

- 3.2.1 Type T-11, Flexible Mineral Fiber with Jacket
- 3.2.2 Type T-12, Flexible Mineral Fiber with Jacket Modified
- 3.2.3 Type T-13, Rigid Mineral Fiber with Jacket
- 3.2.4 Type T-14, Rigid Mineral Fiber with Jacket, Modified
- 3.2.5 Type T-15, Rigid Mineral Fiber
- 3.2.6 Type T-16, Plenums
- 3.2.7 Type T-18, Cellular Elastomer
- 3.2.8 Acoustic Duct-Lining
- 3.2.9 [Cellular Glass] [Urethane Insulation]
- 3.3 ACCEPTANCE

-- End of Section Table of Contents --

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2007

SECTION 23 07 13.00 40

DUCT INSULATION 07/07

NOTE: This specification covers the requirements for insulation for round and rectangular ducting and includes materials, adhesives, and tape.

Select duct surfaces to be insulated, materials, and systems to suit project conditions. Coordinate with drawings.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's

Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 209	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 1136	(2006) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 534	(2007) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 552	(2003) Standard Specification for Cellular Glass Thermal Insulation
ASTM C 553	(2002) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 591	(2007) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 592	(2004) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 795	(2003) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 916	(1985; R 2001e1) Standard Specification for Adhesives for Duct Thermal Insulation

ASTM D 579 (2004) Standard Specification for Greige Woven Glass Fabrics

ASTM E 84 (2007) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E 96/E 96M (2005) Standard Test Methods for Water Vapor Transmission of Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220 (2006) Standard on Types of Building Construction

NFPA 255 (2005; Errata 2006) Standard Method of Test of Surface Burning Characteristics of Building Materials

1.2 SYSTEM DESCRIPTION

NOTE: If Section 23 00 00.00 40 HEATING, VENTILATING, AND AIR-CONDITIONING is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

Section 23 00 00.00 40 HEATING, VENTILATING, AND AIR-CONDITIONING Section 23 31 11.11 40 DUCTS, LOW PRESSURE and Section 23 31 11.12 40 DUCTS, MEDIUM/HIGH PRESSURE apply to work specified in this section.

This section pertains to field applied thermal insulation installed on the external surfaces of ducts and plenums.

1.3 PERFORMANCE REQUIREMENTS

Thermal-insulation system materials shall be noncombustible, as defined by NFPA 220. Adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, shall have a maximum flame-spread classification (FSC) of [25] [_____] and a smoke-developed classification (SDC) of [50] [_____] . Flame-contributed classification (FCC) shall be as specified for the application. These maximum values shall be determined in accordance with [ASTM E 84] [NFPA 255] . Adhesives, coatings, and sealants shall be nonflammable in their wet state.

Adhesives, coatings, and sealants shall have published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

1.4 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals

required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings shall be submitted for duct insulation systems in accordance with paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Adhesives
Coatings
Thermal-Insulation Materials
Jacketing Materials

SD-04 Samples

Contractor shall submit the following samples:

Adhesives
Coatings

Thermal-Insulation Materials
Jacketing Materials

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet [ASTM C 795](#) requirements. Materials shall be asbestos free and conform to the following.

2.1.1 Adhesives

2.1.1.1 Cloth

Adhesives for adhering, sizing, and finishing open-weave glass cloth shall be pigmented polyvinyl acetate emulsion and shall conform to the requirements of [ASTM C 916](#), Type I.

2.1.1.2 Adhesive Vapor Barrier

Adhesives for attaching laps of vapor-barrier materials and presized glass cloth and for attaching insulation to itself, to metal, and to various other substrates, shall be the solvent-base synthetic-rubber type and shall conform to the requirements of [ASTM C 916](#), Type I, for attaching fibrous-glass insulation to metal surfaces. Solvents shall be nonflammable.

2.1.1.3 Cellular Elastomer

Adhesive for cellular elastomer insulation shall be a solvent cutback chloroprene elastomer conforming to [ASTM C 916](#), Type I, and shall be a type approved by the manufacturer of the cellular elastomer for the intended use.

