ullage referenced point and read ullage on tape. Note this reading as the surface liquid ullage level.
- 6.2.8 To find the oil-water interface point, continue to lower the sensor into fluid, noting that the audible tone is continuous. When the audible signal changes to a “beeping” tone, the sensor has entered the water column underneath the oil.
- 6.2.9 Raise the sensor very slowly until the tone once again becomes continuous. Repeat if necessary to refine water entry point (Interface level).
- 6.2.10 Again, read the ullage on the tape. By subtracting the first reading obtained (step 7) from this reading, the total product depth is thus determined. By subtracting the second water level ullage from the maximum tank depth, water level innage is determined.
- 6.2.11 When the measurement is completed, place the spring-loaded wiper knob in the “On” position while rewinding the tape until sensor is stored with the vapor valve entry barrel. Do not close the vapor valve until the fully “stowed” position is confirmed, by noting that yellow pop-up button on top of the wiper housing is up.
- 6.2.12 Lock the reel by rotating the crank/reel lock thumbscrew down position parallel to hub. Depress power “On/Off” switch to conserve battery power.
- 6.2.13 Close the vapor valve, disconnect the valve securing cap, remove the gauging unit, disconnect the grounding cable. Replace the vapor valve cap.

6.3 TEMPERATURE MEASUREMMENT PROCEDURE:

- 6.3.1 If power is off, turn unit on by depressing “On/Off” push-button switch. Unit comes on in Ullage/Interface mode. Depress “Mode” push-button switch to select temperature.
- 6.3.2 If unit was on and in Ullage/Interface mode, simply press the “Mode” push-button to select temperature.
- 6.3.3 Make sure “LO BAT” does not show at left upper corner of display. If “LO BAT” appears, replace battery even though the digital display turns on. The display may continue to operate even though the battery voltage is below normal. Temperature reading however, may be in error.
- 6.3.4 Ground the assembly, release the turn handle reel lock. Lower the sensing sensor to the deepest reading desired. Make sure to exert restraining force while lowering.
- 6.3.5 When the desired temperature ullage level is reached, allow the sensor to rest at this point for at least two (2) minutes. Then joggle the sensing sensor up and down, approximately 6” above and below the desired measurement level until the displayed temperature reading settles. Record this reading. For heavy crude oil products, the joggling procedure is a necessity to ensure accurate readings. The viscous nature and low thermal conductivity properties of these petroleum products makes the joggling procedure a necessity to ensure accurate temperature in a minimum amount of time.
- 6.3.6 Raise the sensor to the next ullage level to be measured. Repeat step 6.3.5. Continue raising sensor to all levels at which readings are desired.
- 6.3.7 When the measurements are complete, push “On/Off” button to turn off and conserve battery power. Rewind the tape into the carriage reel assembly. Wipe the tape as it is rewound by placing the spring-loaded wiper in the “On” position.
- 6.3.8 Lock the reel by rotating reel lock crank down, position. Follow the same procedure as described in step 6.2.13.

7.0 CARE AND MAINTENANCE:

Proper care and maintenance should be practiced to maintain long, trouble free and accurate service and to maximize battery life, as follows:

- 7.1 When not in use, make sure power is off as evidenced by display being extinguished.
- 7.2 Store sensor head assembly in the fully wound position and store in a dry location. Do not allow the instrument to remain for long periods in direct sunlight, or store in temperature above 125° F, or in temperature below freezing. Such temperatures may damage the liquid crystal display.

- 7.3 Wipe excess oil or water from tape, and sensor head. Each time the sensor is raised from the tank, hold the spring-loaded tape wiper switch in the “On” position.
- 7.4 Never permit tape and sensor head to unwind freely (control speed of descent by usage of a restraining force on crank).
- 7.5 **BATTERY REPLACEMENT** (See Approval Label for correct type):

The battery should be replaced whenever the “LO BAT” symbol appears at the upper left corner of the display. If the sensor is used to obtain temperature reading when the battery is low, large errors may result. Always replace battery in a gas free atmosphere. Remove the six machine screws on the hub cover. Lift the cover with its attached P.C. Board. The battery is retained within the reel turning drum by a spring clip battery holder. Remove the battery from the battery cap connector. Replace the battery with a fresh battery of the type listed on the approval label only. Take care to align the viton cover casket, and machine screw fasteners when re-assembling to tape reel hub.

SECTION VIII

8.0 CALIBRATION PROCEDURE:

8.1 ULLAGE:

The ullage circuits do not require calibration in the field with proper care and handling the equipment should function indefinitely.

8.2 TEMPERATURE SENSOR CALIBRATION (Field Operation Only):

The temperature sensor and its associated electronic circuitry have been accurately calibrated at the factory. Temperature calibration by MMC is recommended at twelve-month intervals, with periodic checks being carried out as necessary between these intervals.

Before attempting any calibration, make sure that the battery is at a proper voltage level as evidenced by the fact that "LO BAT" does not appear at the upper left corner of the display when the equipment is powered. Low battery voltage will produce errors in temperature readings. If "LO BAT" appears on the display, check battery voltage and replace. If necessary, calibration of the temperature sensor may be accomplished as follows:

- 8.2.1 Use thermometers accurate to $\pm 0.1^\circ$ and preferably graduated in one-tenth degree intervals. If mercury thermometers are employed, use two separate thermometers to provide greater resolution. One to cover low temperatures and the other to cover the high temperatures.
- 8.2.2 Remove six machine screws on the hub cover. Lift the cover and attached P.C. Board from Hub exposing two potentiometers at back lower left of board. Lowest potentiometer, marked (R13), is the "Zero" control and the potentiometer to the left and above, marked (R18), is the "span control. (See drawing B-2401-31).
- 8.2.3 Turn display on by depressing power "On/Off" button momentarily. Place system in temperature mode by depressing "Mode" switch. Display should now read temperature at sensor tip.
- 8.2.4 Prepare two temperature baths, a cold bath of approximately one-gallon of water, and a hot bath of approximately one gallon of water at a temperature of at least 60° higher than the cold bath.
- 8.2.5 Place the sensor in the cold bath with thermometer and stir the bath well to equalize temperature. Keep sensor and thermometer together at approximately the same point in the bath.
- 8.2.6 Record: Sensor Cold Reading as = pc (as read from digital display).

Record Reference: Thermometer Cold reading as = tc

- 8.2.7 Repeat the above procedure in a hot bath.
- 8.2.8 Record: Sensor Hot Reading as = ph (as read from digital display)
 Record Reference: Thermometer Hot Reading as = th
- 8.2.9 Calculate Zero Correction = $tc \frac{(ph - pc)}{th - tc} - pc$
- 8.2.10 Place sensor in cold bath. Stir and wait until sensor reading on display stabilizes. Note reading and then adjust “Zero” control potentiometer marked (R13) so that the zero-connection calculated in step 7.2.9 above is added to or subtracted from the sensor reading. If the answer in step 7.2.9 is positive, add the correction, if negative, subtract.
- 8.2.11 Now place thermometer in the cold bath with the sensor and stir. Now adjust the “span” potentiometer until the two readings are equal (the displayed reading, and the reading of reference thermometer).
- 8.2.12 Check readings in hot bath. Slight touch-up of “Span” control may be required. Normally not more than a ± 0.1 degrees correction is necessary if the calculated measure “Cold” temperature procedure has been performed correctly.

The above method allows the operator to perform the calibration in one step. If desired, and particularly if the error is minor, an adjustment of zero may be performed in the cold bath to equal the thermometer reading. Then the span may be adjusted in the hot bath. However, this procedure requires repetition until both cold and hot bath readings are correct without further adjustment in either cold or hot baths.

SECTION IX

9.0 GAUGING TAPE REPLACEMENT (With or without new sensor attached):

The gauging tape used for the Trimode closed gauging system is similar but not interchangeable with the gauging tapes used for restricted gauging systems.

The tapes used are bright white faced steel core type, which have been encapsulated with a tefzel jacket. (Tefzel is a registered trade name of the DuPont Corporation). The taps are terminated at the display electronics hub PCB module connection points, by soldered leads within the tape reel internal core. The sensor is connected to the tape by means of a quick connect plug to the tape socket plug.

As with all tefzel coated MMC gauging tapes, the outer surfaces are factory treated to render the surfaces of the tapes with anti-static properties.

The patented process to achieve the desirable anti-static condition is not defeated by tape wiping or cleaning with standard petroleum-based solvents.

Gauging tape replacement is not difficult, but requires careful attention to the travel path of the tape as it exits from the tape reel assembly, passes over the interior guide rollers, cursor pin assembly, anti-chafing rollers and on through the wiper housing.

- 9.1 To replace a tape, remove the vapor valve barrel, tape wiper assembly, stub barrel connector and main reel housing cover.
- 9.2 With the main reel cover removed, the tape reel and tape pay-out through the wiper housing can be seen. Take careful note of how the tape is directed around the various roller and guides. In particular, note the tape path between the upper right-hand roller, the guide roller just below it, cursor pin assembly, and tape wiper split ring bushing.
- 9.3 With the above in mind, or recorded with a simple hand sketch, the screws holding the reel hub cover can be removed. The reel hub cover is both a reel interior cover, and also the reel drive shaft to reel driver. The underside of the cover has a crossbar, which couples it to the reel drive shaft assembly. The coupling action is accomplished by means of the cover cross bar engaging the slotted ends of the drive shaft assembly.

With the reel hub cover removed, note that the outer reel plate is still retained to the reel hub core by a single flat head screw.

Note that directly opposite the flat head screw (180° away) a small pinhead can be seen in a reel plate hole on the same screw hole diameter as the flat head screw. Also, note that the screw hole pin, is at this time, aligned with drive shaft coupling slots.

The interior electrical connector hub end of the gauging tape is not also in view. Note the placement of the terminating epoxy molding piece at the end of the tape within the hub core. Also, note the three wires leading to a connector and a separate black ground wire emanating from the molding.

Remove the black wire screw and unplug the connector by squeezing the mating connector at the ribbed sides which are at opposite sides of the connector shell. Remove the flat head screw holding the outer reel plate to the reel core. Note that the spring-loaded anti-rotation arm cannot be seen pressing the outside layer of tape.

- 9.4 Next, unreel the tape and sensor head until the anti-rotation devices stop the tape from unwinding further. The tape may now, with a little manipulation, be lifted out and pulled out from the rollers and through the hole exiting from the barrel.
- 9.5 A new tape can now be installed in reverse manner. Be sure that the tape numerals face in the same direction as the previous tape numerals faced. Thread the end of the new tape up through the barrel, through the rollers and finally make sure to correctly place the end with the molding and connector into the hub core, ensure that the anti-rotation arm is now again pressing against the outside layer of the new tape. Now wind the tape on to the reel by spinning the tape reel in a counterclockwise direction.

