



**LAMINATES, METAL CLAD, (C-STAGE)
PRE-PREG (B-STAGE)
COPPER FOIL & RESIN COATED FOIL
SPECIFICATION**

**WORK INSTRUCTION
AB-20.11**

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REVISION HISTORY LOG

REVISION	PAGES/ FIGURES	CO NUMBER	ISSUE DATE	DESCRIPTION OF REVISION
08	Pgs. 1-13	16,099	01-10-2006	Revised: Section 10. Added: 2.1.9, 2.2.2, 3.2 - 3.16. Renumbered where applicable.
NA	Pgs. 1-13	16,307	03-15-2006	Revised Form AB2011A.DOC (Dated 03-15-2006)
09	Pgs. 1-12	18,337	02-01-2007	Revised Entire Document. Removed Form AB2011B.DOC Revised Form AB2011A.DOC (Dated 02-01-2007) Added Form AB2011C.DOC (Dated 02-01-2007)
10	Pgs. 1-12	19,016-3	04-18-2008	Revised entire document. Revised form AB2011A.DOC (Dated 04-17-2008) Added form AB2011D.DOC (Dated 04-17-2008)
11	Pgs. 1-12	24,645-3	06-10-2009	Revised: 2.1.9.2, 10.7.1, 10.7.1.2, 10.8.2, Section 4 header. Section 10.2.4, Added: 2.1.9.1, 2.2.7, Renumbered where applicable. Added Form AB2011E.DOC (Dated 06-09-2009)
12	Pgs. 1-12	27,136-3A	04-19-2010	Revised Work Instruction title Revised: 2.1.3, 3.1.9 – 3.1.11, Table under 10.3.1.2, Table under 10.4.3.1, Table under 10.4.5.2 Added: 2.1.9, 4.1, 10.3.1.2.3, 10.5, 10.5.1, Table under 10.5.1, 10.9.3 – 10.9.4 Removed: Section 2.2.1 – 2.2.4 Renumbered where applicable Removed Form AB2011A.DOC Revised Forms AB2011C, D, & E.DOC (Dated 04-19-2010)
13	Pgs. 1-12	31,808-3A	12-06-2011	Removed Form extensions throughout entire document Added: 4.2, 4.3, 10.1.10.6, 11.1, 11.2, 11.2.1 Revised: 10.2.4.1, 10.2.4.4, Table under 10.3.1.2 Revised Forms AB2011C, D, & E (Dated 12-05-2011)
14	Pgs. 1-14	35,365-3A	02-19-2013	Added: 10.1.10.1.1 – 10.1.10.1.4, 10.4.2.2, Note under 10.4.3.1, 10.4.4.2, 10.5.1 Revised: 2.1.3, 2.2.1, 3.9, 3.10, 3.11, 10.2.4.1, 10.2.4.4, Table under 10.3.1.2, 10.4.2.1, Table under 10.4.3.1 Renumbered where applicable
15	Pgs. 1-15	41,209-3A	11-13-2014	Revised: 10.1.10.1.2, Section 10.2.4, 10.7.1, 10.8.1.5 Added: 2 nd Note under 10.4.3.1, 10.4.6.2 Renumbered where applicable
16	Pgs. 1-15	41,420-3A	12-10-2014	Removed “Confidential” from document header
17	Pgs. 1-14	44,847-3A	03-28-2016	Revised: Table under 10.3.1.2 Revised Form AB2011C (Dated 03-28-2016)



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1 SCOPE

- 1.1 This specification meets and may exceed various requirements of the IPC Standards. This specification shall be sent to all vendors who supply TTM, Chippewa Falls Division, with B-Stage, C-Stage, Resin Coated Foil, and Sheeted Copper Foil as this specification states the requirements the vendors are required to follow.

