Table 22.3 Continued

Conformal coating operating temperature	Thermal oven aging temperature									
	1000 Hours					300 Hours				
	FR-4.0	XXXPC	FR-3	FR-2	GPO-2	FR-4.0	XXXPC	FR-3	FR-2	GPO-2
120°C	150°C	165	–	–	–	165°C	190	–	–	–
125°C	155°C	170	–	–	–	170°C	200	–	–	–
130°C	160°C	–	–	–	–	175°C	–	–	–	–
135°C	165°C	–	–	–	–	180°C	–	–	–	–
140°C	170°C	–	–	–	–	185°C	–	–	–	–

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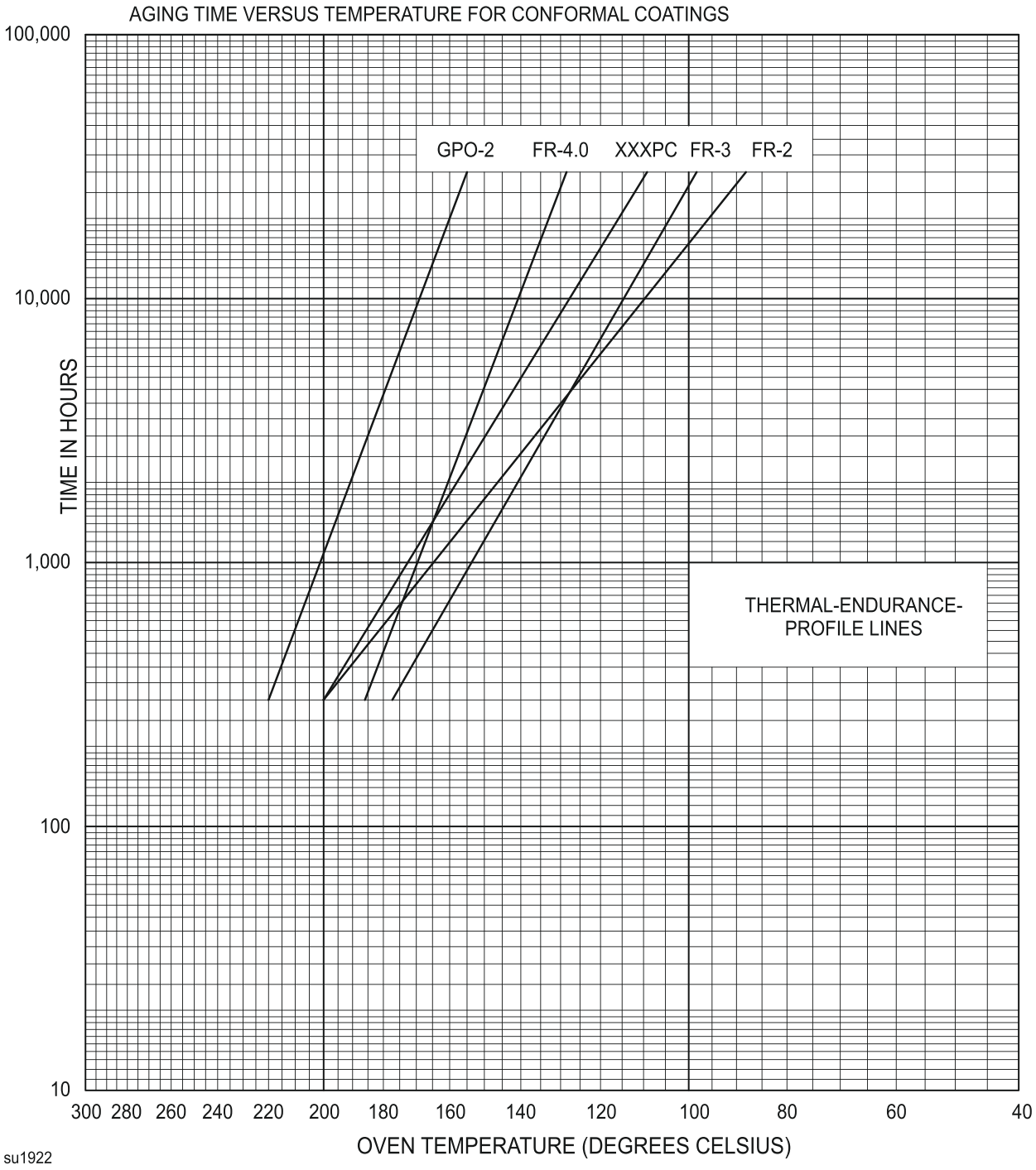
Figure 22.2