Next, plug the connector into its mate and reconnect the ground wire. Replace the outer reel plate and it's flat head screw attachment to the reel core.

With the partially assembled tape reel still freewheeling on the drive shaft, alight the slotted end of the drive shaft, to be in-line with the flat head screw on the outer reel plate and the reel core stop pin directly across from it. The reel hub cover can now be re-installed by visually aligning its underside cross bar with the drive shaft end slots. Replace all core cover screws.

- 9.6 The main reel housing cover can now be replaced. The screws provided for cover attachment to the main reel housing, having built-in "O" ring head seals. Do not replace these screws with ordinary machine screws.

Re-install the wiper housing, being sure to replace its mounting plate to the wiper gasket.

Re-install the stub barrel piece into the tape wiper housing. Be sure to first replace the split full stop busing into the barrel adapter.

As a final check, the gauging tape may be hand unwound from the reel to its full length at which time the anti-rotation arm engagement should be confirmed.

Rewind the freed tape with some slight hand drag.

- 9.7 If a new sensor has also been replaced with a new tape, perform a temperature calibration in accordance with Section VIII. This is a mandatory procedure as the new temperature sensor components must be calibrated to the electronic board within the reel turning drum.

SECTION X

10.0 **HUB COVER AND P.C. BOARD REPLACEMENT:**

To replace the turning drum hub cover and P.C. Board, follow the steps outlined below:

- 10.1 Remove the six machine screws from the hub cover, extract cover, gasket, and P.C. Board.
- 10.2 Unplug battery cap.
- 10.3 Unsolder wires that go to small horn. (Note that these wires originate from the same strip that connects the battery cap).
- 10.4 Now carefully examine three conductor strips that originate at the upper right-hand corner of P.C. board. These wires may not be the same color code as the replacement's hub P.C. Board, and it is important that they be connected to the correct points. Note that one wire (ground) has a terminal lug attached and therefore replaces the previous wire with terminal lug.
- 10.5 Now make a note of the wires that go to top and bottom splices of outer tape conductors. One of these wires goes to a point on the P.C. Board labeled "+V". The other to a point on P.C. Board labeled "SIG". Note which goes to top and which goes to bottom conductor. For example: "SIG" to top connector and "+V" to bottom connector.
- 10.6 Unsolder spliced conductors and remove the nut ground connecting the gauging tape to the driving drum. This now completes disassembly, and the old hub assembly can be put aside.
- 10.7 Position new hub cover and P.C. Board and solder to horn and insulate the two free wires originating from the battery cap strip line. The polarity of these two wires is not important.
- 10.8 Reconnect ground wire with terminal lug to driving drum ground post and replace and tighten nut.
- 10.9 Re-solder and insulate "+V" and "SIG" wire to outer tape conductors taking careful notice of where they originated. (See step 9.5 above)
- 10.10 Replace battery and connect battery cap.
- 10.11 Re-assemble hub cover and attached P.C. Board with six machine screws being careful to line up neoprene gasket.
- 10.12 Perform temperature calibration in accordance with Section VII.

SECTION XI

11.0 FAULT FINDING (See Drawing B-2401-31):

The following section covers only simple faults that may occur. No attempt has been made in this section to cover highly technical faults.

PROBLEM NO. 1: Unit does not turn on when power “On/Off” switch is depressed.

PROCEDURE &
EXPLANATION:

If unit does not turn on at all, check battery voltage using a voltmeter. If battery voltage is lower than four (4) volts, because unit has been accidentally stored for a lengthy period with power on, the voltage is too low to illuminate display. Replace battery. (See Section VII Paragraph 7.5). If battery is okay, check power “On/Off” switch using an OHM meter. Switch should normally show an open circuit. When depressed OHM meter reading should be less than 2 Ohms. If switch is okay, integrated circuit chip is probably at fault. Return to factory or service center for repair.

PROBLEM NO. 2: Unit stays on all the time, even though “On/Off” push-button is depressed.

PROCEDURE &
EXPLANATION:

This symptom is usually indicative of a faulty power “On/Off” push-button switch. Check the switch with an Ohmmeter as explained in Problem No. 1 above.

PROBLEM NO. 3: Unit turns on and off, however when “Mode” switch is depressed system does not switch to temperature it stays in Ullage/Interface mode always.

PROCEDURE &
EXPLANATION:

Use OHM meter to make sure “Mode” switch is normally open and when depressed is closed. If switch is faulty, replace. If switch checks out okay, problem is probably an integrated circuit chip. Return to factory for repair.

PROBLEM NO. 4: Temperature readings are erroneous.

PROCEDURE &
EXPLANATION:

- A) When display is on, does the “LO BAT” appear at the upper left corner? If so, replace battery with a new battery following procedure given in Section VII, Paragraph 7.5.
- B) If “LO BAT” does not appear and display contrast in temperature mode is not good and the decimal point is very faint or not visible, check battery voltage using voltmeter. If voltage has fallen below 5.0 “LO BAT” may not appear. Usually, under these conditions the temperature readings will show extreme errors.
- C) If battery checks out okay, it is possible that the temperature sensor in the sensing head may have been damaged by dropping unit or unit may be out of calibration, due to sever exposure or abuse.

- D) Determine if sensor is still useful by following the calibration procedure given in Section VII.
- E) If fault is not corrected, return to MMC for repair. Sensor or integrated circuit chip may require replacement.

PROBLEM NO. 5: Liquid Crystal Display (LCD) does not function properly one or more segments stay on or off all the time producing strange figures.

**PROCEDURE &
EXPLANATION:**

Display contact may be corroded or dirty. Remove hub cover and associated P.C. Board by first removing six machine screws. Remove the three push-button switches and seal boot fasteners. P.C. Board and associated display may now be separated from cover plate. Remove LCD display bezel (see Dwg. B-2401-31) by first removing two machine screws and nuts. Carefully lift bezel and liquid crystal display from blue connector. Make sure that the long thin elastomer contact strips that fit into the top and bottom horizontal slots of the connector are not lost. Remove connector with associated contact strips exposing P.C. Boards contacts. If corroded or dirty, wipe contact (bottom side only) with cotton swab wet with alcohol, being careful not to saturate LCD with fluid.

CAUTION!

Do not spray contact cleaner on LCD display or permanent damage may be incurred. Re-assemble in reverse order making sure elastomer contact strips are inserted properly in blue connector horizontal slots. Note that blue connector bottom pins fit into mating hose on P.C. Board for proper alignment. If above procedure does not cure problem, then either display or integrated circuit A/D converter is at fault. Spare display can be substituted to isolate problem. Order from MMC together with new connector.

PROBLEM NO. 6: Display is damaged, permanently discolored, broken.

**PROCEDURE &
EXPLANATION:**

Order new display and connector from MMC and follow procedure given in Problem No. 5 to replace.

PROBLEM NO. 7: Unit operated properly in temperature mode, however, when placed in ullage mode, horn does not sound in water, or sound is extremely weak.

**PROCEDURE &
EXPLANATION:**

Sonic sensor has probably been damaged by being dropped and replacement may be required. Check unit in a container of clean lube oil, and then in a container of water. If sensor does not respond per operating procedure, then sensor replacement is probably necessary. Return to factory.

APPENDIX

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WARRANTY

MMC SONIC ULLAGE, INTERFACE, TEMPERATURE & TRIPLE FUNCTION TAPES:

The seller, MMC or its licensed agents, fully warrants equipment of its manufacture against defects in materials or workmanship for a period of one year from the date of shipment. No other warranty period, in excess of one year, may be expressed or implied by sub-agents or others, unless authorized in writing by MMC. The liability of the seller under this warranty is limited, at seller's option, solely to repair or replace with equivalent equipment.

The seller, upon the expiration of the warranty period, has the option to apply a limited credit, not to exceed the original equipment sales price, toward the purchase of a new piece of equipment, if returned equipment is beyond reasonable repair. In any event, non-warranty repair charges will be quoted to the buyer, for authorization, before repair work commences.

In the event of Returns for Warranty Repairs:

- A. The buyer is to notify the seller in writing upon discovery of the defects.
- B. Upon receipt of written authorization from the seller, the equipment is to be returned as directed, transportation prepaid by the buyer.
- C. Buyer is to disclose the use of this product within hazardous chemical substances. It is the responsibility of the buyer to clean or decontaminate this product before returning for repairs. Buyer's refusal will void repair warranty at seller's option.
- D. If seller's examination of such equipment disclosed to his satisfaction that defects were not caused by negligence, misuse, improper installation, accident or unauthorized repair or alteration by the buyer, repairs will be immediately affected.
- E. Buyer is to provide shipping instructions for the return, including mode of transportation. This warranty does not include mechanical parts failure due to wear or corrosion from normal usage, nor does it cover limited life electrical components or elastomer seals.

This warranty is in lieu of all other warranties, expressed or implied, including that implied of fitness for a particular purpose to the original purchaser or to any other person. Seller shall not be liable for consequential damages of any kind.

IMPORTANT:

The equipment has been certified as intrinsically safe instrument for only those classes or categories of hazardous areas so stated on the equipment label, bearing the mark of the applicable approval agency. No other usage is implied or otherwise authorized.

Unauthorized repair or component replacement by the user will void this warranty and may affect the intrinsic safety of the equipment.

GLOSSARY OF APPROVALS

MAJOR APPORVAL STANDARDS & GOVERNEMNT SPECIFICATIONS
ADOPTED BY MMC INTERNATIONAL CORP. FOR
CERTIFICATION, MANUFACTURE, INSPECTION CALIBRATION AND TESTING

INTRINSICALLY SAFE APPROVALS

CAS (CAN.)	Sira Certification Service
CSA	Canadian Standards Association
EECS	Electrical Equipment Certification Service (U.K.)
CSA (EUROPE)	CSA Group Testing IK Limited
BV	Bureau of Veritas

GOVERNMENT REGULATORY BODIES APPROVALS

BV	Bureau of Veritas
EECS	Electrical Equipment Certification Service (U.K.)

