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APPROVAL REPORT

ST420-LT AND ST420-DI SHAFT TACHOMETER SENSORS FOR USE IN HAZARDOUS LOCATIONS

Prepared for:


**Electro-Sensors Inc.
6111 Blue Circle Dr.
Minnetonka, MN 55343 USA**

Project ID: 3043444

Class: 3616 - FMCU

Date of Approval: 26 January 2012

Authorized by:



J. E. Marquedant – Group Manager, Electrical

I INTRODUCTION

- 1.1** Electro-Sensors Inc. (manufacturer) requested FM Approval of their ST420-LT and ST420-DI Tachometer Sensors listed in Section 1.5 to be in compliance with the applicable requirements of the standards listed in Section 1.3 and 1.4.
- 1.1.1** For FM Approval for use in the United States as Dust-ignitionproof for Class II/III, Division 1 and 2, Groups E, F and G hazardous (classified) locations, indoors and outdoors (Type 4X/IP65).
- 1.1.2** For FM Approval for use in Canada as suitable for use in Class II, Division 1 and 2, Groups E, F and G, and Class III, Division 1 hazardous locations, indoors and outdoors (Type 4X/IP65).
- 1.2** This report may be freely reproduced only in its entirety and without modification.
- 1.3** The equipment described in this report was shown to comply with the applicable requirements of the following standards for use in the United States.

Title	Class Number	Issue Date
Electrical Equipment for use in Hazardous (Classified) Locations General Requirements	FM Class 3600	1998
Electrical Equipment for Measurement, Control and Laboratory Use	FM Class 3810	2005
Degrees of Protection Provided by Enclosure (IP Code)	ANSI/IEC60529	2004
Enclosures for Electrical Equipment (1000 Volts Maximum)	ANSI/NEMA 250	2003

- 1.4** The equipment described in this report was shown to comply with the applicable requirements of the following standards for use in Canada.

Title	Class Number	Issue Date
Bonding of Electrical Equipment	CSA C22.2 No. 0.4	2004
Threaded Conduit Entries	CSA C22.2 No. 0.5	1982 (R2003)
Enclosures for use in Class II Groups E, F and G Hazardous Locations	CSA C22.2 No. 25	1966 (R2004)
Special Purpose Enclosures, Industrial Products, A National Standard of Canada	CSA C22.2 No. 94	1991
Industrial Products, Forming Part of Canadian Electrical Code, Part II Safety Standards for Electrical Equipment	CSA C22.2 No. 142	1987 (R2004)
Degrees of protection provided by enclosures (IP Code)	CSA C22.2 No. 60529	2005

- 1.5** **Listing** - The equipment described in this report will appear in the *Approval Guide*, an online resource of FM Approvals, as follows:

1.5.1 United States Listing:

ST420-LT-a. Tachometer Sensor

DIP/II,III/1,2/EFG/T5 Ta=80°C; Type 4X, IP65

a = Frequency Range: L, H or C-XXXX (C-XXXX is customer requested frequency range with 4 digit tracking no.).

ST420-DI-a. Tachometer Sensor

DIP/II,III/1,2/EFG/T5 Ta=80°C; Type 4X, IP65

a = Frequency Range: L, H or C-XXXX (C-XXXX is customer requested frequency range with 4 digit tracking no.).

1.5.2 Canada Listing:

ST420-LT-a. Tachometer Sensor

DIP/II,III/1,2/EFG/T5 Ta=80°C; Type 4X, IP65

a = Frequency Range: L, H or C-XXXX (C-XXXX is customer requested frequency range with 4 digit tracking no.).

ST420-DI-a. Tachometer Sensor

DIP/II,III/1,2/EFG/T5 Ta=80°C; Type 4X, IP65

a = Frequency Range: L, H or C-XXXX (C-XXXX is customer requested frequency range with 4 digit tracking no.).

1.6 As described in this report, the construction of the ST420-LT and ST420-DI Tachometer Sensors provide for the degree of protection against electrical shock, fire and injury required for hazardous locations.