Conditioning time versus oven temperature for normal operating temperature of conformal coatings



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22.4 Voltage transient test

22.4.1 After conditioning and immediately prior to voltage transient testing, the samples are to be wrapped with a tight-fitting aluminum foil (representing an electrically conductive contaminate deposit along the surface of the coating) that covers the test pattern but does not cover the insulated test lead wire and solder points. A 50 – 60 Hz and 120 V voltage source is to be applied on the samples between opposite legs of the test pattern, namely lead A and lead B in Figure 22.1. Each sample is to be subjected to ten randomly triggered (with respect to the 60 Hz supply waveform) applications of a 6 kilovolt surge impulse superimposed on the supply source at 60 second intervals. The surge generator is to have a source impedance of 50 ohms. With no load on the generator, the surge waveform is to have the following characteristics:

a) Initial rise time of 0.5 microsecond between 10 percent and 90 percent of peak amplitude;

b) The period of the ensuing oscillatory wave is to be 10 microseconds; and

c) Each successive peak of alternating polarity is to be 60 percent of the preceding peak.

22.4.2 All samples, unconditioned and conditioned, are to be subjected to the voltage transient test.

22.4.3 There shall be no ignition, dielectric breakdown through the coating, or evidence of a carbon path being created on the surface of the coating material.

22.5 Dielectric withstand voltage and breakdown voltage test

22.5.1 The samples subjected to the voltage transient test described in 22.4.1 are to withstand a 1000 V potential difference for one minute without breakdown. The voltage stress is to be applied between lead A and the foil covering connected to lead B. After one minute, the voltage stress is to be increased until breakdown occurs.

22.5.2 The conditioned samples (see 22.3.1 – 22.3.3) are to withstand the dielectric stress for one minute without breakdown.

22.5.3 The conditioned samples shall have an average dielectric breakdown value at least fifty percent of the unconditioned samples average dielectric breakdown.

22.6 Abrasion resistance test

22.6.1 General

22.6.1.1 Five samples of Figure 22.1 are to be subjected to the following test. The Abrasion resistance test is optional and shall be performed based on the end product requirements.

22.6.1.2 Scratches are made across five pairs of conducting parts and the intervening separations at points where the separations will be subject to the maximum potential gradient during the tests.

22.6.1.3 The scratches are made by means of a hardened steel pin, the end of which has the form of a cone having a tip angle of 40 degrees, its tip being rounded and polished, with a radius of 0.25 mm ± 0.02 mm.

22.6.1.4 Scratches are made by drawing the pin along the surface in a plane perpendicular to the conductor edges at a speed of 20 mm/s ± 5 mm/s as shown in Figure 22.3. The pin is so loaded that the force exerted along its axis is 10 N ± 0.5 N.