INDUSTRY RECOGNIZED INSPECTION BODIES APPORVALS

ABS	American Bureau of Shipping
CCS	China Classification Society
DNV	Det Norske Veritas (Norway)
LLOYD'S	Lloyd's of London (U.K.)
BV	Bureau of Veritas

GAUGING TAPE AND OTHER MEASUREMENT SPECIFICATIONS

FEDERAL	United States Government Specification
NIST	National Institute of Standards & Technology Test
API	American Petroleum Institute (Partial Adaptation)
ASTM	American Society for Testing Materials

PERIODIC FACTORY INSPECTIONS BY REGULATING BODIES

CSA (UK)	Performs annual inspections for SIRA/CSA for equipment approval provisions of directive 2014/34/EU
CSA (CANADA)	CSA performs quarterly inspections
BV	Performs annual inspections
DNV	Performs annual inspections
CCS	Performs annual inspections

TEMPERATURE CONVERSION CHART

°C = 5/9 (°F-32) °F = (9/5°C)+32
 Kelvin = °C +273.15 Rankine = °F +459.67

Table Example:
 To Convert 1000°C to °F look up 1000 read left
 To Convert 1000°F to °C look up 1000 read right

To °F	From	to °C	to °F	From	to °C	to °F	From	to °C
-0.4	-18	-27.78	165.2	74	23.33	323.6	162	72.22
+3.2	-16	-26.67	168.8	76	24.44	327.2	164	73.33
+6.8	-15	25.56	172.4	78	25.56	330.8	166	74.44
+10.4	-12	-23.33	176.0	80	26.67	334.4	168	75.56
+17.6	-8	-22.22	179.6	82	27.78	338.0	170	76.67
+21.2	-6	-21.11	183.2	84	28.89	341.6	172	77.78
+24.8	-4	-20.00	186.8	86	30.00	345.2	174	78.89
+32.0	+0	-17.78	190.4	88	31.11	348.8	176	80.00
+35.6	+2	-16.67	194.0	90	32.22	352.4	178	81.11
+39.2	+4	-15.56	197.6	92	33.33	356.0	180	82.22
+42.8	+6	-14.44	201.2	94	34.44	359.6	182	83.33
+46.4	+8	-13.33	204.8	96	35.56	363.2	184	84.44
+50.0	+10	-12.22	208.4	98	36.67	366.8	186	85.56
+53.6	+12	-11.11	212.0	100	37.78	370.4	188	86.67
+57.2	+14	-10.00	215.6	102	38.89	374.0	190	87.78
+60.8	+16	-8.89	219.2	104	40.00	377.6	192	88.89
+64.4	+18	-7.78	222.8	106	41.11	381.2	194	90.00
+68.0	+20	-6.67	226.4	108	42.22	384.8	196	91.11
+71.6	+22	-5.56	230.0	110	43.33	388.4	198	92.22
+75.2	+24	-4.44	233.6	112	44.44	392.0	200	93.33
+78.8	+26	-3.33	237.2	114	45.56	395.6	202	94.44
+82.4	+28	-2.22	240.8	116	46.67	399.2	204	95.56
+86.0	+30	-1.11	244.4	118	47.78	402.8	206	96.67
+89.6	+32	0.00	248.0	120	48.89	406.4	208	97.78
+93.2	+24	+1.11	251.6	122	50.00	410.0	210	98.89
+96.8	+36	+2.22	255.2	124	51.11	413.6	212	100.00
+100.4	+38	+3.33	258.8	126	52.22	435.2	214	101.11
+104.0	+40	+4.44	262.4	128	53.33	438.8	216	102.22
107.6	42	5.56	266.0	130	54.44	442.4	218	103.33
111.2	44	6.67	269.6	132	55.56	446.0	220	104.44
114.2	46	7.78	273.2	134	56.67	449.6	222	105.56
118.4	48	8.89	276.8	136	57.78	453.2	224	106.67
122.0	50	10.00	280.4	138	58.89	456.8	226	107.78
125.6	52	11.11	284.0	140	60.00	460.4	228	108.89
129.2	54	12.22	287.6	142	61.11	464.0	230	110.00
132.8	56	13.33	291.2	144	62.22	467.6	232	111.11
136.4	58	14.44	294.8	146	63.33	471.2	234	112.22
140.0	60	15.56	298.4	148	64.44	474.8	236	113.33
143.6	62	16.67	302.0	150	65.56	478.4	238	114.44
147.2	64	17.78	305.6	152	66.67	482.0	240	115.56
150.8	66	18.89	309.2	154	67.78	485.6	242	116.67
154.4	68	20.00	312.8	156	68.89	492.8	244	117.78
158.0	70	21.11	316.4	158	70.00	496.4	246	118.89
161.6	72	22.22	320.0	160	71.11	500.0	248	120.00

LIST OF CHEMICALS

The following list of chemicals, although not all-inclusive, are known to attack PES, the material from which a portion of the sonic liquid level sensor is made.

Prolonged submergence of the sensor should be avoided.

After submergence in any of these chemicals, a thorough cleaning of the sensor head should be conducted to prolong sensor life.

*ACETALDEHYDE – CH_3CHO

*ETHYL ACETATE – $\text{CH}_3\text{COOC}_2\text{H}_5$

*ACETONE – CH_3CHOH_2

*ETHYLENE GLYCOL – $\text{HOC}_2\text{H}_4\text{OH}$

*ANILINE – $\text{C}_6\text{H}_5\text{CL}$

*METHYL ETHYL KETONE – $\text{C}_2\text{H}_5\text{COCH}_3$

BENZALDEHYDE – $\text{C}_6\text{H}_5\text{CL}$

*METHYLENE CHLORIDE – CH_2CL_2

CHLOROBENZENE – $\text{C}_6\text{H}_5\text{CL}$

NITRO BENZENE – $\text{C}_6\text{H}_5\text{NO}_2$

CRESOL – $\text{CH}_3\text{C}_6\text{H}_4\text{OH}$

*PHENOL – $\text{C}_6\text{H}_5\text{OH}$

*CYCLOHEXANONE – $\text{C}_6\text{H}_{10}\text{O}$

*PYRIDINE – $\text{C}_5\text{H}_5\text{OH}$

DICHLOROBENZENE – $\text{C}_6\text{H}_4\text{CL}_2$

TOLUENE – $\text{C}_6\text{H}_5\text{CH}_3$

1,2 DICHLORETHANE – $\text{CH}_2\text{CLCH}_2\text{CL}$

TRICHLOROETHYLENE – $\text{CLCH}=\text{CCL}_2$

*These chemicals are known to be water soluble, ranging from very to slightly; while this information is useful in sensor cleaning procedure, it will also make interface readings less accurate. In such case, good interface readings will depend upon the relative specific gravities involved. In the extreme case of dissolved water within a cargo, and upon ullage gauging of these chemicals, a beeping tone will be heard instead of the normal steady horn tone. This sensor response should not be interpreted as a malfunctioning unit.

GUIDELINES FOR TAPE REPAIR:

The MMC sonic Trimode tape is verified as Intrinsically Safe by SIRA and BASEEFA (British Approvals Service for Electrical Equipment in flammable atmospheres) in the United Kingdom.

In order to maintain the validity of the approval, tape units can be repaired only by MMC or our authorized guaranteed repair offices approved by SIRA, BV, DNV, BASEEFA, CSA. We cannot offer that approval; it must be given by the approval agency.

To maintain our agreement with the above-mentioned approval agencies and yet accommodate our customers as much as possible, we have developed three sets of modules, which can be purchased as units and installed by the owners of the tapes. However, we must know the serial number of the tapes involved in order to maintain our records properly.

The Modules Developed are:

COMPLETE HUB ASSEMBLY, consisting of P.C. Board with ancillary components, (without battery) faceplate, nameplate, gasket, and battery connection cap (approval agency and temperature scale °C or °F to be specified when ordering).

TAPE AND SENSOR ASSEMBLY, consisting of triple sensor, P.C. Board, screw and tape and header assembly. (Tape length and type graduation to be specified by customer when ordering).

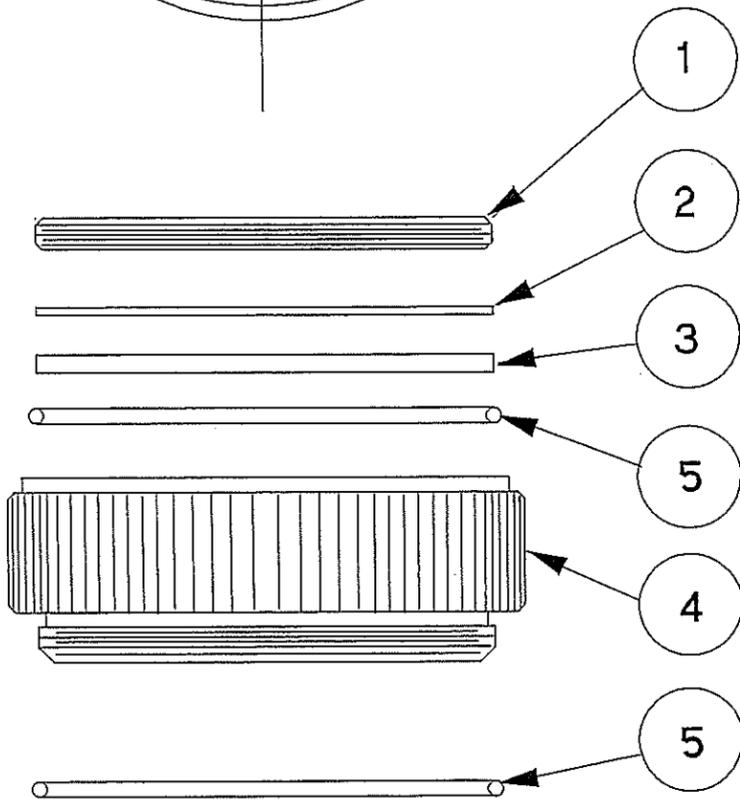
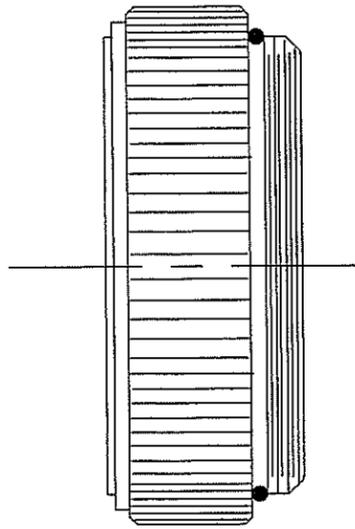
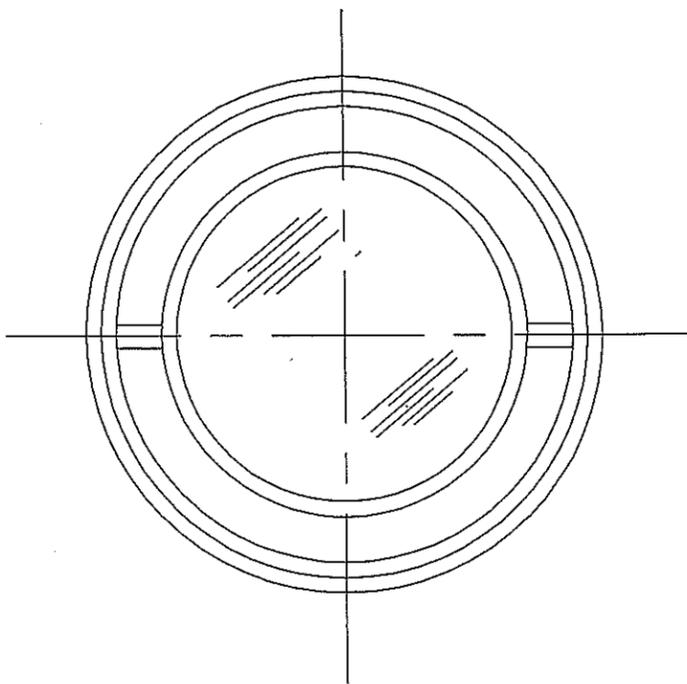
TAPE WIPER ASSEMBLY, consisting of wiper blades, ON/OFF knob, mounting plate and screws.