II DESCRIPTION

2.1 The ST420-LT and ST420-DI sensors are tachometer sensors used for measuring the speed of a shaft. The sensors detect magnetic pulses from a rotating shaft which has magnetic pulser targets mounted on the shaft (disc type or wrap type). The output from the transmitters is a continuous 4 – 20 mA analog signal in direct proportion to the pulse frequency (rotating shaft speed). The ST420-LT and ST420-DI sensors are available in three different frequency range options, low (option L for 0.2667 to 26.67 Hz), high (option H for 0.2667 to 266.7 Hz) or customer (option C) supplied. The ST420-LT and ST420-DI sensors are packaged within a M18x1 stainless steel sensor housing with either a ½ inch NPT female conduit thread type (ST420-DI version) for ½ inch trade size conduit connection or with a flexible liquid tight fitting for connection with ½ inch liquid tight flexible conduit (ST420-LT version).

2.2 The ST420-LT and ST420-DI sensors are rated for 8 to 30 Vdc and shall be powered by a Class II power supply. The ST420-LT and ST420-DI sensors come complete with a NRTL listed, 10 foot length of shielded, 2 x 24 AWG stranded copper wire rated for 105°C for electrical connection using a suitable Class II/III wiring method to a suitably rated junction box. The ambient temperature range of the ST420-LT and ST420-DI sensors are rated for use from -20°C to +80°C.

III EXAMINATIONS AND TESTS

3.1 The following test samples, considered to be representative of the ST420-LT and ST420-DI sensors were examined, tested, and compared to the manufacturer's drawings. All testing was conducted at FM Approvals facilities in West Glocester, Rhode Island USA. All test data is on file at FM Approvals under Project ID: 3043444 along with other documents and correspondence applicable to this program.

Test sample 1 – ST420-LT Tachometer sensor, with 10 foot length of ½ inch trade size flexible liquid tight conduit attached. The test sample also include a 10 foot length of 2x24AWG shielded stranded flying cable wire pre-installed within the liquid tight conduit for electrical connection.

Test sample 2 – ST420-DI Tachometer sensor, with 10 foot length of 2x24AWG shielded stranded flying cable wire. The body of the sensor incorporates a ½ inch female NPT trade size conduit connection. Three wraps of Teflon tape was used on the conduit used prior to the environmental protection tests.

3.2 Dust-Ignitionproof Tests - The following tests verified the suitability of the ST420-LT and ST420-DI sensors as suitable for Class II and III, Division 1 and 2, Groups E, F and G for hazardous locations for use in US and Canada.

3.2.1 Impact Tests – Test samples 1 and 2 were subjected to impacts from a 25 mm spherical steel tip at a 7 Joule magnitude. The impact was obtained by dropping a 1.0 kg weight from a height of 0.7 m onto various test points on the test samples. Results were satisfactory in that no damage occurred to the test samples that would invalidate the Type of Protection.

3.2.2 Dust Exclusion Test – Test Samples 1 and 2 were individually suspended in a circulating dust atmosphere of 200 mesh talc. The test sample was connected to a vacuum pump adjusted to draw a vacuum of 20 mBar on the sample. The test lasted a total of eight hours and at the conclusion of the test, the test sample was removed from the test chamber; excess dust was removed from the surface and opened. Results are satisfactory as the sensors were found to have excluded the entry of dust.

3.2.3 Dust Blanketing Temperature Test - Surface temperature tests were waived on the ST420-LT and ST420-DI sensors, as the maximum power dissipated by the device is less than 1 watt. The power dissipation would not produce a temperature rise greater than 20°C in the rated 80°C ambient. This qualifies the manufacturer's request for a temperature code of T5 at a 80°C maximum ambient temperature rating. This is satisfactory.

3.3 Protection Against Electrical Shock, Fire and Injury – Electrical utilization equipment acceptability is based on the ability of the equipment to minimize the risk of electrical shock, injury and fire. The following verifies that the ST420-LT and ST420-DI sensors were found to meet these requirements for US and Canada.