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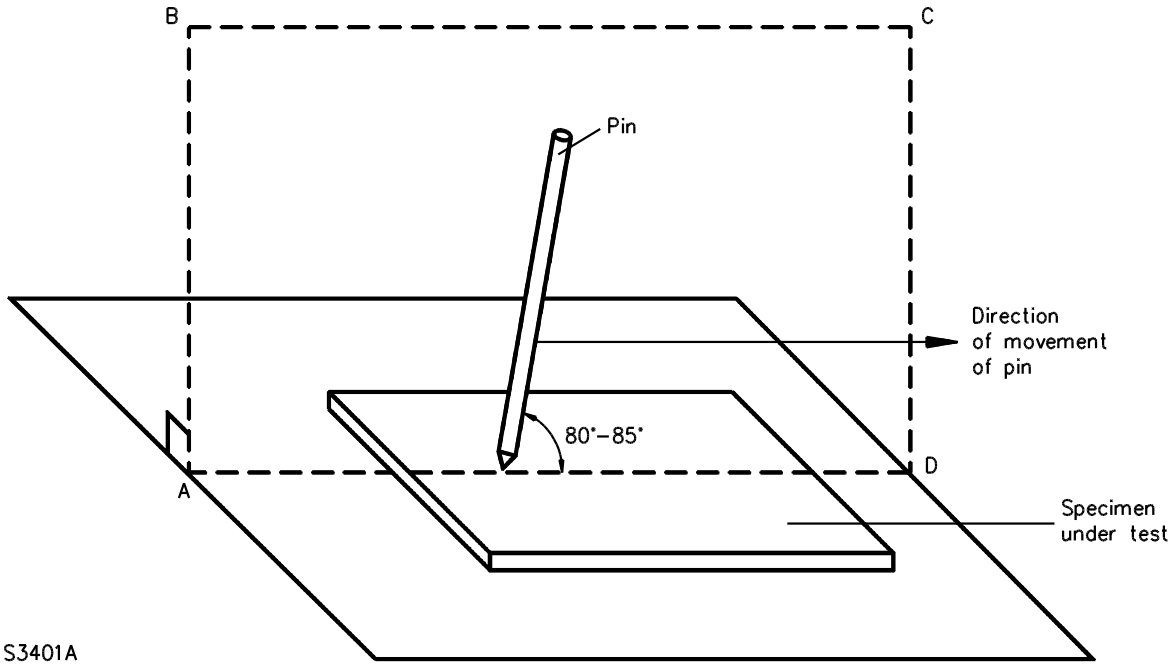
Figure 22.3

Abrasion resistance test for coating layers



NOTE – The pin is in the place ABCD which is perpendicular to the sample under test.

22.6.1.5 The five scratches shall be at least 5 mm apart and at least 5 mm from the edge of the sample.

22.6.1.6 After this test, the coating layer shall neither have loosened nor have been pierced and it shall withstand an electric strength test as specified in 22.6.2 between conductors.

22.6.2 Electric strength

22.6.2.1 The dielectric material is subjected to a voltage substantially sine-wave form having a frequency of 50 Hz or 60 Hz. The test voltage is based on the assumption that the working voltage across the dielectric material will be less than 184 V or less than 1.41 kV between primary and secondary (SELV – safety extra low voltage) circuitry. Working voltages above these levels shall be evaluated based on the end product performance requirements. See Table 22.4 for the test voltage.

Table 22.4
Abrasion resistance electric strength test voltage

Working voltage (peak or d.c.)	Test voltage, volts r.m.s.
Less than 184 V	2000
Less than 1.41 kV	3000

22.6.2.2 The voltage applied to the dielectric material under test is gradually raised from zero to the prescribed voltage and held at that value for 60 seconds.

22.6.2.3 There shall be no dielectric material breakdown during the test. Dielectric material breakdown is considered to have occurred when the current which flows as a result of the application of the test voltage

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rapidly increases in an uncontrolled manner, i.e. the dielectric material does not restrict the flow of the current. Corona discharge or a single momentary flashover is not regarded as dielectric material breakdown.

MARKING

23 Details

23.1 An industrial laminate, vulcanized fibre, filament wound tubing or other material that complies with the requirements in this Standard shall include the following markings on the smallest unit shipping containers for the material:

a) The manufacturer's name, trademark, or symbols by which the organization responsible for the product may be identified;

b) The distinctive material designation; and

c) An identification code to indicate the factory at which the material is produced, when manufactured at more than one location.

23.2 A prefabricated multilayered laminate (Mass Laminate) shall be limited to a unique grade designation for each ultrathin laminate and prepreg combination.

23.3 A metal base laminate shall be limited to a unique grade designation for each dielectric insulation material. Multiple types of metal materials may be used with one dielectric insulation material under the same grade designation.

23.4 Material formulation changes or polymer variations shall require a new unique product designation. The extent of the name change shall be obvious to the user.

Exception: In cases where testing of a polymer variation shows the same or better results, the material may retain the same designation if the compliance criteria are met as defined in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, Section 9.9, Polymer Variations.