2 APPLICABLE DOCUMENTS

2.1 Reference Documents

- 2.1.1 Purchase Order
- 2.1.2 Part Record
- 2.1.3 IPC-4101, Specification for Base Materials for Rigid and Multilayer Printed Boards
- 2.1.4 IPC-4103, Specification for Base Materials for High Speed/High Frequency Applications
- 2.1.5 IPC-TM-650, Test Methods Manual
- 2.1.6 IPC-4562, Metal Foil for Printed Wiring Applications
- 2.1.7 IPC-4563, Resin Coated Copper Foil for Printed Wiring Boards
- 2.1.8 [AB-20.04](#), Supplier/Subcontractor Corrective Action System
- 2.1.9 [AB-07.43](#), Lamination Tooling Drawings
- 2.1.10 Order of Precedence
 - 2.1.10.1 Part Record
 - 2.1.10.2 Purchase Order
 - 2.1.10.3 This specification
 - 2.1.10.4 IPC Specifications

2.2 Forms

- 2.2.1 Packaging Requirements for Laminate and B-Stage, [AB2011C](#)
- 2.2.2 Curl Requirement Specification, [AB2011D](#)
- 2.2.3 Part Record Generation/Modification Flowchart, [AB2011E](#)

3 TERMS AND DEFINITIONS

- 3.1 SCAR – Supplier Corrective Action response
- 3.2 Dimensional Stability – A measure of the dimensional change of material that is caused by factors such as temperature changes, humidity changes, chemical treatment (aging), and stress exposure.
- 3.3 Peel Strength after Thermal Stress – The force per unit, in lbs/inch, width that is required to peel a conductor foil from a laminate perpendicular to the surface of the substrate.
- 3.4 Thermal Stress Etched – This test is designed to determine the thermal integrity of unclad laminates using short-term solder exposure.
- 3.5 Thermal Stress Unetched – This test is designed to determine the thermal integrity of metallic clad laminates using short-term solder exposure.
- 3.6 Basis Weight – Weight per unit area (typically oz/yd²) of glass fabric prior to the laminator applying resin.
- 3.7 Resin Content – Difference between the basis weight of the glass fabric and the weight of the coated glass fabric. Resin content is the percentage of weight due to the resin.
- 3.8 Core Thickness – The thickness of the core of the laminate after the copper has been etched off, also known as “Thickness” in the TTM part record.
- 3.9 Visual – Visual inspection of the laminate and prepreg shall be done in accordance with IPC-4101, section 3.8.3.1 for laminate and section 3.8.3.2 for prepreg and this specification.
- 3.10 Surface/subsurface Imperfections – Inspection of the surface/subsurface shall be done in accordance with IPC-4101, section 3.8.3.1.6 and this specification.
- 3.11 Curl – Also referred to as Bow in IPC-4101, which is an out of plane measurement of corners of a copper clad laminate when placed unrestrained on a hard, flat surface such that the middle of the panel is contacting the surface and corners are raised (concave side down). Expressed in inches.
- 3.12 Material Size – The length and the width of the material. Also known as “Dimensions” in the TTM part record, i.e. 18.5 X 24.5.
- 3.13 Foil Weight – The weight of the copper per unit area, typically oz/ft².
- 3.14 Glass Construction – Describes the combination of glass fabric types used to make a core, i.e. 2116/2113, 106, etc. This is also known as “Glass Laminations” in the TTM part record.
- 3.15 Material Type – The type of resin used to manufacture the Prepreg.
- 3.16 Copper Cladding – Describe the foil weights to construct the laminate, i.e. 1/1, H/H, 1/H, etc. This is also known as “side 1” and “side 2” of “Copper” in the TTM part record.



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4 SAFETY AND ENVIRONMENTAL

- 4.1 TTM encourages suppliers to implement an Environmental Management System.
- 4.2 TTM requires suppliers to implement the Electronic Industry Code of Conduct (EICC).
- 4.3 TTM requires suppliers to install a Business Continuity Plan, including Pandemic Preparedness, and test the plan at least yearly.

5 HANDLING

6 EQUIPMENT

7 TOOLING

8 MATERIALS

9 START - UP

10 OPERATION

10.1 Material Requirements (C-Stage)

10.1.1 Thermal Stress – Per applicable IPC specifications

- 10.1.1.1 The sample shall be examined under 5 x magnification. There shall be no evidence of measling, weave exposure, or material degradation. The copper shall show no blistering or delamination.

10.1.2 Surface Imperfections (Laminate)

- 10.1.2.1 Foil indentations shall be located and measured per IPC specifications. The copper surface condition shall meet the requirements of the IPC specifications with the following exceptions:

10.1.2.1.1 Pits, dents, or fiber dents between .0025” and .025” in length shall not exceed 3 in any 12” by 12” area.

10.1.2.1.2 Pits or dents less than .0025” in the longest dimension shall not be counted in the 3 feature per square foot requirement.

