APPROVAL REPORT

MODELS 653T, 653L, & 653S
TEMPERATURE TRANSMITTERS
FOR HAZARDOUS (CLASSIFIED) LOCATIONS

Prepared For:

ABB KENT-TAYLOR
VIA STATALE 113
22016 LENNO

J.I. 2D5A6.AX
(3610, 3611, 3615)
October 2, 1997

Factory Mutual Research
1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, Massachusetts 02062
I INTRODUCTION

1.1 Standards - ABB Kent-Taylor requested Approval of the apparatus listed in Section 1.2 to be in compliance with the applicable requirements of the following standards:

<table>
<thead>
<tr>
<th>Title</th>
<th>No.</th>
<th>Issue Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II and III, Division 1, Hazardous (Classified) Locations</td>
<td>3610</td>
<td>October 1988</td>
</tr>
</tbody>
</table>

Note: Factors applied to voltage or current rather than energy.

- Electrical Equipment for Use in Class I, Division 2, Class II, Division 2 and Class III, Division 1 and 2 Hazardous Locations
- Electrical and Electronic Test, Measuring, and Process Control Equipment
- Explosionproof Electrical Equipment General Requirements
- Electrical Equipment for Use in Hazardous (Classified) Locations
1.2 **Listing** - Intrinsically safe apparatus for Class I, II, and III, Division 1, Groups A, B, C, D, E, F, and G, nonincendive for Class I, Division 2, Groups A, B, C, and D in accordance with ABB Kent-Taylor’s document no. 1H5-15-10085; explosionproof for Class I, Division 1, Groups B, C, and D; dust-ignitionproof for Class II, Division 1 and suitable for Class II, Division 2, Groups E, F, and G; suitable for Class III, Division, indoor and outdoor (NEMA Type 4X) hazardous locations and will appear in the Approval Guide as follows:

**IS/I.I.III/I/abcdefg** - 1H5-15-10085/1-98

**NI/I.I/ABCD; anI/I.I/ABCD; 1H5-15-10085/1-98**

**XP/I.I/BCD; DIP/I.I/EFG; S/I.I.III/2/EFG**

**Entity Parameters:** $V_{max} = 28$ V, $I_{max} = 120$ mA, $P_{max} = 0.84$ W, $C_i = 0$ uF, $L_i = 10$ uH

**NI Field Circuit Parameters:** $V_{max} = 28$ V, $I_{max} = 27$ mA, $C_i = 0$ uF, $L_i = 10$ uH

Temperature transmitter. **Model Codes** 653a,b,c,d,e,7,g,h,i,0,k,l

- **a = Version** L, Nonisolated
- **T, Isolated**
- **S, Isolated plus serial communications**
- **c = Input Sensor** 1, 5
- **d = Broken Sensor Drive** 1, 2, 3, Y
- **e = Output Response** 1, 2, Y
- **g = Housing** 1, A
- **h = Output Meter** 1, 2, 3, 4, 5
- **i = Mounting Bracket**
- **k = Software Configuration**
- **l = Calibration**

II **Description** - The transmitters listed in Section 1.2 are intended for the measurement of temperature. The Models 653T, Model 653L, and Model 653S are loop-powered, two wire programmable temperature transmitters packaged with an optional display into an explosion proof enclosure, ABB’s KKA housing. The temperature transmitter modules described below are encapsulated into non-metallic housings. The display options, not encapsulated, is connected to the encapsulated block by two pins, located near the input and output terminals of the transmitter.

The Model 653T is a galvanically isolated programmable temperature transmitter that is capable of measuring thermocouple and RTD sensor signals.

The Model 653L is a programmable temperature transmitter that is capable of measuring RTD sensor signals.

The Model 653S is a galvanically isolated programmable temperature transmitter that is capable of measuring thermocouple and RTD sensor signals.
2.1 Operational Parameters - The temperature transmitter electronic operates on a supply of 28 Vdc. The ambient operating temperature range of the temperature transmitter is -40°C to 85°C.

III EXAMINATION AND TESTS

3.1 General - Representative samples of the temperature transmitters were examined and tested by Factory Mutual Research Corporation (FMRC) to determine acceptability as an intrinsically safe apparatus for use in the specified hazardous locations. The temperature transmitters were also examined for use in specified hazardous locations. The examination was conducted under normal, one and two fault conditions with applicable factors and included circuit analysis, temperature measurements and component tests as well as a review of the manufacturer's documentation and the equipment's physical construction. All were satisfactory and are summarized in the following sections. All data is on file at FMRC along with other documents and correspondence applicable to this program.

3.2 Intrinsic Safety Examination - Examination previously conducted by FMRC and is reported in FMRC Approval Report J.I. 2D5A7.AX and 3X1A3.AX.