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SUPPLEMENT SA – FOLLOW-UP INSPECTION

The information contained in this supplement is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this supplement may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary to fulfill the objectives of the standard.

SA1 Scope

SA1.1 This Supplement describes the manufacturer's production program necessary to verify that the product continues to be in compliance with the requirements in this Standard.

SA1.2 This Supplement also describes the duties and responsibilities of the field representative of the certification organization.

SA1.3 Recognizing that manufacturers are required to have quality assurance systems in place for the control of their production processes and products, this Supplement only covers the sampling inspections, tests, and other measures taken by the manufacturer and considered to be the minimum requirements of the certification organization. Such inspections, tests, and measures are supplemented by the certification organization as an audit of the means that the manufacturer exercises to determine conformance of products with the certification organization's requirements.

SA1.4 The certification organization shall have additional authority specified in legally binding agreements, signed by both the certification organization and manufacturer, to control the use and application of the certification organization's registered mark(s) for product, packaging, advertising, and associated literature. The legal agreements shall cover the control methods to be used by the certification organization and the manufacturer's options for appeal. Any additional inspections, tests, or other measures deemed necessary by the certification organization but to be taken by the manufacturer are to be applied in order to control the use and application of the certification organization's registered Mark(s).

SA2 Glossary

SA2.1 For the purposes of this Supplement, the following definitions apply.

SA2.2 CERTIFICATION ORGANIZATION – A third party organization independent of the manufacturer who, under a legally binding contract with the manufacturer, evaluates a product for compliance with requirements specified in the Standard, and who maintains periodic inspection of production of these products to verify compliance with the specifications in the Procedure and this Supplement.

SA2.3 FIELD REPRESENTATIVE – An authorized representative of the certification organization who makes periodic unannounced visits to the manufacturer's facilities for purposes of conducting inspections and monitoring the manufacturer's production program.

SA2.4 INSPECTION REPORT – The report generated by the field representative summarizing the results of the inspection visit.

SA2.5 MANUFACTURER – The authorized party who maintains and operates the facilities where a Recognized Component is produced or stored and where the product is inspected and/or tested as described in this Supplement.

SA2.6 PROCEDURE – The document issued by the certification organization, upon determination that a product is eligible for Recognition, for use by the manufacturer and the field representative. The document contains requirements and other provisions and conditions regarding the Recognized product and provides the authorization for the manufacturer to use the Recognition Marking on products fulfilling these requirements.

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SA2.7 RECOGNIZED COMPONENT – A part or subassembly intended for use in other equipment and that has been investigated for certain construction or performance, or both, characteristics. A Recognized Component is incomplete in construction features or is restricted in performance capabilities so as not to warrant its acceptability as a field-installed component. It is intended solely as a factory-installed component of other equipment where its acceptability is determined by the certification organization.

SA2.8 RECOGNITION MARKING – A distinctive Mark of the certification organization that the manufacturer is authorized to apply to Recognized Components as the manufacturer's declaration that they conform to the requirements of the Standard.

SA2.9 VARIATION NOTICE (VN) – A document used to record observed differences between a product or manufacturing process and the description of the product or process in the Procedure and/or Standard.

SA3 Responsibility of the Manufacturer

SA3.1 It is the manufacturer's responsibility to restrict the use of the Recognition Marking to those products specifically authorized by the certification organization that are found by the manufacturer's own quality assurance program to comply with the Procedure description.

SA3.2 The manufacturer shall confine all Recognition Marking to the location or locations authorized in the Procedure.

SA3.3 During hours in which the manufacturer's facilities are in operation, the manufacturer shall permit the Field Representative free access to any portion of the premises where the product is being produced, stored or tested.

SA3.4 The Field Representative shall be permitted to select a sufficient quantity of material, as indicated in the Procedure, that is representative of current production for the purposes of the Follow-Up Test Program at the Certification Organization. The packaging and shipment of these samples is the responsibility of the manufacturer.

SA3.5 A material that is found to no longer be in compliance with the requirements of the certification organization shall be corrected by the manufacturer if the Recognition Mark is to be used on the product. If the noncompliance was the result of a manufacturing process, the manufacturer shall check subsequent production until it is certain that the process has been corrected and the noncompliance will not occur.