10.1.2.1.3 Imperfections of any size that contains deposits of foreign materials such as resin, dirt, grit, etc., are unacceptable.

10.1.2.1.4 Any single surface defect which causes a conductor defect such as an open, dent, line depth reduction, line width reduction or raised conductor is cause for rejection.

10.1.3 Subsurface Imperfections (Laminate)

10.1.3.1 Panels shall be inspected and verified so that no imperfection shall exceed IPC specifications at incoming material inspection and/or at in-process AOI inspection with the following exception: subsurface imperfections will be rejected if the defect falls beneath conductors or between closely spaced in-plane conductors.

10.1.4 Dimensional Stability, per applicable IPC specifications.

10.1.5 Dielectric Thickness

10.1.5.1 Core thickness shall be measured per IPC specifications.

10.1.5.2 Tolerances per the Part Record.

10.1.6 Cure requirements.

10.1.6.1 As agreed upon between TTM and supplier.

10.1.7 Curl

10.1.7.1 Maximum displacement for curl (copper clad & un-clad) unrestrained on a flat surface is 0.50" for even copper weights and symmetric constructions for all core thickness.

10.1.7.2 Maximum displacement for curl (copper clad) unrestrained on a flat surface is 0.75" for uneven copper weights and asymmetric constructions for all core thickness.

10.1.8 Grain Direction

10.1.8.1 All C-Stage laminate shall meet the grain direction requirement as stated per the Part Record.

10.1.9 Square/Edge condition for panels with 0.50" oversize.

10.1.9.1 Minimum length and width dimensions shall be $-.000'' + .060''$.

10.1.9.2 Perpendicularity shall be $.050''$ maximum.

10.1.9.3 Rippled edges cannot extend more than $.125''$ into panel, and no loose copper.

10.1.9.4 Rippled edged height cannot exceed 0.0025 above/below base copper.

10.1.9.5 Edges shall not exhibit burrs $> 0.0025''$.

10.1.10 Panel Identification

- 10.1.10.1 All individual panels of material must be identified for lot traceability. Exceptions as agreed upon between user and supplier. Reference Corporate Stamping Requirements Drawing for location. **NOTE:** Markings must be located on the long side of panel.
 - 10.1.10.1.1 Ink stamping is the preferred method of identification, but the ink must act as a resist and be legible after the preclean and develop/etch/strip (DES) processes.
 - 10.1.10.1.2 If laser stamping is chosen, the stamp must be engraved into the b-stage so that if the copper is etched, it is still legible. The laser stamp also must be legible after adding liquid resist.
 - 10.1.10.1.3 “Pin” or “Impression” stamping is the least desirable method of identification. If this is the only method available, the stamp depth must be minimal so that it does not increase the panel thickness in this area, yet remains legible.
 - 10.1.10.1.4 Non identified panels may be returned to vendor, at vendor’s expense. An ADR is required if shipping without a stamp. Reference section 10.8 of this specification for ADR instructions.
- 10.1.10.2 For Differential Copper Weights (i.e.: .5 / 1) panels must be stamped on the side with the heaviest copper. For any panel that has a combination of Differential Copper Weights and Standard cu/Reverse Treat cu, the requirements for Differential Copper Weights takes precedence.
- 10.1.10.3 Standard cu/Reverse Treat cu with even copper weight panels must be stamped on the standard copper side.
- 10.1.10.4 On asymmetric constructions and even copper weights, stamp on heavy glass side.
- 10.1.10.5 The order of precedence for marking is:
 - 10.1.10.5.1 Differential copper weights - heaviest copper
 - 10.1.10.5.2 Standard cu/Reverse Treat cu - standard copper
 - 10.1.10.5.3 Asymmetric Glass construction - heaviest glass
- 10.1.10.6 Laminate hi-pot pretesting only allowed with written approval by TTM.

10.2 Material Requirements (Pre-preg and resin coated foil)

10.2.1 Pre-preg Visual Properties

10.2.1.1 Inclusions and Imperfections per IPC specifications. Testing in accordance with IPC specifications.

10.2.2 Cleanliness

10.2.2.1 Must be free of loose fibers and dust.

10.2.3 Tooling

10.2.3.1 All pre-preg must be cut and tooled per the Part Record. Reference corporate tooling drawings for pre-preg size, tolerances, and tooling hole locations.