LIST OF DRAWINGS

“CLOSED TAPE”

<u>DRAWING NUMBER</u>	<u>REV.</u>	<u>DESCRIPTION</u>
A-2562-146	B	Primary Sight Glass Assembly, Closed Hand Gauging
A-2562-147	A	Secondary Sight Glass Assembly, Closed Hand Gauging
B-2401-31	A	P.C. Board Component Placement & LCD Assembly
B-2401-72	C	Sub-Assembly, Hub Cover plate and P.C. Board, ATEX
B-2562-92	B	Tape Wiper to Barrel Assembly
B-2562-269	B	Tape Wiper and Plate Sub-Assembly, Closed Hand Gauging
D-2562-117	E	Sub-Assembly Case Closed Hand Gauging
S-2562-1MB	A	Outline Assembly Closed Triple Function Gauging Tape (Ullage, Interface, Temperature)

UNAUTHORIZED USE, MANUFACTURE OR REPRODUCTION IN WHOLE OR PART, IS STRICTLY PROHIBITED.



REQ	ITEM	DESCRIPTION
2	5	"O" RING, 2-129, VITON
1	4	BODY, SIGHT GLASS ASS'Y
1	3	SIGHT GLASS, TEMPERED
1	2	NYLON WASHER
1	1	RETAINING RING, THREADED

REV.B PT# 5 WAS BUNA-N , 10-3-14
 REV.A REVERSED LISTING ORDER OF PT'S 4&5,9/98

NEXT ASS'Y D-2562-117 JOB NUM.
 MACHINING DETAILS B-2562-172

MMC INTERNATIONAL CORP.
 INWOOD NEW YORK 11696

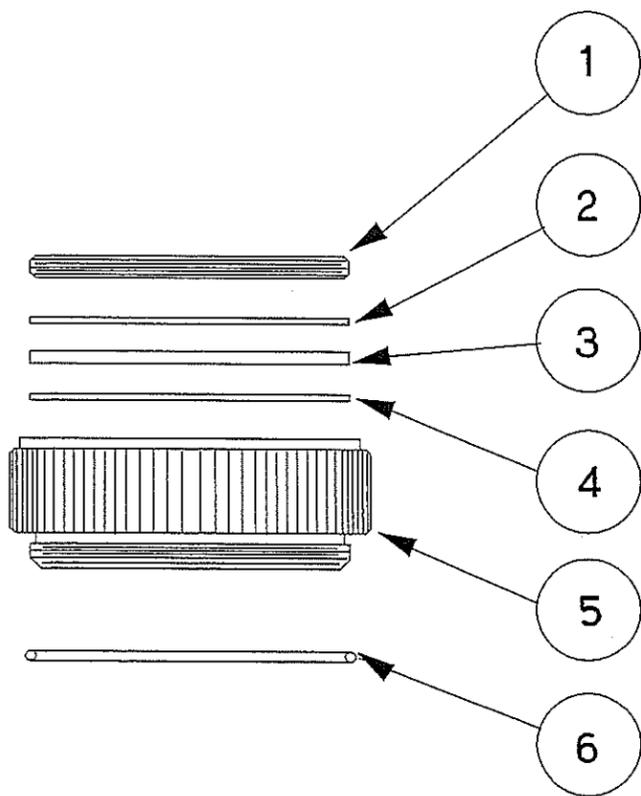
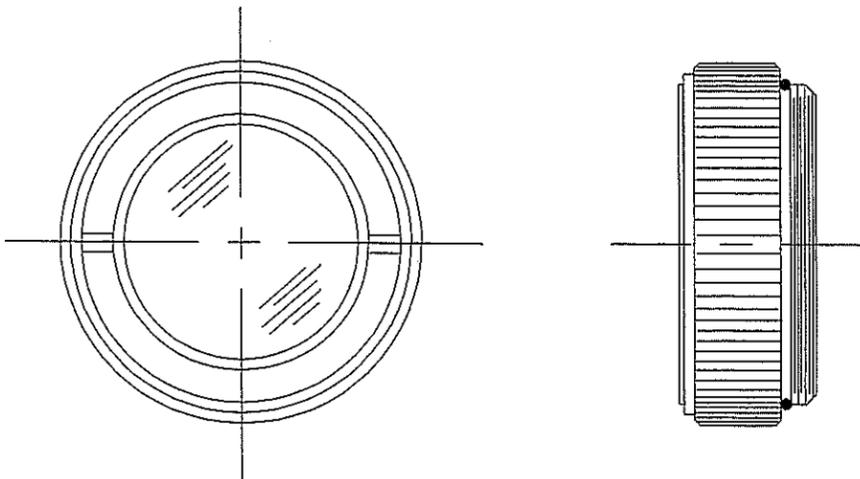
DRN BY : F.S.G
 DATE : 5/92

**PRIMARY
 SIGHT GLASS ASSEMBLY**

CLOSED HAND GAUGING

APP'D DWG. NO. REV.
A-2562-146 **B**

UNAUTHORIZED USE, MANUFACTURE OR REPRODUCTION IN WHOLE OR PART, IS STRICTLY PROHIBITED.



1	6	"O" RING, 2-024, VITON
1	5	BODY, SIGHT GLASS ASS'Y
1	4	GASKET, RUBBER, VITON
1	3	SIGHT GLASS, TEMPERED & XMARK
1	2	NYLON WASHER
1	1	RETAINING RING, THREADED
REQ	ITEM	DESCRIPTION

REV.A, PT#6 WAS BUNA-N 10-03-14

NEXT ASS'Y D-2562-117

JOB NUM.

MACHINING DETAILS B-2562-138

**SECONDARY
SIGHT GLASS ASSEMBLY**

CLOSED HAND GAUGING

MMC INTERNATIONAL CORP.
INWOOD NEW YORK 11696

DRN BY : F.S.G

DATE : 5/92

APP'D

DWG. NO.

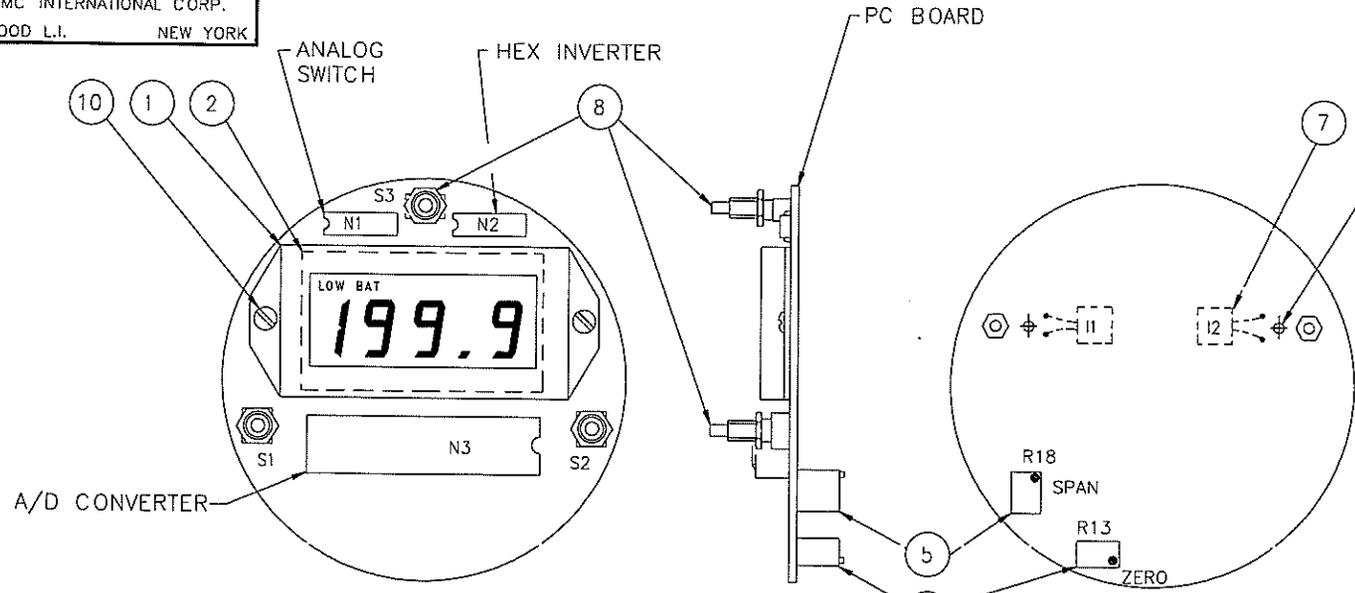
A-2562-147

REV.

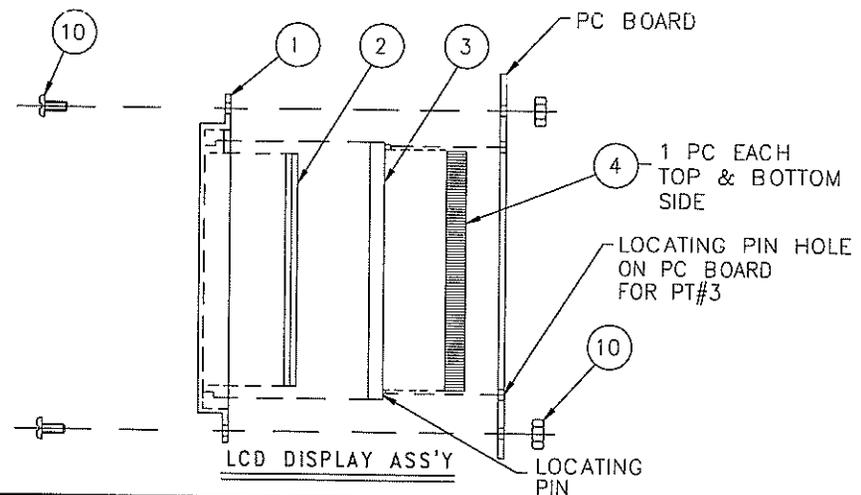
A

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REVISIONS			
SYM.	DESCRIPTION	DATE	APP'D
A	CONVERTED TO CAD FORMAT U1 & L2 MOVED TO PCB TOP SIDE, PT#9 (LED REFLECTOR) DELETED	7-99	FSG