3.3.1 Protection from Electric Shock - The maximum normal operating parameters of the ST420-LT and ST420-DI sensors for use in outdoor wet locations, are specified to be less than 16Vrms, 22.6 V peak, 35 Vdc. As for Canada, the circuit voltage does not have a voltage more than 30Vrms or 42.4V peak and is classified as an Extra-low Voltage Class 2 circuit. Therefore, the equipment is not considered to be 'Hazardous Live' for the USA and as for Canada pose a 'Shock Hazard'.

3.3.1.1 Protective Ground - The ST420-LT and ST420-DI sensors contains an external protective ground terminal connection. This external ground terminal connection is installed pursuant to the user's

manual and is an integral part of the housing. Refer to Sections 4.1.4 and 4.1.5 for protective ground connection depictions. This is satisfactory.

- 3.3.1.2 Dielectric Tests** - A test potential of 500 Vac was applied for 1 minute between the input supply terminals of test sample 2 tied together and the protective ground terminal (outer sensor case) with no occurrence of breakdown. This is satisfactory.
- 3.3.1.3 Field Wiring** - The ST420-LT and ST420-DI sensors come complete with a NRTL listed, 10 foot length of shielded, 2 x 24 AWG stranded copper wire rated for 105°C for electrical connection using a suitable Class II/III wiring method to a suitably rated junction box. No consideration was needed in regards to vibration as the lead wires conductor size was not smaller than 24 AWG. This is satisfactory.
- 3.3.2 Protection Against Mechanical Hazards** - The ST420-LT and ST420-DI sensors do not have any moving parts, provisions for carrying or lifting, provision for wall mounting, parts which are likely to become expelled in the event of a fault. It is considered fixed equipment. As a result, no further evaluation is needed for protection against mechanical hazardous. This is satisfactory.
- 3.3.3 Mechanical Resistance to Shock, Impact and Resistance to UV radiation** - Rigidity, shock and impact testing was waived as the ST420-LT and ST420-DI sensors is made from solid metallic fabricated material as described in Section II of this report. There are no parts likely to crack or loosen which will cause a hazard such as electric shock, fire, moving parts, damaging of barriers or invalidated creepage distances. As a result, no further evaluation is needed for protection against shock and impact. This is satisfactory.
- 3.3.4 Protection Against the Spread of Fire** - The PCB shaft tachometer board has a 94V-0 flammability rating, and the electronics and connection facilities of the ST420-LT and ST420-DI sensors are enclosed in a metallic housing. This design construction and the lower power dissipation determined satisfactory compliance against internal spread of fire. This is satisfactory.
- 3.3.5 Equipment Temperature Limits and Resistance to Heat** - The ST420-LT and ST420-DI sensors are considered to be industrial measurement equipment. There are no parts which need to be touched for functionality reasons. The maximum temperature of the field wiring within the enclosure was determined to be approximately the maximum ambient (80°C) due to the low power of the equipment. The equipment is suitably factory wired with conductors rated to 105°C, 300V. This is satisfactory.
- 3.3.6 Protection against Hazards from Fluids** - The ST420-LT and ST420-DI sensors were examined to determine if the process of cleaning and the spillage of liquids could result in a hazard. The ST420-LT and ST420-DI sensors are not supplied with hazardous live voltages and has a water tight enclosure. As a result, external cleaning and spillage of liquids will not present a hazard. This is satisfactory.
- 3.3.7 Process Pressure Test** - The ST420-LT and ST420-DI sensors are not intended to be used in a process which contains liquids. The process pressure test is not applicable. This is satisfactory.
- 3.3.8 Protection against Radiation, Laser Sources, and Against Sonic and Ultrasonic Pressure** - The ST420-LT and ST420-DI sensors is not a source for producing radiation, laser emissions, sonic or ultrasonic pressure. As a result, no further evaluation is needed. This is satisfactory.
- 3.3.9 Protection Against Liberated Gases, Explosion and Implosion** - The ST420-LT and ST420-DI sensors do not contain gases, batteries or high vacuum devices. As a result, no further evaluation is