2.1.2 Coatings

2.1.2.1 Outdoor Vapor-Barrier Finishing

Coatings for outdoor vapor-barrier and weather-barrier finishing of insulation shall comply with manufacturer's recommendation for material compatibility, service life, and environment.

2.1.2.2 Indoor Vapor-Barrier Finishing

Coatings for indoor vapor-barrier finishing of insulation surfaces shall be pigmented resin and solvent compound and shall conform to [ASTM C 1136](#).

2.1.2.3 Outdoor and Indoor Nonvapor-Barrier Finishing

Coatings for outdoor and indoor nonvapor-barrier finishing of insulation surfaces shall be pigmented polymer emulsion recommended by the insulation-material manufacturer for the surface to be coated and shall be applied to the specified dry-film thickness.

2.1.2.4 Cellular Elastomer Insulation

Finish coating for cellular elastomer insulation shall be a polyvinylchloride lacquer approved by the manufacturer of the cellular

elastomer for the intended use.

2.1.2.5 Coating Color

[[Coating color shall [be white.] [conform to color code specified.] [blend with background of surrounding area.]] [Coating colors will be selected by the Contracting Officer.]]

2.1.3 Insulation

Insulation conductances shall be maximum values, as tested at any point, not an average. Insulation conductance found by test to exceed the stipulated maximum shall either be replaced or augmented by an additional thickness to bring it to the required maximum conductance.

Insulation materials requirements for exterior applications are acceptable for interior applications.

Thermal-Insulation Materials shall meet referenced standards within this section.

2.1.3.1 Exterior Insulation

[Cellular glass insulation shall be rigid closed cell material complying with ASTM C 552.] [Cellular polyurethane insulation shall be rigid material complying with ASTM C 591.] Minimum insulation thickness shall be [50] millimeter [2] inches [_____].

2.1.3.2 Interior Insulation

Mineral fiber shall conform to ASTM C 592, shall be suitable for surface temperatures up to 188 degrees C 370 degrees F, and shall be not less than 64.1 kilogram per cubic meter [4]-pound per cubic foot [_____] density, unless otherwise specified. Thermal conductivity shall be not greater than 37.5 milliwatt per meter per degrees K [0.26] Btu inch per hour per square foot per degree F at 66 degrees C (338.8 degrees K) 150 degrees F, unless otherwise specified.

2.1.3.3 Rigid Boards

Rigid boards shall be Form A, blocks and boards, Class 1, for use at temperatures up to 204 degrees C 400 degrees F, nonloadbearing, minimum 50 kilograms per cubic meter 3-pound per cubic foot density. Thermal conductivity shall be not greater than 34.6 milliwatt per meter per degree K [0.24] Btu inch per square foot per hour per degree F [_____] at 24 degrees C (297.1 degrees K) 75 degrees F.

2.1.3.4 Flexible Blankets

Flexible blankets shall be Type 1 blankets and felts, flexible, resilient for use at temperatures up to 204 degrees C, 400 degrees F, minimum 16.0 kilogram per cubic meter 1-pound per cubic foot density. Thermal conductivity shall be not greater than 0.052 watt per meter per degree K [0.36] Btu by inch per square foot per hour per degree F [_____] at 24 degrees C (297.1 degrees K) 75 degrees F. Insulation shall conform to ASTM C 553.

2.1.3.5 Cellular Elastomer

Cellular elastomer shall conform to ASTM C 534, except that the water-vapor permeability shall not exceed [0.44] kilogram per pascal per second per meter [0.30] perm-inch per hour per inch mercury [_____] pressure-differential for 25 millimeter 1 inch thickness.

2.1.4 Jacketing

Jacketing Materials shall meet referenced standards within this section.

2.1.4.1 Composite Jacketing

Jacketing shall be a 3-ply laminate of 560 kilogram per cubic meter 35-pound per cubic foot white-bleached kraft bonded to not less than [0.03] millimeter [1]-mil [_____] thick aluminum foil and reinforced with glass fiber. Fire-resistance classification shall be as follows:

	<u>FOIL EXPOSED</u>	<u>KRAFT EXPOSED</u>
FSC	5	25
FCC	0	10
SDC	0	15

Water-vapor permeance rating of the composite shall be 1.15 nanogram per pascal per second per square meter 0.02 perm or grain per hour per square foot per inch of mercury pressure-differential determined in accordance with ASTM E 96/E 96M.