CERTIFIED PRODUCT DWG.
 Fielded/Approval Type
 NO MODIFICATIONS PERMITTED
 WITHOUT PRIOR APPROVAL
 OF AUTHORIZED PERSON
 CHIEF ENG. FSG
 ISSUE DATE: 7/6/99



* REPLACEABLE PARTS

SYM	REQD	PART NO.	REF	DESCRIPTION	MAT'L
	2ea	10	16 2401 2	SCR,W,PAN IID #2-56 X 9/32LG, HEX NUT #2-56	STN. STL
		9			
S1, S2, S3	3	8	5-2401-32	SWITCH, PUSHBUTTON, N.O. SUBMINIATURE	1/4-40 THD
I1, I2	2	7	5-2402-8	LED, WHITE FLAT	PLASTIC
R13	1	6	5-2401-31	POTENTIOMETER, 100K (ZERO)	CERMET
R18	1	5		POTENTIOMETER, 100K (SPAN)	CERMET
	2	4	16-2401-3	ZEBRA CONNECTOR STRIP, 20 CONTACTS	CONDUCTIVE ELASTOMER
	1	3		RETAINER, ZEBRA CONNECTOR	PLASTIC
	2	2	5-2401-9	LCD DISPLAY, 3 1/2 DIGITS, DUAL IN-LINE	GLASS
	1	1	7-2272-3	LCD DISPLAY HOLDER	PLASTIC

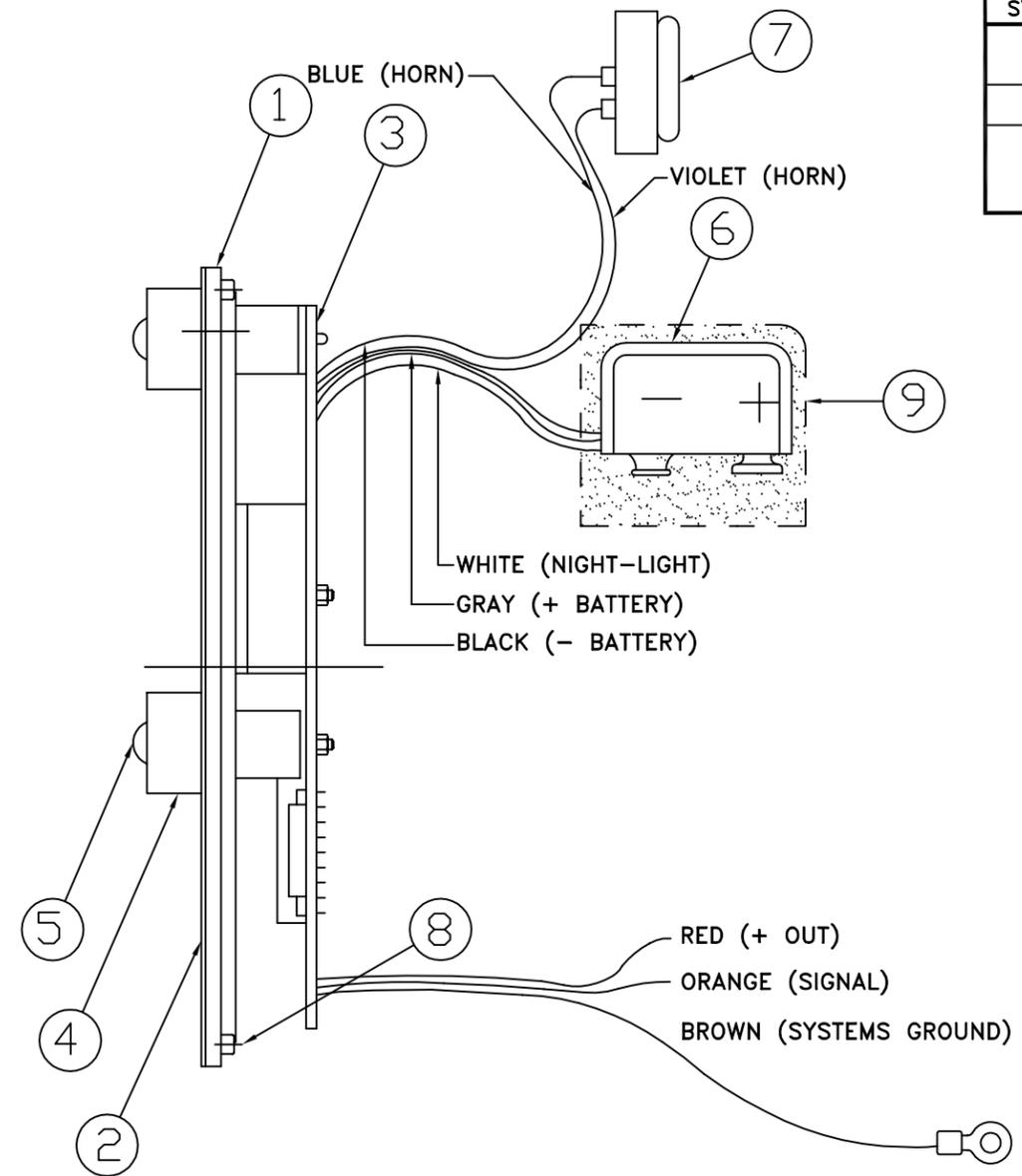
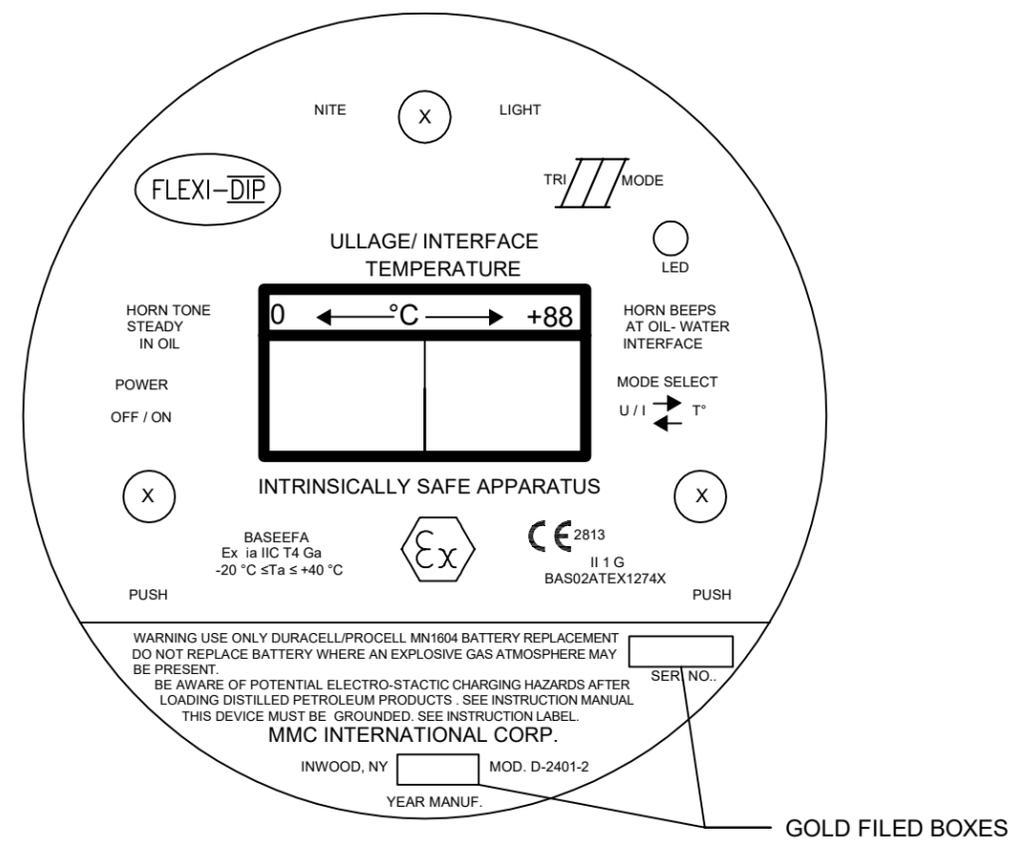
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			TRIMODE PC BOARD COMPONENT PLACEMENT & L.C.D. ASSEMBLY		MMC INTERNATIONAL CORP. INWOOD L.I. NEW YORK	
FRAC.	DEC.	ANG.			DWG. NO.	REV.
± 1/64	± .005	± 30'	SCALE FULL	NO. REQ'D.	DRAWN P.E. DATE 3/12/84	B-2401-31
NEXT D-2401-15 & ASSY. D-2401-17		CHECKED	DATE	DATE		
		APPROVED	DATE	DATE		

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INWOOD L.I. NEW YORK

NOTES:

- FACTORY MUTUAL NAMEPLATE USED ON DWGS. D-2562-1FRL AND D-2562-1FOL
CSA/SIRA NAMEPLATE USED ON DWGS. DB-2562-1FRL AND DB-2562-1FOL

REVISIONS			
SYM.	DESCRIPTION	DATE	APP'D
A	ORIGINAL SCANNED & COVERED TO CAD FORMAT	1/99	FSG
B	UPDATED TO ATEX IIC APP'L	8/11	FSG
C	UPDATED TO LATEST ATEX STANDARDS	7/22	C.E.