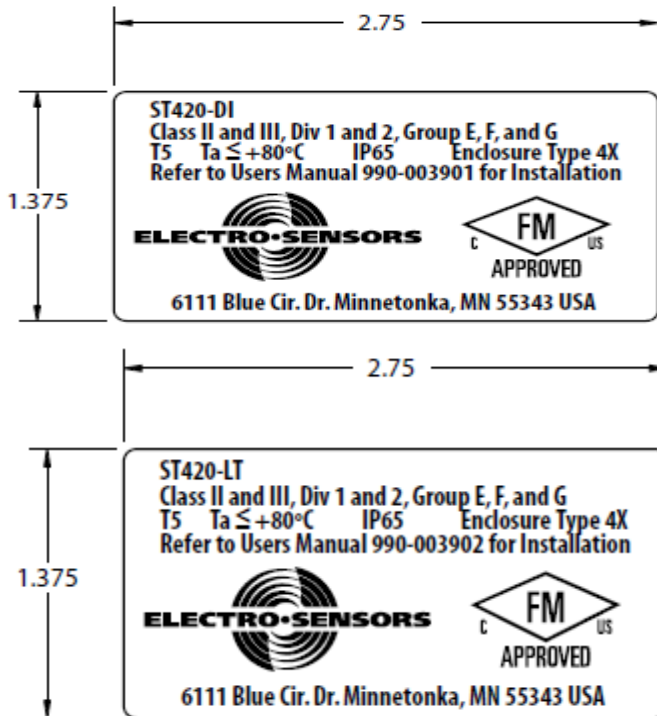
needed for protection against Liberated Gases, Explosion and Implosion. This is satisfactory.

- 3.3.10 Components** - The ST420-LT and ST420-DI sensors do not have any components such as motors, over-temperature protection devices, fuse holders accessible to the operator, transformers, etc. which are required to be examined for electric shock, fire and injury. The PCB shaft tachometer board is specified as FR4 laminate, Green Glass Epoxy, with a 94V-0 flammability rating or better. This is satisfactory.
- 3.3.11 Protection by Interlocks** - The ST420-LT and ST420-DI sensors do not contain any protection by interlocks therefore no further examination was needed. This is satisfactory.
- 3.4 Environmental Tests** - The following tests verified the Type 4X environmental rating for the ST420-LT and ST420-DI sensors.
- 3.4.1 Pre-Conditioning** – As the ST420-LT sensors employ resilient non-metallic gaskets / o-ring seals which provide protection against the ingress of water and dust, the complete enclosure with such gaskets / seals in place was subjected to the following preconditioning. Test sample 1 was subjected to 90% relative humidity at a temperature of (20 ± 2) K above the maximum service temperature, (i.e., 95°C) for 168 hours.
- 3.4.2 Hosedown Test** - A pre-conditioned test sample 1, as described in Section 3.4.1, and test sample 2 were subjected to a stream of water from a hose with a 1 inch (25.4 mm) diameter nozzle, delivering 65 gallons (246 l) per minute. The water was directed at all points of potential water entry such as seams, joints, external operating mechanisms, and such. The nozzle was moved along each test point at a uniform nominal rate of 6 mm/sec ($\frac{1}{4}$ in/sec) at the sample from all sides from a distance of 10 to 12 feet (3 to 3.7 m) for a minimum of 5 minutes. At the conclusion of the test, the enclosure sample was opened and was found to have excluded the entry of water. This is satisfactory.
- 3.4.3 Corrosion Test** – This testing was waived as the materials used for the construction of the ST420-LT and ST420-DI sensors are stainless steel type. This is satisfactory.
- 3.4.4 External Icing Test** - This test was waived, as the ST420-LT and ST420-DI sensors do not contain areas that could accumulate ice and have no external operators that could be damaged by ice. This is satisfactory.
- 3.5 Ingress Protection Rating Tests** – The following tests verified the IP65 rating for the ST420-LT and ST420-DI sensors.
- 3.5.1 Dust Exclusion Test (IP6X)** - This testing was satisfactorily carried out as described in Section 3.2.2. This is satisfactory.
- 3.5.2 Hosedown Test (IPX5)** – Test samples 1 and 2 were subjected to a stream of water from a hose with a $\frac{1}{4}$ inch (6.3 mm) diameter nozzle, delivering 3.3 gallons (12.5 l) per minute. The stream of water was applied on all joints for a period of at least 3 minutes from a distance of 8.2 to 9.8 feet (2.5 to 3 m) for three minutes. At the conclusion of the test, the sample was opened and was found to have excluded the entry of water. This is satisfactory.