2.1.4.2 Sheetmetal Jacketing

Sheetmetal jacketing shall be [minimum [0.55] millimeter [26]-gauge (0.0217 inch) galvanized steel in conformance with ASTM A 653/A 653M] [aluminum in conformance with ASTM B 209M ASTM B 209], having lock-forming corner bead and joint capability.

2.1.4.3 Glass Cloth

Glass cloth shall be plain weave conforming to ASTM D 579, Style 141, and shall weigh not less than [250] gram per square meter [7.23] ounces per square yard [_____] before sizing. Cloth shall be factory-applied wherever possible.

Glass reinforcing cloth shall be a leno weave, 26-end and 12-pick thread conservation, with a warp-and-fill tensile strength in kilonewton per meter pounds per inch of width of 7.9 and 5.3 45 and 30, respectively, and with a weight not less than [50] gram per square meter [1.5] ounces per square yard [_____] . [Style 191 leno-weave glass cloth conforming to ASTM D 579 may be provided.]

2.1.4.4 Vapor Barrier Material

Vapor barrier material shall conform to ASTM C 1136, Type I, low vapor transmission, high puncture resistance for use on insulation for piping, ducts, and equipment, and as indicated.

PART 3 EXECUTION

3.1 INSTALLATION OF INSULATION SYSTEMS

Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands, and tapes shall be smoothly and securely pasted down. Adhesives shall be applied on a 100-percent coverage basis. Departure from these requirements shall be a basis for rejection.

Joints shall be tight, with insulation lengths tightly butted against each other. Where lengths are cut, cuts shall be smooth and square and without breakage of end surfaces. Where insulation terminates, ends shall be neatly tapered and effectively sealed or finished. Longitudinal seams of exposed insulation shall be directed away from normal view.

Surfaces shall be clean and free of all oil and grease before insulation adhesives or mastics are applied. Solvent cleaning required to bring metal surfaces to such condition shall be provided.

Insulation shall not impede access to duct covers/doors used for duct cleaning and/or maintenance.

Installation Drawings for duct insulation systems shall be in accordance with the adhesive manufacturer's recommended instructions for application.

3.2 SYSTEM TYPES

3.2.1 Type T-11, Flexible Mineral Fiber with Jacket

Sheet metal ducts shall be covered with mineral-fiber duct insulation with factory-attached vapor-barrier jacket. Vapor seal shall be maintained. Jacket overlap shall be not less than [50] millimeter [2] inches [_____].

Insulation nominal thickness shall be 50 millimeter 2 inches [_____].

Insulation shall be adhered to sheet metal surfaces with vapor-barrier adhesive.

Insulation on all rectangular ducting with side- or bottom-surface dimensions over 750 millimeter 30 inches shall, in addition to being adhered with adhesive, be impaled on pins secured to the duct surface and then locked by means of flush pin caps. Pins shall be clipped flush with face of cap. Pins shall be 300 millimeter 12 inches on center placed not more than [50] millimeter [2] inches [_____] from duct edges, and there shall be not less than [two] [_____] rows of pins per surface. Pins shall be sealed with outdoor vapor-barrier coating and vapor-barrier duct tape.

When insulation is in place, total thickness shall be reduced by not more than [13] millimeter [0.5] inch [_____], and no condensation shall appear on any surface.

Jackets, jacket flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacketing bands for butt joints shall be not less than [100] millimeter [4] inches [_____] wide. In lieu of jacketing bands, pressure-sensitive vapor-barrier tape not less than 75 millimeter [3] inches [_____] wide shall be used to seal horizontal and transverse seams.

Duct insulation shall be rigid-board 50 kilogram per cubic meter 3-pound per cubic foot density where penetrations through sleeves or prepared

openings occur.

Duct insulation at fire dampers shall be provided.