3.2.1 Entity Parameters - Based upon the unprotected capacitance and inductance values stated above, the maximum entity parameters will be stated as follows:

<table>
<thead>
<tr>
<th>Vmax (V)</th>
<th>Imax (mA)</th>
<th>Pmax</th>
<th>Ci (uF)</th>
<th>Li (uH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>120</td>
<td>0.84</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

3.2.2 Class II and Class III Examination - Examination previously conducted by FMRC and is reported in FMRC Approval Report J.I. 2Z8A2.AX.

3.3 Nonincendive Examination - Examination previously conducted by FMRC and is reported in FMRC Approval Report J.I. 2D5A7.AX.

3.3.1 NI Field Circuit Parameters - Based upon the unprotected capacitance and inductance values stated reported in FMRC Approval Report J.I. 2D5A7.AX, the NI Field Circuit Parameters will be stated as follows:

<table>
<thead>
<tr>
<th>Vmax (V)</th>
<th>Imax (mA)</th>
<th>Ci (uF)</th>
<th>Li (uH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>27</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>
3.4 Electrical Utilization Examination - 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 temperature transmitter was found to meet the requirements of FMRC Standard Class number 3810. Examination previously conducted by FMRC and is reported in FMRC Approval Report J.I. 2Z8A2.AX, 2D5A7.AX, and 3X1A3.AX.

3.5 Explosionproof Examination - Examination previously conducted by FMRC and is reported in FMRC Approval Report J.I. 2Z8A2.AX.

3.6 Dust-Ignitionproof Examination - Examination previously conducted by FMRC and is reported in FMRC Approval Report J.I. 2Z8A2.AX.

3.7 Environmental Evaluation - The temperature transmitter's enclosure was found to meet NEMA 4X requirements. Examination previously conducted by FMRC and is reported in FMRC Approval Report J.I. 2Z8A2.AX.

IV MARKING - The information appears on the temperature transmitter meets Standard requirements.

V REMARKS

5.1 Installation shall be in accord with the manufacturer's instructions and the National Electrical Code (ANSI-NFPA 70).

5.2 For guidance on installation, see ANSI/ISA-RP12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.

5.3 Electrical equipment connected to the associated apparatus should not use or generate more than 250 volts rms.

5.4 Tampering and replacement with nonfactory components may adversely affect the safe use of the system.

VI FACILITIES AND PROCEDURES AUDIT - The manufacturing site at Via Statale 113, 22016 Lenno, is examined with regard to facilities and quality control procedures and results was satisfactory in that the level of performance which produced the item which was tested was maintained.

VII MANUFACTURERS RESPONSIBILITIES

7.1 Documentation that is applicable to this Approval is on file at FMRC and listed in the Documentation File, Section VIII, of this report. No changes of any nature shall be made unless notice of the proposed change has been given and written authorization obtained from FMRC. The Approved Product - Revision Report, FMRC Form 797, shall be forwarded to FMRC as notice of proposed changes.

7.2 The manufacturer shall supply copies of the installation drawings referenced in Section 1.2 with each temperature transmitter. Copies of the installation drawings shall also be made available to the installer upon request.
VIII DOCUMENTATION FILE - The following documentation is applicable to this Approval and is on file at FMRC.

<table>
<thead>
<tr>
<th>Document No.</th>
<th>Revision</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1H5-15-01815</td>
<td>A</td>
<td>653 FM Cert Drawing</td>
</tr>
<tr>
<td>1H5-15-10085</td>
<td>C</td>
<td>653 Control Drawings</td>
</tr>
</tbody>
</table>

IX CONCLUSION - The apparatus described in Section 1.2. meets FMRC requirements. Approval is granted when the Approval Agreement is signed and received by FMRC.

EXAMINATION AND TESTS BY: S. A. Sylvia

ORIGINAL DATA: PDR 2Z8A2.AX, 2D5A7.AX, and 3X1A3.AX

ATTACHMENTS: Control Drawing 1H5-15-10085/ 1/98

WRITTEN BY: Stephen A. Sylvia, Engineer
Instrumentation Section
Approvals Division

REVIEWED BY: R. Lelievre, Asst. Manager
Instrumentation Section
Approvals Division
This sheet applies only to transmitters installed in loops which are NOT Intrinsically Safe.

Drawing applies only to following Cat. Nos:
653 L* • • 7 • • ø • •
T S

* Can be any digit

Note: the digit "7" means FM approval

KENT-TAYLOR 2-WIRE SYSTEM CONNECTIONS

Separate Transmitter
Power Supply
Receiving Instrument

Transmitter Power Supply
Built into Receiving instrument

Alternate location
Separate Power Supply
Separate Power Supply

External Ground Connection

Notes:
1. If transmitter has an internal output meter, jumper W is omitted.
2. Non-incendive component field wiring parameters: $V_{\text{max}} = 28\, \text{V dc}$, $I_{\text{max}} = 27\, \text{MA}$, $C = 0\, \mu\text{F}$, $L = 10\, \mu\text{H}$ for installation in non incendive circuits in Class I Division 2 Groups A,B,C,D hazardous locations. See National Electric Code section 501-4 (b) exception.
4. Use listed dust tight seal at conduit entry for installation in Class II, III hazardous locations.