10.2.4 Preservation

10.2.4.1 Pre-preg must be shipped with:

10.2.4.1.1 60 days of shelf life remaining for pre-preg with a 90-day shelf life

10.2.4.1.2 120 days of shelf life remaining for pre-preg with 180-day shelf life

10.2.4.1.3 90 days of shelf life remaining for pre-preg stored in condition 1

10.2.4.2 Supplier shall request an Advanced Deviation Request Number (ADR #) prior to shipping product that will exceed this requirement. Reference Section 10.8 of this specification for ADR instructions.

10.2.4.3 Before the ADR # is granted, pre-preg must be retested if:

10.2.4.3.1 Over 45 days old for pre-preg with a 90-day shelf life

10.2.4.3.2 Over 90 days old for pre-preg with 180-day shelf life

10.2.4.4 The requirements for the retested data must include:

10.2.4.4.1 The retested values recorded on the test report

10.2.4.4.2 The date retested

10.2.4.4.3 The original test results

10.2.4.5 The retest must be done within 7 days of shipping and prepreg must be desiccated per the IPC standard.

10.2.4.6 Pre-preg must be vacuum packed, where appropriate, and sealed to eliminate the possibility of moisture absorption and to reduce the risk of handling damage.

10.2.4.7 Pre-preg packages are to be in quantities specified by TTM and not to exceed 25 pounds per package and a maximum of 100 sheets.

10.2.4.8 Any minimum order quantity (MOQ) will be waived at TTM's discretion for any ADR request.



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10.2.4.9 All prepreg that was issued an ADR number must have a label or other designation that lists the ADR number as well as the expiration date of the prepreg. This notification must be very visual and if a label is used, it should be placed next to the package label.

10.3 Supplier Quality Assurance Provisions

10.3.1 All individual shipments shall be accompanied by the following documentation.

10.3.1.1 Each C-Stage construction within an individual press load must be tested and recorded on a test report or as agreed upon between user and supplier.

10.3.1.2 Certification of Compliance shall be to this specification, IPC Specification sheet as well as the purchase order. The Certification of Compliance must be accompanied by test analysis data included in the table below.

	Value, Note or Pass/Fail	C-Stage	Pre-preg	Resin coated foil	Sheeted copper foil	Barcode
Designation code (see IPC for codes)	Note	C	C	C	C	
TTM part number	Note	C	C	C	C	X
TTM PO number	Note	C	C	C	C	X
Core Thickness	Note	C		X		
Copper Cladding	Note	C				
AB-20.11	Note	C	C	C	C	
Lot number	Note	C	C	C	C	X
Quantity	Note	C	C	C	C	
Manufacture date	Note	C	C	C	C	
Expiration Date	Note		C			
Cut date (if applicable)	Note		C			
Material size	Note	C	C	C	C	
Material type	Note	C	C	C		
Foil Weight	Note				C	
Glass Construction	Note	C	C			
Foil vendor	Note	C			C	
ADR number, if applicable	Note	C	C	C	C	
Approval Signature	Note	C	C	C	C	
Certification statement per IPC	Note	C	C	C	C	
Statement of RoHS Compliance	Note	C	C	C	C	
Grain Direction	Note	C	C			
Volatile Content – if applicable	Value		PR			
Resin Content – if applicable	Value		PR			
Scale Flow – if applicable	Value		PR			
Resin Flow – if applicable	Value		PR			
Flow Window – if applicable	Value		PR			
Melt Viscosity – if applicable	Value		PR			

- 10.3.1.2.1 Additional items may be required for prepreg. These will be recorded in the part record and may include minimum viscosity, treated weight (which is an alternate way of expressing resin content), or gel time.
- 10.3.1.2.2 All items marked with a “C” are critical and must be included on the C of C. All items marked with an “X” do not need to be recorded on the C of C, but must be made available upon request.
- 10.3.1.2.3 All items marked with a “PR” must be included on the C of C if required by the part record.
- 10.3.1.2.4 All measurements shall be performed per IPC-Specifications unless otherwise specified.
- 10.3.1.2.5 Thickness values shall be performed per this specification, paragraph 10.1.5.
- 10.3.1.2.6 Supplier shall provide certification and test data from the copper suppliers upon request.
- 10.3.1.2.7 Visual shall be performed per this specification, paragraph 10.1.3.