Duct insulation terminating at insulated or uninsulated sheet metal and equipment surfaces, supports, damper fittings, walls, and similar penetration and construction points shall be sealed with outdoor vapor-barrier coating and, where lengths exceeding [600] millimeter [24] inches [_____] are involved, flashed with glass-cloth tape and sheet metal trimming. Glass-cloth tape shall be in two layers with not less than [75] millimeter [3] inches [_____] of overlap imbedded in not less than [1.6] millimeter [1/16] inch [_____] dry-film thickness of outdoor vapor-barrier coating.

3.2.2 Type T-12, Flexible Mineral Fiber with Jacket Modified

NOTE: If Type T-12 system is used keep T-11 system in specifications. This insulation system is a modification of Type T-11 system.

Insulation methods and materials are the same as Type T-11 except that vapor-barrier integrity is not required and nylon twine shall be used 300 millimeter 12 inches on center additionally to secure insulation not pinned.

3.2.3 Type T-13, Rigid Mineral Fiber with Jacket

Sheet metal ducts shall be covered with insulation with factory-applied vapor barrier and finished with field-applied glass-cloth jacket. Vapor seal shall be maintained. Jacket overlap shall be not less than [50] millimeter [2] inches [_____].

Insulation nominal thickness shall be 50 millimeter 2 inches [_____].

Insulation shall be adhered to sheet metal surfaces with vapor-barrier adhesive.

Insulation on sheet metal with side- or bottom-surface dimensions over 750 millimeter 30 inches, in addition to being adhered with adhesive, shall be impaled on pins secured to the duct surface and then locked by means of flush pin caps clipped flush with face of cap. Pins shall be 300 millimeter 12 inches on center placed not more than [50] millimeter [2] inches [_____] from duct edges, and there shall be not less than [two] [_____] rows of pins per surface. Pins shall be sealed with outdoor vapor-barrier coating and vapor-barrier duct tape. Pinned area and other surfaces shall be level with adjoining insulated surface. Edges shall be square and straight without scallops; where necessary, areas shall be leveled with a mixture of finish insulating cement and nonvapor-barrier adhesive diluted with three parts water.

Vapor-barrier jackets, jacket flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacketing bands for butt joints shall be not less than [100] millimeter [4] inches [_____] wide.

Duct insulation at fire dampers shall be provided.

Insulation shall be brought tightly against raised-flange standing seams and sealed with vapor-barrier coating. A 75 millimeter 3 inch wide strip

of the insulation of adequate thickness to give 13 millimeter 0.5 inch covering over flange shall be provided. Strip shall be routed out to accommodate the still-exposed portion of the seam or flange and shall be cemented in place over the seam or flange by use of vapor-barrier coating material.

Duct insulation terminating at insulated and uninsulated sheet-metal and equipment surfaces, supports, damper fittings, access doors, walls, and similar penetration and construction points shall be sealed with outdoor vapor-barrier coating. Where lengths exceeding 600 millimeter 24 inches are involved, insulation shall be flashed with glass-cloth tape and sheet-metal trimming. Glass-cloth tape shall provide not less than [75] millimeter [3] inch [_____] overlap, shall be in two layers, and shall be embedded in not less than [1.6] millimeter [1/16] inch [_____] dry-film thickness of outdoor vapor-barrier coating. Sheet metal trimming shall be installed after glass-cloth jacket is in place.

Glass-cloth jacketing shall be applied over the insulation outer corner sheet-metal angles and securely cemented in place with nonvapor-barrier adhesive. Corner angles shall be not less than [0.04] millimeter [30]-gage [_____] galvanized sheet metal with leg dimensions equal to thickness of insulation. Glass cloth embedded in the adhesive shall be pulled tight and wrinkle-free and shall lap seams not less than [100] millimeter [4] inches [_____] . The entire outer surface shall be given a flood coat of nonvapor-barrier adhesive while the first coat is still wet.

Insulation shall be finished with not less than [0.152] millimeter [6] mils [_____] dry-film thickness of nonvapor-barrier coating suitable for painting.

NOTE: If Type T-14 system is used, keep T-13 system
in specifications. This insulation system is a
modification of Type T-13 system.

3.2.4 Type T-14, Rigid Mineral Fiber with Jacket, Modified

Installation methods and materials are the same, as Type T-13 except when no vapor-barrier jacketing and no vapor-barrier integrity is required. Pinned areas and other areas shall be leveled with a mixture of finish insulating cement and nonvapor-barrier adhesive diluted with 3 parts water.