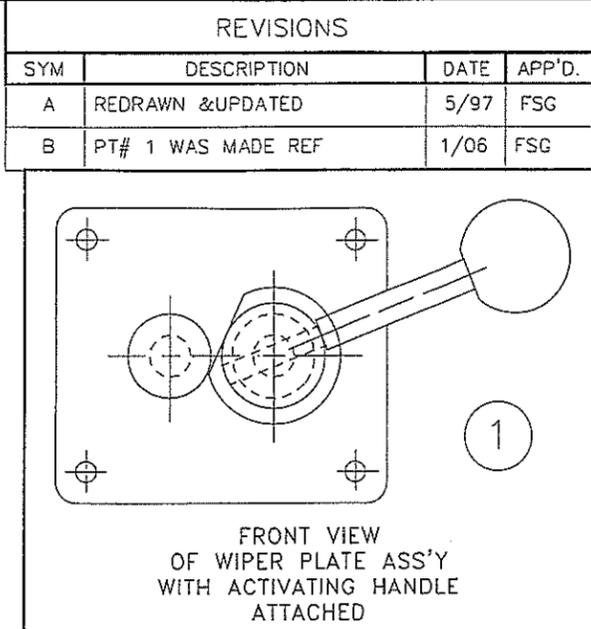
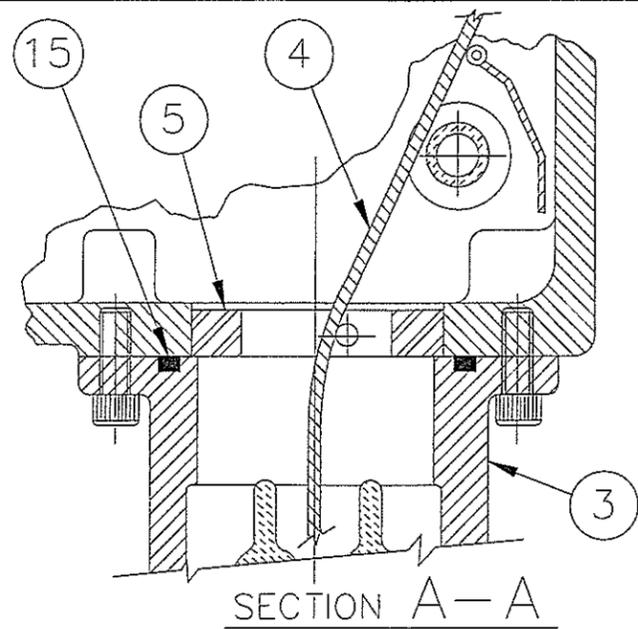
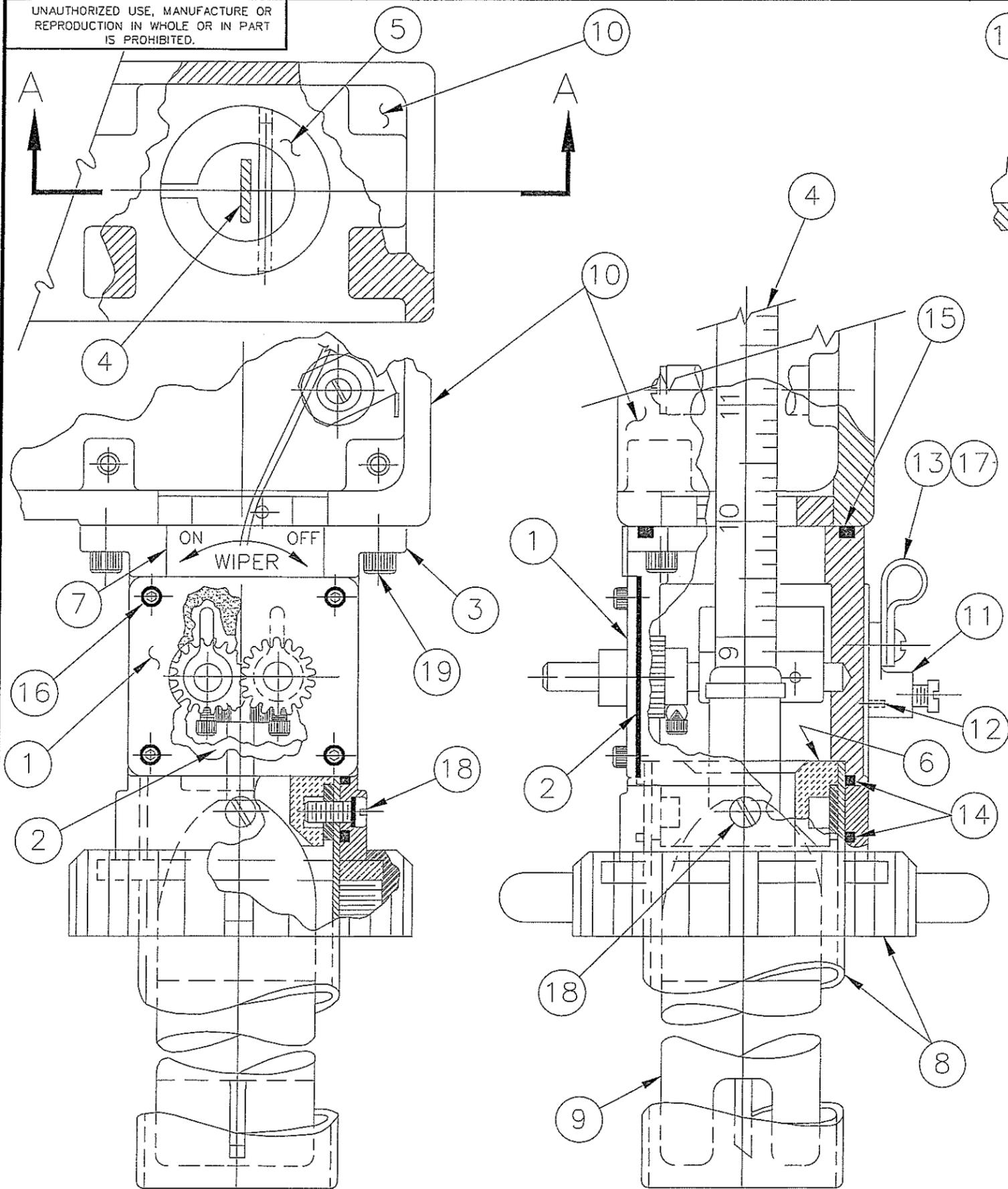


SIRA ATEX APPROVAL LABEL
PART # 2

REQ'D	PT.#	DWG. NO.	DESCRIPTION	MAT'L.
1	9		BATTERY BOOT	VINYL
1	8		"O"- RING, PARKER # S-155	BUNA-N
1	7	A-2401-63	HORN, PIEZO ELEC. SUB-ASS'Y.	EFBRD24C41
1	6	B-2401-15	BATTERY, CONNECTION CAP	POTTED
3	5	AMR N-5040-R	PUSH BUTTON SEAL CAP	BUNA-N
3	4	A-2272-17	PUSH BUTTON GUARD	ALUM
1	3	B-2401-3	HUB, SMT PC BOARD, TRIPLE	1/16, FR4
1	2	AS SHOWN	NAME PLATE, HUB TRIPLE HAND TAPE	ALUM./MYLAR
1	1	A-2455-13	HUB, FACEPLATE	LEXAN

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			TITLE SUB-ASSY HUB COVERPLATE & PCB (TRIPLE FUNCTION)	MMC INTERNATIONAL CORP. INWOOD L.I. NEW YORK	
FRAC	DEC	ANG.			
= 1/64	± .005	± 30'			
SCALE	FULL	NO REQ'D	DRAWN L. CORRADO	DATE 11/87	DWG NO.
NEXT ASSY.	SEE NOTES		CHECKED	DATE	B-2401-72
			APPROVED F.S.GIANNONE	DATE	REV. C

UNAUTHORIZED USE, MANUFACTURE OR REPRODUCTION IN WHOLE OR IN PART IS PROHIBITED.



REF	NO.	DESCRIPTION	MAT'L.
REF	19	SCREW, SOC. HD. 10-32 N.F. x 1/2 LG.	STN. STL.
REF	18	SCREW, PAN HD. W/"O"-RING 10-32 N.F. x 3/8 LG.	STN. STL.
	1	17 SCREW, TRUSS. HD. 6-32 N.C. x 3/8 LG.	STN. STL.
	4	16 SCREW, SOC. HD. 4-40 N.C. x 1/4 LG.	STN. STL.
	1	15 SQR. RING, HOUSING TS #2-130	BUNA-N
	2	14 O-RING, BARREL PARKER #2-031	BUNA-N
	1	13 CABLE CLAMP 3/16 I.D. x #6 SCREW HOLE	NYLON
	1	12 DOWEL PIN 1/16 DIA x 1/4 LG.	STL.
	1	11 GROUND LUG, T & B 71003 W/FIL. HD. SCREW	COPPER/SS
REF	10	CASE MACHINING DWG. D-2562-115	ALUM
REF	9	SENSING PROBE, B-2401-13	
REF	8	STORAGE BARREL ASS'Y, AS CUSTOMER SPECIFIED	
	1	7 NAMEPLATE DWG. A-2562-94	MYLAR
	1	6 PROBE STOP DWG. B-2562-143	NYLATRON
	1	5 BUSHING, ANTI-CHAFING DWG. B-2562-145	NYLATRON
REF	4	GAUGING TAPE ASS'Y DWG. B-2562-128	
REF	3	HOUSING, TAPE WIPER DWG. D-2562-86	ALUM
REF	2	GASKET, DWG. A-2562-90	BUNA-N
REF	1	TAPE WIPER & PLATE SUB-ASS'Y, B-2562-269	
QTY.	NO.	DESCRIPTION	MAT'L.