SA4 Responsibility of the Field Representative

SA4.1 At each visit to the manufacturer's facility, the Field Representative shall review a representative sampling of product production which bears the Recognition Marking, to assure that the Recognition Marking has been applied in accordance with this Supplement, and the Procedure description. An inspection report shall be completed after each visit.

SA4.2 Any observed differences between the product marking and the description of the marking in the Procedure and/or Standard shall immediately be called to the attention of the manufacturer. Any observed differences shall be confirmed in a Variation Notice.

SA4.3 Production that is found to no longer be in compliance with the requirements of the certification organization shall be brought into compliance by the manufacturer if the Recognition Marking is to be used on the product or packaging. If the non-compliance was the result of a manufacturing process, the manufacturer shall check subsequent production until it is certain that the process has been corrected and the noncompliance will not recur. The Field Representative shall verify that the product marking continues to be in compliance with the requirements of the certification organization.

SA4.4 Production that does not comply with the provisions of these follow-up inspection instructions shall have the Recognition Marking removed or obliterated. The manufacturer shall satisfy the Field Representative that all Recognition markings are removed or obliterated from rejected material. Those

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Recognition markings not destroyed during the removal from the product packaging shall be turned over to the Field Representative for destruction. If rejection of production is questioned by the manufacturer, the manufacturer may hold the material at the point of inspection, typically at the factory, pending an appeal.

SA5 Selection of Samples for Follow-Up Testing

SA5.1 The Field Representative shall randomly select representative samples of production for the purposes of Follow-Up Testing at the Certification Organization. The sample selection interval shall be specified by the Certification organization, and the Field Representative shall assure that all selected samples are properly identified through the use of sample identification tags provided by the Certification organization. The follow-up tests performed at the Certification organization are described in the "Follow-Up Test Program" Section of this Supplement.

SA6 Follow-Up Test Program

SA6.1 The following tests are to be performed by the Certification organization on samples of material received from the Field Representative. For permanent coatings, only Qualitative Infrared Analysis is necessary. Upon completion of Follow-Up Testing, the Certification organization shall report the results to the manufacturer.

SA6.2 FLAMMABILITY TEST (for materials classified other than HB) – Test samples are to be subjected to the appropriate burning tests, indicated in the Procedure, in accordance with the methods described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The classifications obtained in the Follow-Up Tests are to be the same as those indicated in the Procedure.

SA6.3 QUALITATIVE INFRARED ANALYSIS – An infrared spectrum of the material is to be obtained by means of an infrared spectrophotometer in accordance with the methods described in Infrared Spectroscopy, Section 43, of the Standard for Polymeric Materials – Short Term Property Evaluation, UL 746A. Instrument settings used in obtaining the spectrum shall be identical to those used in obtaining the original spectrum of the material referenced in the procedure. The spectrum obtained shall indicate the same composition as that recorded in the spectrum obtained under the original investigation.

SA6.4 THERMOGRAVIMETRY (when indicated in the Procedure) – A thermogram of the material is to be obtained by means of a thermal analyzer with a thermogravimetric module in accordance with the methods described in Thermogravimetry, Section 46, of the Standard for Polymeric Materials– Short Term Property Evaluations, UL 746A. Instrument settings used in obtaining the thermogram shall be identical to those used in obtaining the original thermogram of the material referenced in the procedure. The thermogram obtained shall indicate the same characteristic weight loss over the programmed temperature range as that recorded in the thermogram obtained under the original investigation.

SA6.5 TENSILE STRENGTH (for materials with a maximum thickness < 0.61 mm (0.024 inch) – The tensile strength of the material is to be obtained in accordance with the methods described in Tensile Properties of Thermoplastic Materials, Section 9, of the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. The results obtained in the Follow-Up Tests are to satisfy the requirements specified in the Procedure.

SA6.6 AXIAL COMPRESSIVE STRENGTH (for Filament Wound Tubing materials only) – The axial compressive strength of the material is to be obtained in accordance with the methods described in ASTM D348. The results obtained in the Follow-Up Tests are to satisfy the requirements specified in the Procedure.