3.2.5 Type T-15, Rigid Mineral Fiber

This insulation system consists of 25 millimeter 1 inch thick mineral fiber, without jacket, placed between concealed hot and cold ducts to prevent cold-duct heat gain.

3.2.6 Type T-16, Plenums

NOTE: If Type T-16 system is used, keep T-11 and
T-13 systems in specifications. This system is a
modification of Type T-11 and Type T-13 systems.

Installation methods and materials are the same as Type T-11 and Type T-13, except as follows:

No glass-cloth jacket is required.

Plenum surfaces shall be made airtight.

Mineral-fiber insulation with a vapor-barrier jacket not less than [25] millimeter [1] inch [_____] thick shall be applied to external walls and ceilings where the external side is exposed to nonconditioned spaces. Ceilings that separate plenum space from connected occupied space need no vapor-barrier jacket. Insulation with vapor-barrier jacket, as required, shall be applied before installation of piping, ducting, electrical conduit, ceiling suspension system, and other equipment. All air-leakage paths and vapor-barrier penetrations shall be sealed with [vapor-barrier jacket] [mastic].

3.2.7 Type T-18, Cellular Elastomer

External surfaces shall be covered with 13 millimeter 0.5 inch cellular-elastomer sheet insulation. Vapor seal shall be maintained. Insulation shall be cemented into continuous material with a solvent cut-back chloroprene adhesive recommended by the manufacturer for the specific purpose. Adhesive shall be applied to both of the surfaces to be joined to a minimum thickness of [0.25] millimeter [10] mils [_____] wet or 3.5 meter square per liter 150 square feet per gallon of undiluted adhesive.

Duct stiffeners shall be covered with cellular elastomer insulation strips.

Surfaces exposed to weather, to view, or to ultraviolet light shall be finished with a [0.051] millimeter [2]-mil [_____] minimum dry-film thickness of a polyvinylchloride lacquer recommended by the manufacturer and applied in not less than [two] [_____] coats.

3.2.8 Acoustic Duct-Lining

Acoustic duct-lining shall not be allowed.

3.2.9 [Cellular Glass] [Urethane Insulation]

Sheetmetal surfaces covered with [cellular glass] [urethane insulation] shall be cleaned and coated with [adhesive] [mastic] recommended by the insulation manufacturer. In addition, the insulation shall be impaled on pins secured to the duct surface and locked by means of flush pin caps clipped flush with face of cap.

Insulation nominal thickness shall be 50 millimeter 2 inches [_____] .

Pins shall be 300 millimeter 12 inches on center placed not more than [50] millimeter [2] inches [_____] from the duct edges, and there shall be not less than [two] [_____] rows of pins per surface. Pins shall be sealed with exterior vapor-barrier coatings and duct tape. Pinned areas and other surfaces shall be level with adjoining insulated surface. Edges shall be square and straight, without scallops.

Exterior surface of the insulation shall be coated with mastic to thickness recommended by the manufacturer.

For glass cloth exterior coverings, the cloth shall be applied while the mastic is still wet. After installing the cloth, the entire exterior surface shall be given a flood coat of mastic recommended by the

manufacturer.

For sheetmetal exterior, the installation shall be completed using interlocking seams and corner beads.

3.3 ACCEPTANCE

NOTE: Following a minimum of 90 calendar days operation (or installation), but no later than one year, the Systems Engineer/Condition Monitoring Office/Predictive Testing Group should inspect the installation using Infrared Imaging. This technology can identify insulation voids, insulation settling, and areas of insufficient insulation. Identification of insulation materials and locations is required to effectively identify these types of problems. The Systems Engineer/Condition Monitoring Office/Predictive Testing Group needs to know the warranty expiration date, if there is a warranty, in order to perform the inspections within the prescribed time frame.

Final acceptance will depend upon providing construction (Record Drawings) details to the Contracting Officer. Construction details shall include, by building area, the insulation material type, amount, and installation method. An illustration or map of the duct routing locations may serve this purpose. Data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Record Drawings insulation/material." Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database.

-- End of Section --