IV MARKING

4.1 The ST420-DI and ST420-LT Sensors' certification markings and labels are found in the manufacturer's users manual and as labeled on the shipping box since the equipment was determined to have insufficient space for certification marking and product ratings. A certification reference label is also applied by the user after installation onto the product as indicated in the user's manual. Below in the following Sections are depictions of the marking methods used for the ST420-LT and ST420-DI sensors.

4.1.1 ST420-DI and ST420-LT Sensors Shipping Box Labels –



4.1.2 ST420-DI User's Manual 990-003901 markings –

Approvals/ Ratings	Dust Ignition-proof for use in Class II and III, Div 1 and 2, Groups E, F, G when installed with a Class II, Div 1 rated fitting and conduit. See Installation (p. 2). T5 Ta ≤ 80 °C IP65 Enclosure Type 4X
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4.1.3 ST420-LT User's Manual 990-00902 markings –

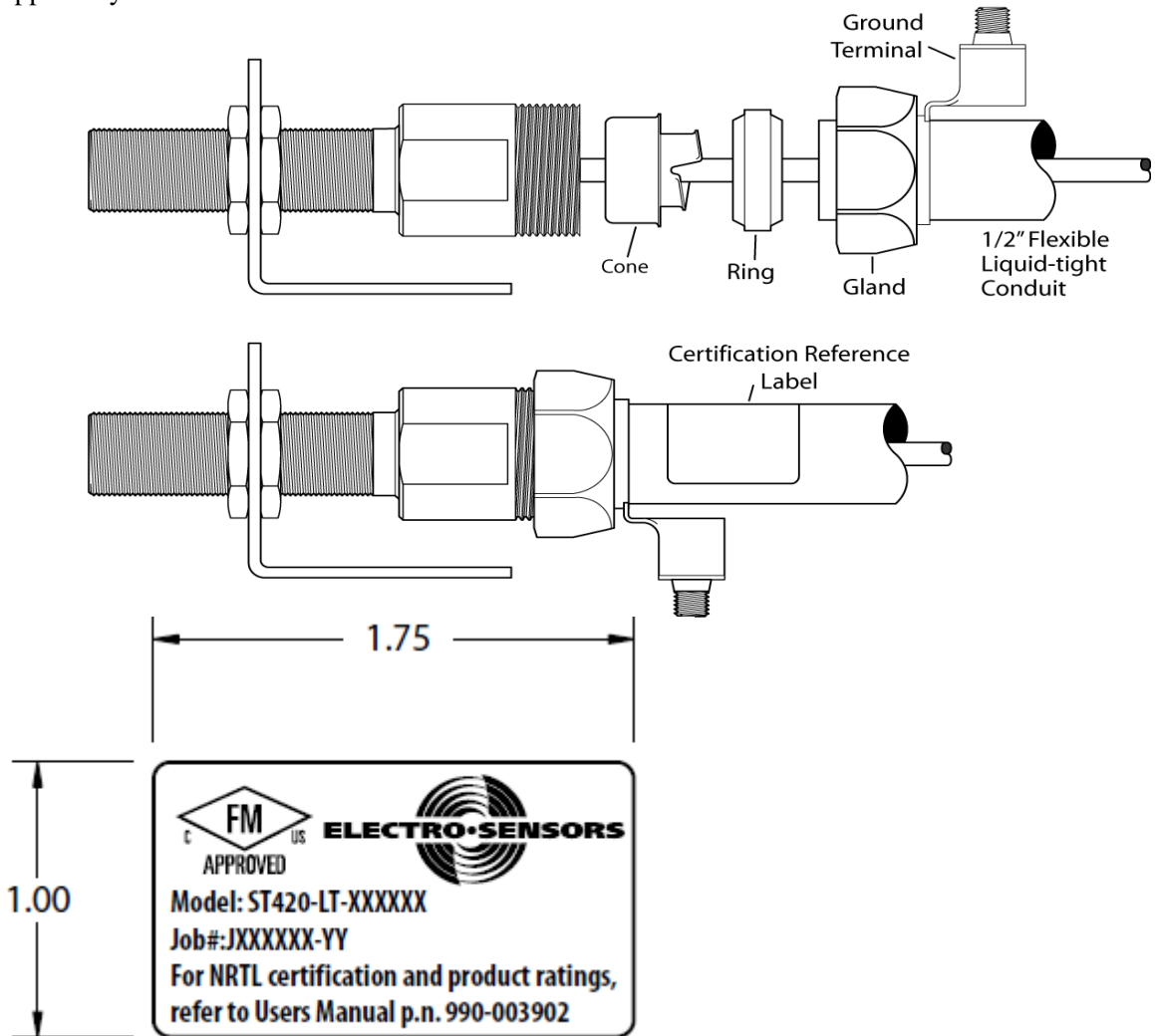
**Approvals/
Ratings**

Dust Ignition-proof for use in Class II and III, Div 1 and 2, Groups E, F, G when installed using Class II rated ½ in flexible liquid-tight conduit.
T5 Ta ≤ 80 °C IP65 Enclosure Type 4X

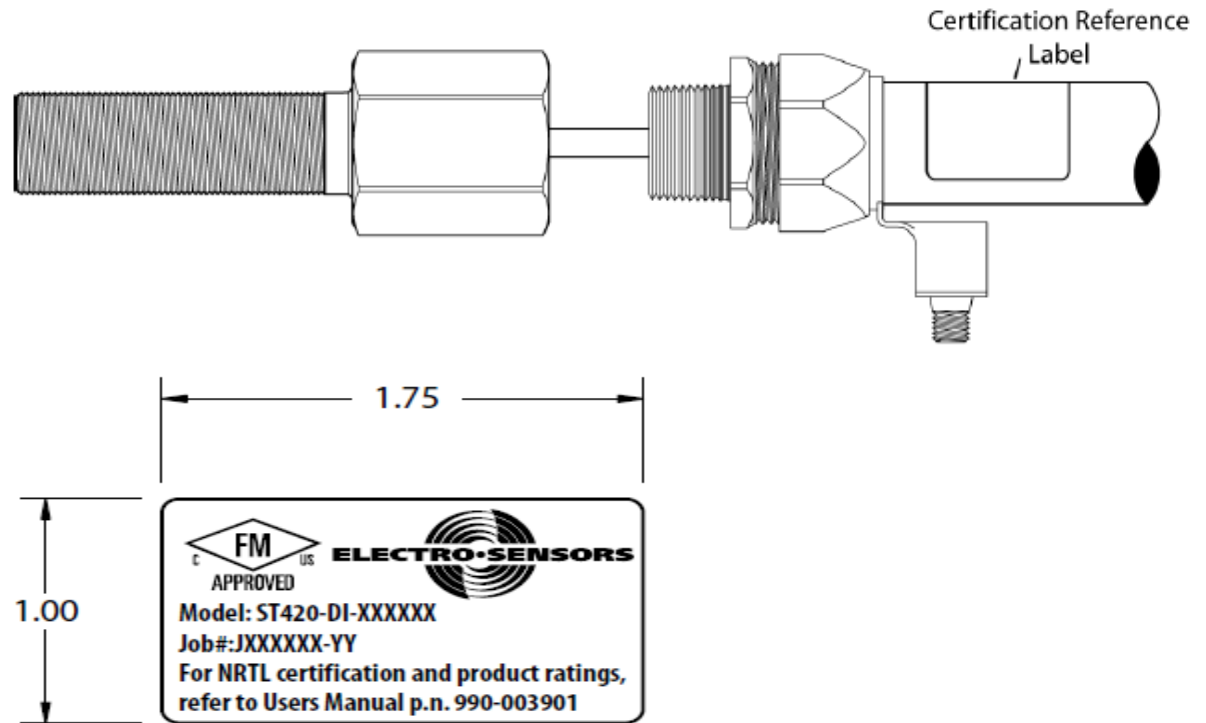


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4.1.4 ST420-LT user applied Certification Reference label as depicted in User's Manual 990-00902 as applied by installer after installation -