Output (Kent-Taylor 2-wire transmitter):
4 to 20 mA dc

Power:
24V dc nominal
8V min, 35V max.

Not for Construction unless Certified
This sheet applies only to FM Approved transmitters installed in Intrinsically Safe Loops

KENT-TAYLOR 2-WIRE SYSTEM CONNECTIONS
(Refer to Sheet 3 for Approved Loop Configuration)

Output (Kent-Taylor 2-wire transmitter): 4 to 20 mA dc

Power: 24V dc nominal, 8V min

Notes:
1. If transmitter has an internal output meter, jumper W is omitted
2. Maximum entity parameters for transmitter:
   \( V_{\text{MAX}} = 28 \text{ V dc}, I_{\text{MAX}} = 120 \text{ mA}, C_i = 0 \mu\text{F}, L_i = 10 \mu\text{H}. \)
   Barrier \( V_{oc} \) or \( V_r \geq 6 \text{ V}. \)
3. Use Listed dust tight seal at conduit entry for installation in Class II, III hazardous locations.
This sheet applies only to FM Approved transmitters installed in Intrinsically Safe Loops

INTRINSIC SAFETY
APPROVED LOOP CONFIGURATION

Installation and wiring must be in accordance with information in Instruction Manual supplied with Barrier/Converter Module

Notes:
1. When one side of output barrier circuit can be grounded, use one single channel barrier.
   When neither side of output circuit can be grounded, use one dual channel barrier
   or two single channel barriers.
2. Return barrier must be either diode return or 10V 47 ohm
ENTITY AND NON-INCENDIVE COMPONENT FIELD WIRING CONCEPTS

Entity Concept

Equipment which is FM approved for intrinsic safety may be connected to barriers based on the ENTITY CONCEPT. This concept permits interconnection of approved transmitters, meters and other devices in combinations which have not been specifically examined by FM, provided that the agency's criteria are met. The combination is then intrinsically safe if the entity concept is acceptable to the authority having jurisdiction over the installation.

The entity concept criteria are as follows:

The intrinsically safe devices, other than barriers, must not be a source of power.

The maximum voltage ($V_{max}$) and current ($I_{max}$), which the device can receive and remain intrinsically safe, must be equal to or greater than the voltage ($V_{oc}$ or $V_r$) and current ($I_{sc}$ or $I_r$) which can be delivered by the barrier.

The sum of the maximum unprotected capacitance ($C_i$) for each intrinsically device and the interconnecting wiring must be less than the capacitance ($C_A$) which can be safely connected to the barrier.

The sum of the maximum unprotected inductance ($L_i$) for each intrinsically device and the interconnecting wiring must be less than the inductance ($L_A$) which can be safely connected to the barrier.

The maximum entity parameters $V_{max}$, $I_{max}$, $C_i$ and $L_i$ for the 600T Series transmitter are listed on page 2 of this document.

The entity parameters $V_{oc}$ or $V_r$, $I_{sc}$ or $I_r$, $C_A$ and $L_A$ for barriers are provided by the barrier manufacturer.

Non-incendive Component Field Wiring concepts

The non-incendive field wiring concept is very similar to the entity concept except it allows devices approved with Non-incendive Component Field Wiring parameters to be installed in Class I Division 2 hazardous locations when connected to appropriate sources of power provided that the appropriate criteria are met. The combination is then safe if the concept is acceptable to the authority having jurisdiction over the installation.

The criteria are as follows:

There must be only one source of power. The source may be an intrinsic safety barrier or it may be a device marked with Non-incendive Component Field Wiring parameters suitable for connection to non-incendive circuit components located in Division 2 hazardous locations.

The maximum voltage ($V_{max}$) and current ($I_{max}$), which the device can receive and remain non-incendive, must be equal to or greater than the voltage ($V_{oc}$ or $V_r$) and current ($I_{sc}$ or $I_r$) which can be delivered by the source of power.

The sum of the maximum unprotected capacitance ($C_l$) for each device and the interconnecting wiring must be less than the capacitance ($C_A$) which can be safely connected to the source of power.

The sum of the maximum unprotected inductance ($L_l$) for each device and the interconnecting wiring must be less than the inductance ($L_A$) which can be safely connected to the source of power.

The Non-incendive Component Field Wiring parameters $V_{max}$, $I_{max}$, $C_l$ and $L_l$ for the 600T Series transmitter are listed on page 1 of this document.

The parameters, $V_{oc}$ or $V_r$, $I_{sc}$ or $I_r$, $C_A$ and $L_A$, for the source of power are provided by the manufacturer of that equipment.