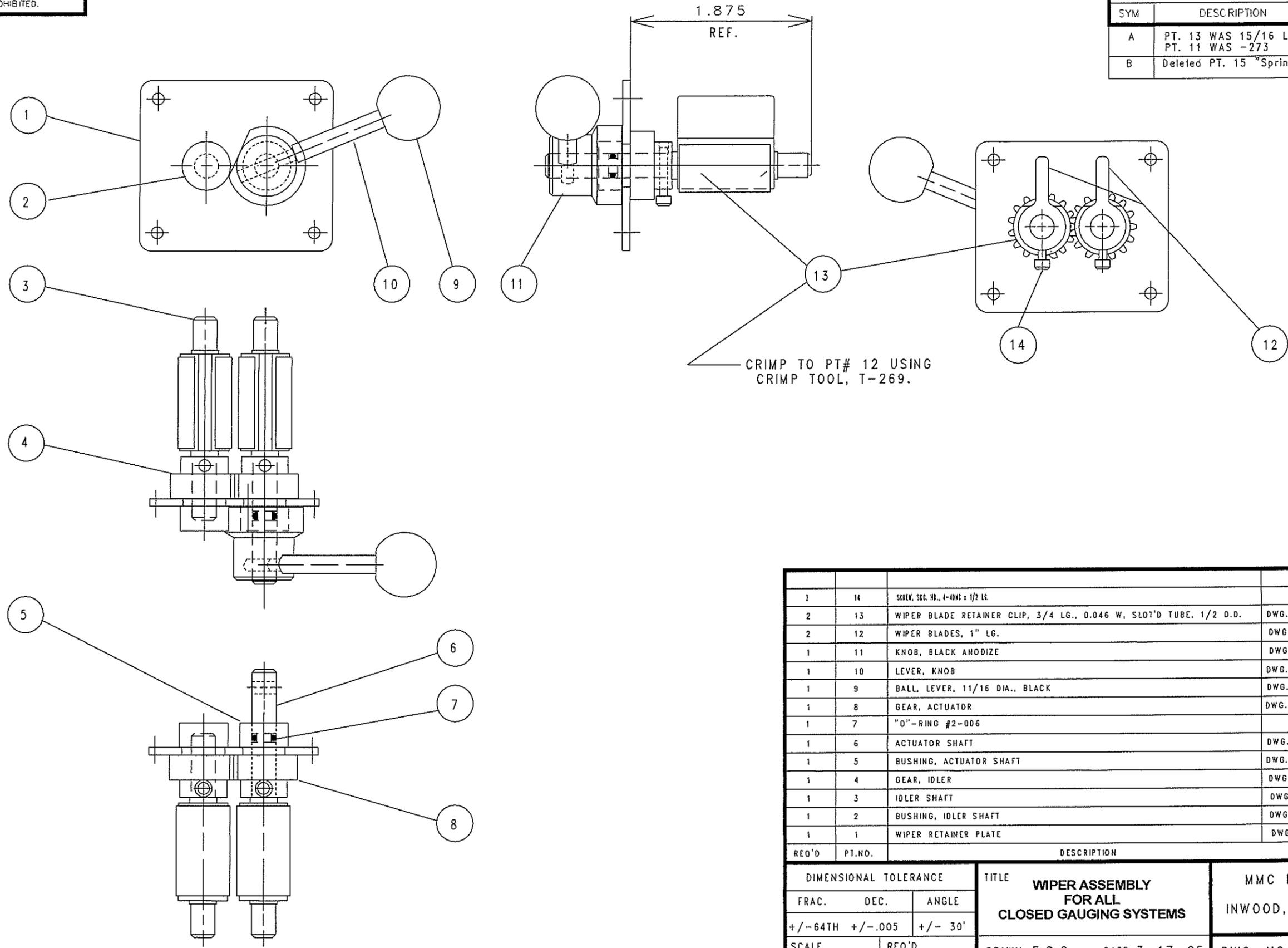
LIST OF MATERIAL

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			TAPPE WIPER TO BARREL ASS'Y CLOSED HAND GAUGING		MMC INTERNATIONAL CORP.	
FRAC.	DEC.	ANG.			INWOOD, L.I. NEW YORK	
±1/64	±.005	±30'				
SCALE FULL (1:1)	NO. 1 REQ'D. PER ASS'Y	DRAWN: J.A.	DATE 9/91	DWG. NO.	REV	
NEXT ASSY. D-2562-98		CHECKED:	DATE	B-2562-92	B	
		APPROVED: F.S.G.	DATE			

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REVISIONS

SYM	DESCRIPTION	DATE	APP'D
A	PT. 13 WAS 15/16 LG, PT. 11 WAS -273	2/97	FSG
B	Deleted PT. 15 "Spring"	06/05	FSG

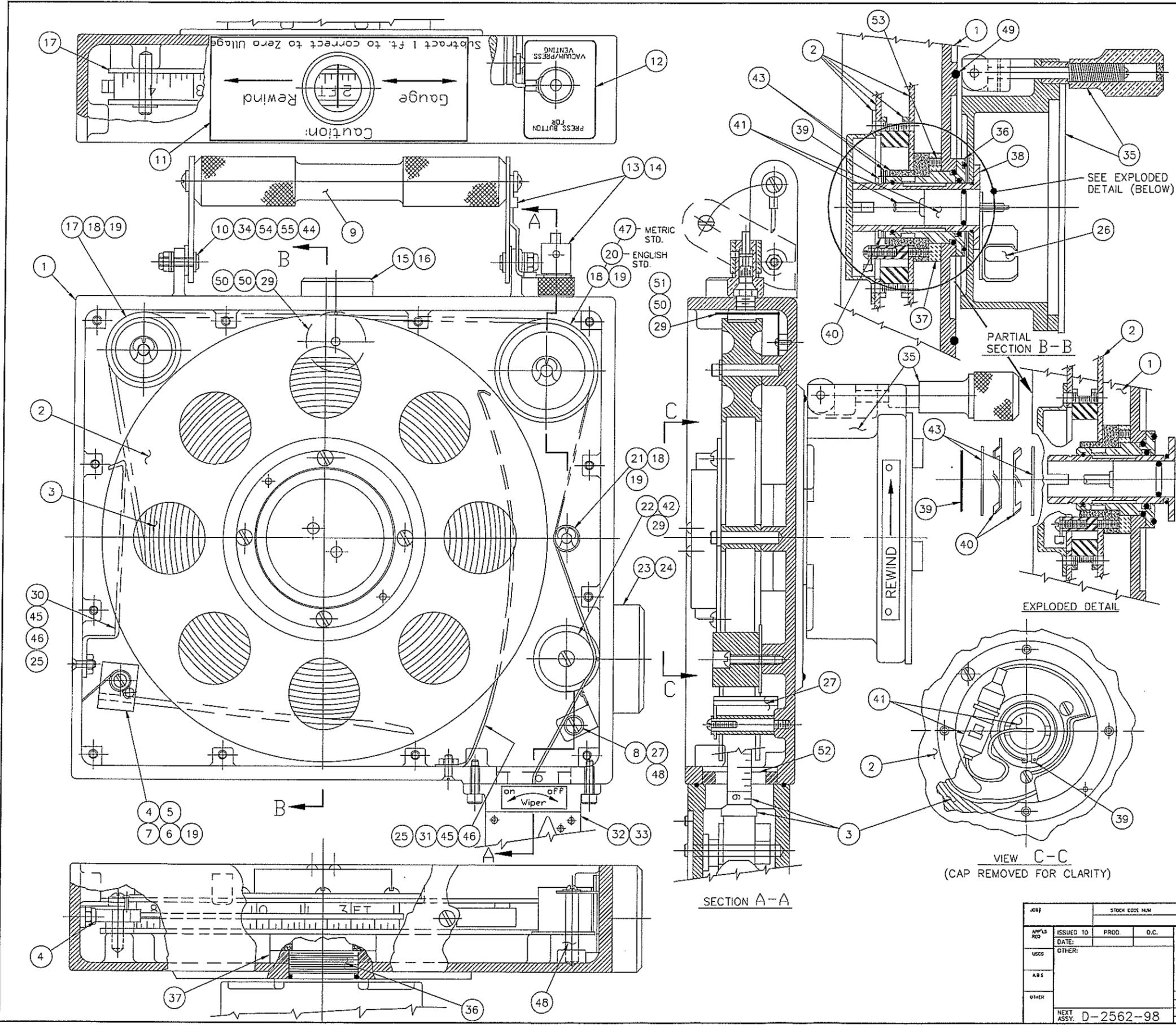


QTY	PT. NO.	DESCRIPTION	MAT'L
1	14	SCREW, SOC. HD., 4-40NC x 1/2 LG.	STN. STL.
2	13	WIPER BLADE RETAINER CLIP, 3/4 LG., 0.046 W, SLOT'D TUBE, 1/2 O.D.	DWG. A-2562-299 STN. STL.
2	12	WIPER BLADES, 1" LG.	DWG. A-2562-21 VITON
1	11	KNOB, BLACK ANODIZE	DWG. A-2562-270 ALUM.
1	10	LEVER, KNOB	DWG. A-2562-273 STN. STL.
1	9	BALL LEVER, 11/16 DIA., BLACK	DWG. A-2562-273 PLASTIC
1	8	GEAR, ACTUATOR	DWG. A-2562-275 DELRIN
1	7	"O"-RING #2-006	BUNA-N
1	6	ACTUATOR SHAFT	DWG. A-2562-272 STN. STL.
1	5	BUSHING, ACTUATOR SHAFT	DWG. A-2562-271 STN. STL.
1	4	GEAR, IDLER	DWG. A-2562-275 DELRIN
1	3	IDLER SHAFT	DWG. A-2562-272 STN. STL.
1	2	BUSHING, IDLER SHAFT	DWG. A-2562-271 STN. STL.
1	1	WIPER RETAINER PLATE	DWG. A-2562-274 STN. STL.
REQ'D	PT. NO.	DESCRIPTION	MAT'L

DIMENSIONAL TOLERANCE			TITLE		MMC INTERNATIONAL CORP	
FRAC.	DEC.	ANGLE	WIPER ASSEMBLY FOR ALL CLOSED GAUGING SYSTEMS		INWOOD, NEW YORK	
+/-64TH	+/- .005	+/- 30'				
SCALE		REQ'D	DRAWN F.S.G	DATE 3-17-95	DWG. NO.	REV
NEXT ASS'Y B-2562-92			APP'D	DATE	B2562-269	B

REVISIONS				
SYL	DESCRIPTION	DATE	BY	APP'D
A	REDRAW AS CAD VERSION AND UPDATED	4/97	FSG	
B	PT#51 WAS FOR #6 SCR., PT#25 DELETED	9/98	FSG	
C	PT#S 14,20,21,22,47 WERE NYLATRON MATL	10/98	FSG	
D	PT# 42 WAS 7/8 LG	01/05	FSG	
E	PT# 29 WAS -141	05/17	FSG	