SA6.7 ZINC CHLORIDE ANALYSIS (for Vulcanized Fibre materials only) – The zinc chloride analysis values shall be obtained in accordance with the methods described in ASTM D619 for extraction and atomic absorption (AA) spectroscopy, atomic emission spectroscopy (AES) or inductively coupled plasma spectrometry (ICP) for measurement. The results obtained in the Follow-Up Tests are to satisfy the requirements specified in the Procedure.

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ANNEX A
Typical IR Spectrums

A1 General

A1.1 The graphs shown in Figure A1.1 – Figure A1.34 represent typical infrared spectrums for various types of UL/ANSI industrial laminates.

Figure A1.1

Typical IR spectrum for industrial laminates UL/ANSI Types X, XP, XPC

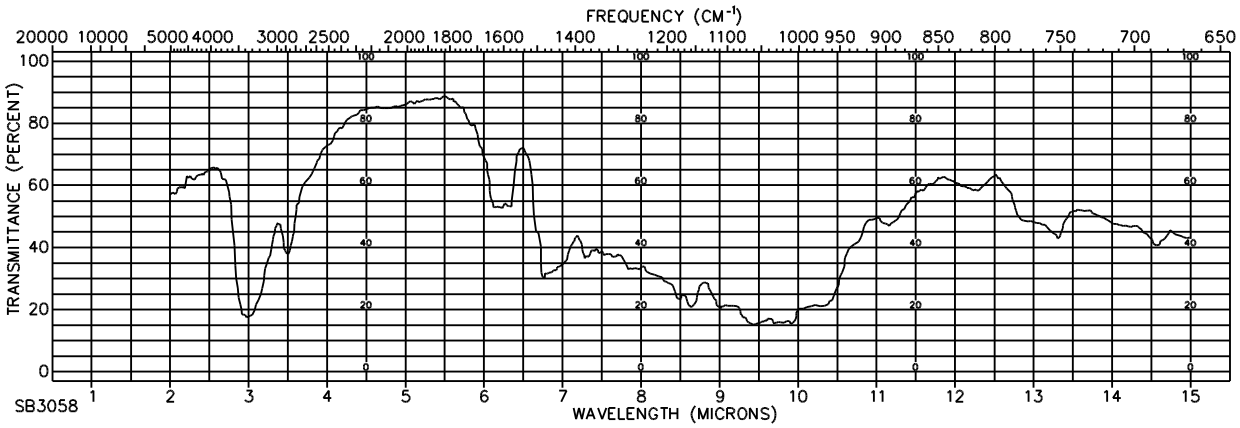

Figure A1.2

Typical IR spectrum for industrial laminates UL/ANSI Types XX, XXP, XXX

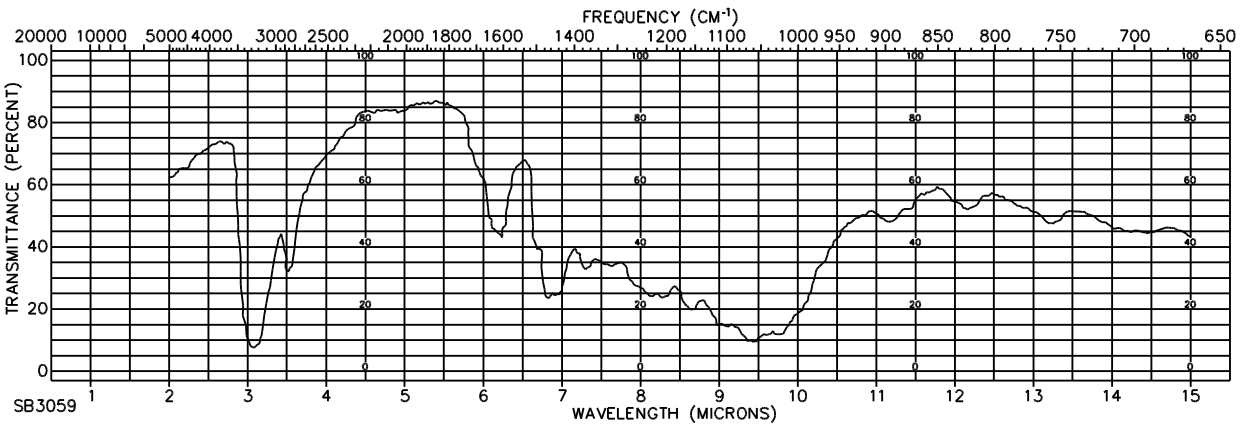

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Figure A1.3

Typical IR spectrum for industrial laminates UL/ANSI Types XXXP and XXXPC

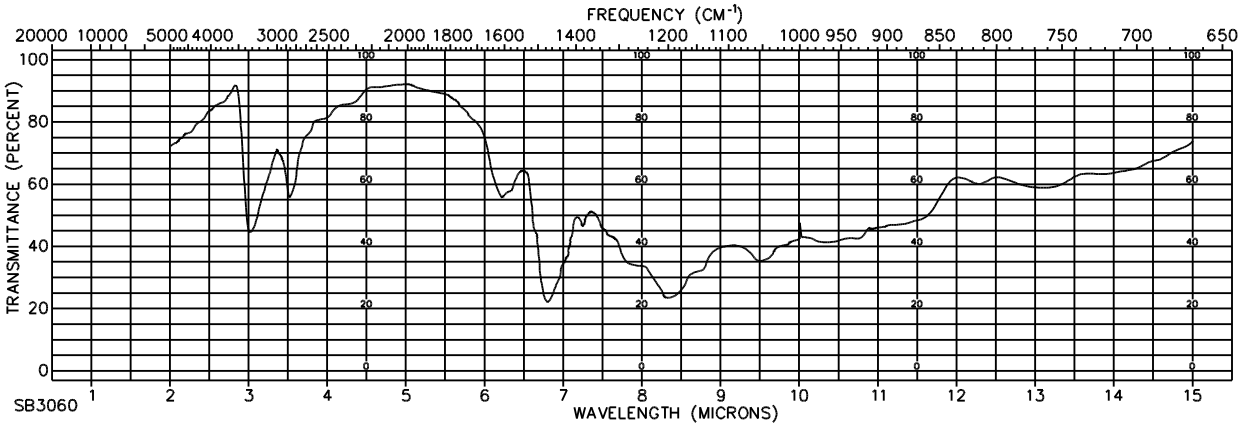
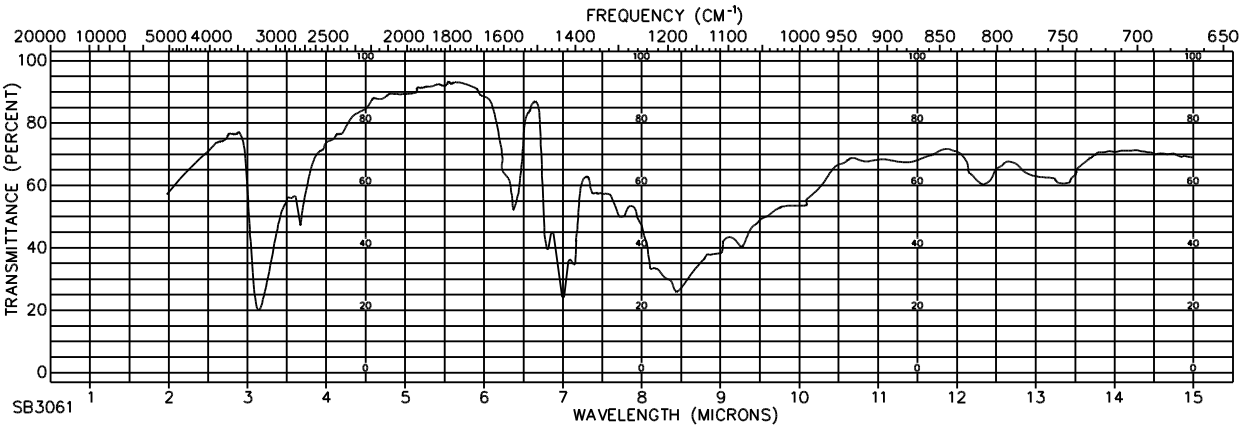


Figure A1.4

Typical IR spectrum for industrial laminates UL/ANSI Types C, CE, L, and LE



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