4.1.5 ST420-DI user applied Certification Reference label as depicted in User's Manual 990-00901 as applied by installer after installation –



V REMARKS

- 5.1 Installation in the United States of America shall be in accordance with the National Electrical Code[®], ANSI/NFPA-70, and the manufacturer's instructions.
- 5.2 Installation in Canada shall be in accordance with the Canadian Electrical Code C22.1, and the manufacturer's instructions.
- 5.3 The product(s) described in this report were certified by FM Approvals under a Type 3 Certification System as identified in ISO Guide 67.

VI FACILITIES AND PROCEDURES AUDIT

The manufacturer's design control and manufacturing facility located in Minnetonka, Minnesota is subject to follow-up audit inspections. The facility and quality control procedures in place have been found to be satisfactory to manufacture product identical to that examined and tested as described in this report. These facilities are subject to follow-up audit inspections.

VII MANUFACTURER'S RESPONSIBILITIES

- 7.1 The manufacturer shall advise FM Approvals of all proposed changes to the documentation listed in Section VIII of this report through FM Approvals Form 797, Approved Product Revision Report. No

changes of any nature shall be made unless notice of the proposed change has been submitted and written authorization obtained from FM Approvals.

- 7.2** On 100% of production, the manufacturer shall inspect the protective grounding system.

VIII DOCUMENTATION

The following drawings depict the design of the products identified in Section 1.5 and are on file at FM Approvals, blueprint file 3043444.

<u>Drawing No.</u>	<u>Revision Level</u>	<u>Drawing Title</u>
213-000030	A	Label Sensor Alignment 0.375" DIA
213-012920	A	Label ST420-DI Cable
213-012921	A	Label ST420-DI FM Reference
213-012922	A	Label ST420-DI FM Shipping Box
213-012930	A	Label ST420-LT Cable
213-012931	A	Label ST420-LT FM Reference
213-012932	A	Label ST420-LT FM Shipping Box
300-004601	B	Gland T&B 5332 Style 316SS
305-006402	B	Housing Sensor Closed M18x1 SS 1/2" Flex
305-006403	A	Housing Sensor Closed M18x1 SS 1/2" NPT
535-052300	D	PCB, Shaft Tach 4-20
698-059400	A	Schematic - PCB ST420
750-001100	D	ASSY PCB ST420
750-001100 BOM	D	ASSY PCB ST420
800-001900 BOM	B	ST420-DI-L 2 - 200 RPM, 8 PPR
800-0019XX	B	ST420-DI Final Assembly
800-004100 BOM	B	ST420-LT-L 2 - 200 RPM, 8 PPR
800-0041XX	B	ST420-LT Final Assembly
990-003901	B	ST420-DI 4-20mA Shaft Tachometer Sensor/Transmitter USERS MANUAL
990-003902	A	ST420-LT 4-20mA Shaft Tachometer Sensor/Transmitter USERS MANUAL

IX CONCLUSION

The equipment identified in Section 1.5 of this report meets FM Approvals requirements. Since a duly signed Master Agreement is on file for this manufacturer, FM Approval is effective the date of this report.

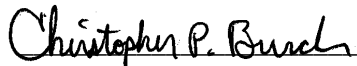
TESTING BY: C. Burch

EXAMINATION BY: C. Burch

PROJECT DATA RECORD: 3043444

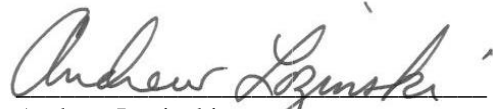
ATTACHMENTS: None

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