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INWOOD, L.I. NEW YORK



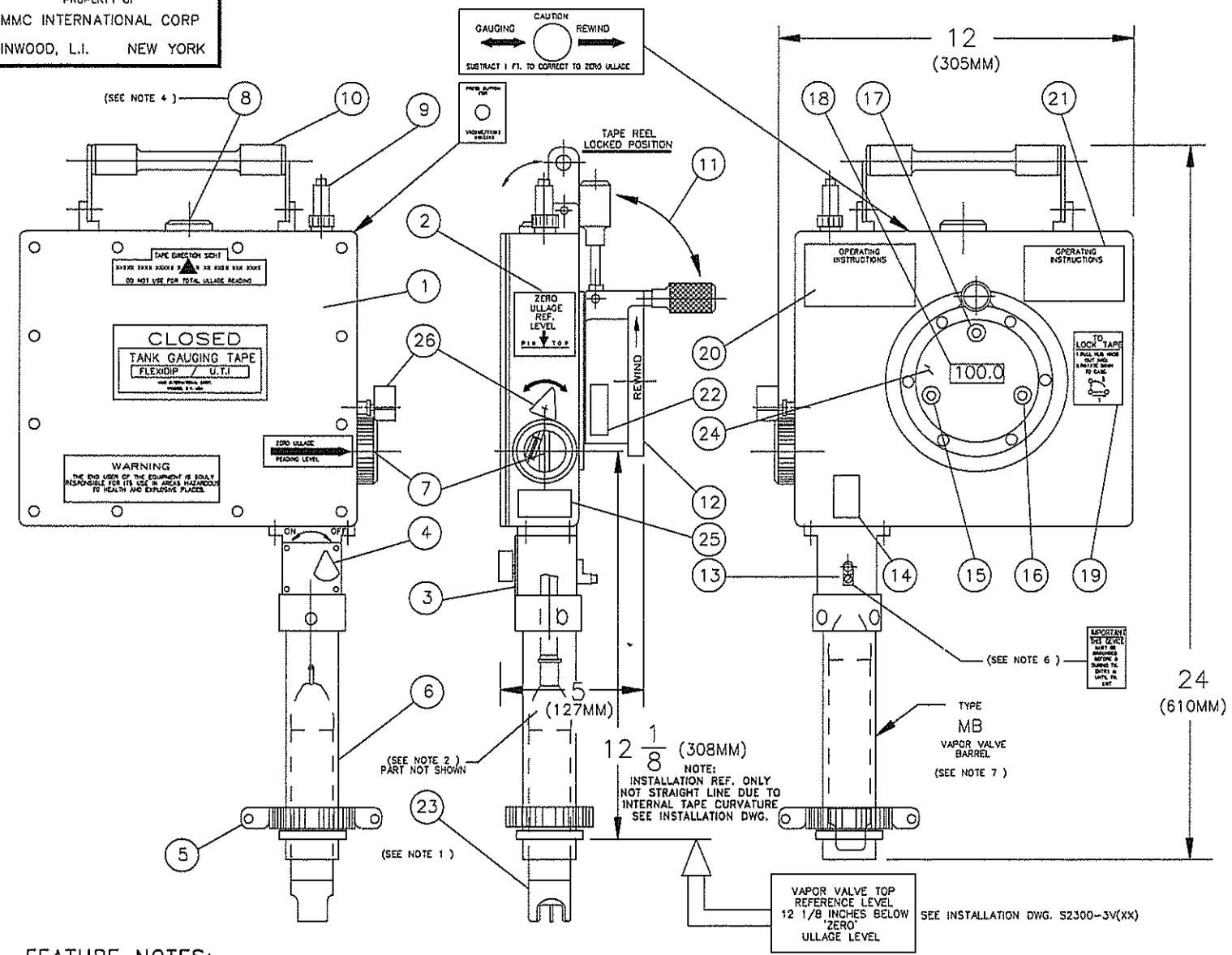
QTY	DESCRIPTION	MAT'L	ASTM NO.
2	55 WASHER, FLAT, #10 x .045 THK	NYLON	
2	54 WASHER, FLAT, #10 x 3/4 O.D. x .035 THK	TEFLON	
1	53 SCREW, SET, 10-32NF x 1/4 LG.	STN STL	
1	52 BUSHING, SPLIT, TAPE GUIDE ASS'Y, DWG B-2562-145	NYLATRON	
1	51 SPACER WASHER, 1/16 THK., #4 SCREW	STN STL	
1	50 SCREW, RD. HD., 6-32NC x 1/4 LG.	STN STL	
REF	49 "O"-RING, FRICTION STOP, #2-353	BUNA-N	
1	48 POST, SPLASH GUARD DWG. A-2562-144	ALUM	
1	47 ROLLER, TAPE GUIDE, TOP RIGHT (METRIC) DWG A-2562-165	HDPE	
2	46 NUT, HEX, #8-32 N.C	STN STL	
2	45 SCREW, FL'T, HD. 8-32 N.C. x 1/2 LG	STN STL	
2	44 STOP NUT, NYLON INSERT, #10-32 N.F.	STN STL	
2	43 WASHER, FLAT, 1 5/8 O.D. x 1.010 I.D. x .035 THK	STN STL	
1	42 SCREW, RND. HD 10-32 N.F. x 3/4 LG.	STN STL	
REF	41 CONNECTOR ASSY, HUB DWG #B-2562-137		
2	40 WASHER, FINGER SPRING, BARNES #F1555-018	STN STL	
1	39 RING, RETAINING WALDES TRUARC #5100-100	STN STL	
REF	38 SHAFT, HUB DWG #B-2562-105	STN STL	
1	37 NUT, BOX BEARING DWG #A-2562-127	ALUM	
1	36 SHAFT COLLAR ASSY DWG #B-2526-112, NI-PLATED	BRASS	
1	35 HUB ASSY DWG #D-2562-103		
4	34 WASHER, FLAT #10	STN STL	
REF	33 SCREW, SOCKET HD. 10-32NF x 1/2 LG.	STN STL	
REF	32 WIPER HOUSING ASSY DWG #B-2562-92		
1	31 SPRING, TAPE RET. RIGHT DWG #A-2562-149	STN STL	
1	30 SPRING, TAPE RET. LEFT DWG #A-2562-148	STN STL	
2	29 CURSOR PIN ASSY DWG #A-2562-141	STN STL	
28			
1	27 SPLASHGUARD DWG #A-2562-332	STN STL	
1	26 BATTERY, 9V, TYPE MN1604 (NOT SHOWN)	ALKALINE	
2	25 WASHER, FLAT, #8 HOLE SIZE	STN STL	
REF	24 O-RING (SIGHTGLASS, PRI.) #2-129	BUNA-N	
1	23 SIGHTGLASS, PRIMARY DWG #A-2562-146		
1	22 ROLLER, TAPE GUIDE, SIGHTGLASS, DWG #A-2562-126	HDPE	
1	21 ROLLER, TAPE GUIDE, CENTER, DWG #A-2562-125	HDPE	
1	20 ROLLER, TAPE GUIDE, TOP RIGHT(ENGLISH), DWG #A-2562-124	HDPE	
4	19 RING, RETAINING TRUARC #5133-25	STN STL	
3	18 POST, ROLLER DWG #A-2562-133	ALUM	
1	17 ROLLER, TAPE GUIDE, TOP LEFT, DWG #A-2562-123	HDPE	
REF	16 O-RING (SIGHT GLASS, SEC.) #2-024	BUNA-N	
1	15 SIGHT GLASS, SECONDARY, DWG #A-2562-147		
REF	14 VALVE, PUSH BUTTON ASS'Y, #DWG #A-2562-134	NYLATRON	
REF	13 VALVE, PRESSURE RELIEF, #DWG #B-2562-134		
REF	12 LABEL (PRESS. RELIEF) DWG #A-2562-82		
REF	11 LABEL (SIGHT GLASS, SEC.) DWG #A-2562-93		
2	10 SCREW, PAN HD. #10-32 NF. x 1" LG.	STN STL	
1	9 HANDLE ASSY DWG #B-2562-108		
2	8 SCREW, RND. HD. #6-32 N.C x 1/4" LG	STN STL	
1	7 SPRING, TORSION DWG #A-2562-150	STN STL	
1	6 SCREW, TRUSS. HD. #6-32 N.C x 5/8" LG	STN STL	
1	5 POST, ANTI-WIND ARM DWG #A-2562-132	STN STL	
1	4 ARM, ANTI-WIND DWG #B-2562-107		
1	3 TAPE ASSY DWG #B-2562-128		
1	2 TAPE REEL ASSY DWG #D-2562-121		
1	1 CASE, CASTING (#D-2562-87) & MACHINING (#D-2562-115)	ALUM	

QTY	STOCK CODE	MAN	REV'S	PART NO.	DESCRIPTION	MAT'L	ASTM NO.
SUB-ASSEMBLY CASE CLOSED HAND GAUGING							
FOR PETROLEUM PRODUCT USAGE SEE DWG D-2562-N7C FOR CHEMICAL USAGE							
SCALE: Full (1-1) 1 WT MAX							

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GENERAL SPECIFICATIONS

ACCURACY FLUID LEVEL ± 1/8 INCH (3mm)
 TEMPERATURE ± 0.5°F (0.3°C)
 APPROVALS INTRINSICALLY SAFE; FM, BASEEFA, CSA, SAA
 TEMP. LIMITS AMBIENT -20 TO 120°F (-29 TO 49°C)
 PRODUCT -40 TO 180°F (-40 TO 80°C)
 TAPE LENGTHS 50, 75, 100FT. (15, 25, 30M, 37M)
 TYPICAL WEIGHT 14 LBS. (6.4Kg)
 PRESS. LIMITS 3 PSI-WORKING, 7.5 PSI MAX.



26	WIPER ASS'Y, SIGHT GLASS, B-179
25	FULL STOW LABEL, METRIC OR ENGLISH DIM., PER ORDER
24	APPROVAL LABEL & OPERATING DESCRIPTION
23	UTI SENSOR & GAUGING TAPE, 316SS, TEFLON COATED TAPE
22	BATTERY, 9V, MN1804 PER APPROVAL LABEL, 1 AS SPARE
21	OPERATING INSTRUCTIONS, TEMPERATURE
20	OPERATING INSTRUCTIONS, ULLAGE-INTERFACE
19	TAPE REEL ROTATION LOCKING INSTRUCTIONS
18	TEMPERATURE DISPLAY, LCD TYPE, 'F' OR 'C', AS SPECIFIED
17	NIGHT LIGHT PUSH BUTTON
16	OPERATING MODE SELECTOR, PUSH BUTTON
15	POWER ON-OFF PUSH BUTTON
14	GROUNDING INSTRUCTION LABEL
13	GROUNDING LUG FOR SUPPLIED GROUNDING CABLE
12	ELECTRONIC DISPLAY & BATTERY ENCLOSURE HUB CASE
11	CRANK, TAPE REEL & ELEC. HUB CASE, & REEL LOCK
10	CARRYING HANDLE, SWING AWAY TYPE, NYLATRON
9	PRES./VAC VENT BUTTON & VAPOR PURGING ADAPTOR
8	SECONDARY GAUGING TAPE SIGHT GLASS, REMOVABLE
7	PRIMARY GAUGING TAPE SIGHT GLASS, REMOVABLE
6	SENSOR STORAGE BARREL & VALVE ENTRY TUBE
5	SECURING COLLAR, BARREL TO VAPOR VALVE
4	REMOVABLE WIPER ASSEMBLY, STN. STL. W/VITON WIPERS
3	TAPE WIPER & STORAGE BARREL ATTACHMENT
2	TAPE REEL CASE, ALUM, NYLON COATED
1	REMOVABLE COVER WITH MOLDED VITON SEAL, NYLON COATED

FEATURE NOTES:

- GAUGING TAPE IS ANTI-STATIC COATED.
- POSITIVE INTERNAL TAPE HEAD STOP STD.
- CASE IS LABELED PER FULL REWIND STOP POSITION.
- SIGHT GLASS EASILY REMOVEABLE FOR CLEANING OR REPLACEMENT. TEMPERED GLASS USED. TAPE DIRECTION & MOTION EASILY SEEN.
- INTERNAL REEL STOP TO PREVENT BACKWARD TAPE REWIND.
- COILED EXPANSION TYPE GROUNDING CABLE WITH LARGE ALLIGATOR CLIP, STANDARD SUPPLY
- INTERCHANGEABLE BARRELS ARE AVAILABLE FOR ALL MMC VAPOR VALVES; TYPES A, B, MB, MMB, MATING BARRELS FOR COMPETITIVE VALVES ARE ALSO AVAILABLE. CUSTOM VAVE ADAPTERS ARE MANUFACTURED TO CUSTOMER SPECIFICATIONS.
- MOLDED STORAGE CASE IS STANDARD SUPPLY.

ITEM NO.	FEATURE DESCRIPTION	
	OUTLINE ASS'Y MMC CLOSED TRIPLE FUNCTION ULLAGE-INTERFACE, TEMPERATURE GAUGING TAPE	MMC INTERNATIONAL CORP. INWOOD, L.I. NEW YORK
DRAWN	F.S.G	DATE 10/05
CHECKED		DATE
APPROVED		DATE
DWG. NO. S2562-1MB		REV. A