10.4 Packaging and Shipping Requirements of C-Stage, pre-preg, resin coated foil and sheeted copper foil.

10.4.1 Construction of packages

- 10.4.1.1 Packages to be constructed such that product will not be damaged during normal shipping.

10.4.2 Weight of package and contents

- 10.4.2.1 Total weight of package with material must not exceed 25 pounds.
- 10.4.2.2 Packages shall not have any paper inside.



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10.4.3 Labeling of Packages

10.4.3.1 The label on the packages must include the following information.

NOTE: For bar coding, the 1D (1 Dimensional) standard should be used.

NOTE: It is recommended that the TTM part number and Quantity are displayed in a 48, bold font. This is for ease of viewing while on the shelf.

	Bar coding Requirement	C-Stage	Pre-preg	Resin coated foil	Sheeted copper foil
TTM PO number	X	X	X	X	X
Material type		X	X	X	X
Material size		X	X	X	X
Quantity	X	X	X	X	X
Lot number	X	X	X	X	X
Manufacture date	X	X	X	X	X
Expiration date	X		X		
TTM part number	X	X	X	X	X
Grain direction		X	X	X	
6 Peel labels		X	X	X	X
Foil weight		X		X	X
Copper Cladding		X			
Glass Construction		X	X		
Core Thickness		X			

10.4.4 Labeling of Containers

10.4.4.1 The labels on the container shall be identical to the label on the package.

10.4.4.2 The containers must be labeled to quickly indicate if it is prepreg or laminate. Recommendation is to use a different color label for prepreg, but a big sticker indicating prepreg or laminate placed near the package label is acceptable.

10.4.5 Peel label requirements

10.4.5.1 The peel labels on the package must include the following information. Each individual peel label must not exceed .5" in height and 3.5" in width. The print on the peel labels must be legible.



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10.4.5.2 Each package is required to have a minimum of 6 peel labels.

	C-Stage	Pre-preg	Resin Coated foil	Sheeted copper foil
TTM PO number	X	X	X	X
Lot number	X	X	X	X
TTM part number	X	X	X	X
Foil weight			X	X
Copper Cladding	X			
Copper Manufacturer				
Core thickness	X			
Material type		X	X	
Glass Construction		X	X	
ADR number, if applicable	X	X	X	X

10.4.6 Shipping method

10.4.6.1 It is the responsibility of the supplier to recommend a shipping method that enables the material to meet the end user requirements, even if TTM is paying the shipping expense.

10.4.6.2 All shipments of pre-preg are required to have a temperature indicator in each box to ensure that if the temperature is elevated for an extended period, the indicator would be tripped. It is at TTM's discretion whether prepreg would be returned or samples sent for retest.

10.4.6.3 The shipping requirements of AB2011C are required.

10.4.6.3.1 Some of the requirements of this specification may be out of the control of the vendor, but it will be their responsibility to work with the freight carriers to meet this specification.

10.5 Packing Slip

10.5.1 Prepreg and Laminate must be on separate packing slips.

10.5.2 The information on the packing slip must include the following information

	C-Stage	B-Stage	Resin Coated foil	Sheeted copper foil
Expiration date		X		
Customer Part Number	X	X	X	X
Customer P. O. Number	X	X	X	X
Packing Slip Number	X	X	X	X
Material Size	X	X	X	X
Batch / Lot Number	X	X	X	X
Copper Cladding	X			
Grain Direction	X	X	X	
Material Type	X	X	X	X
Core Thickness	X			



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10.6 Traceability Requirements

10.6.1 Lot traceability is required for the following items and is made available to TTM upon request.

	C-Stage	B Stage	Resin Coated foil	Sheeted copper foil
Glass lot code	X	X		
Compounded resin lot code		X	X	
Breakdown of resin component part numbers		X	X	
Breakdown of resin lot codes		X	X	
Breakdown of resin quantity		X	X	
Cut copper part number	X		X	X
Cut copper lot code	X		X	X
Cut copper manufacturer	X		X	X
Copper roll part number	X		X	X
Copper roll lot code	X		X	X
Copper roll manufacturer	X		X	X
Pre-preg part number	X	X		
Pre-preg lot code	X	X		

10.7 Rejected Material

10.7.1 Rejected lots of material may be put on hold and may require containment, root cause and corrective action analysis. **A response within 48 hours is recommended for containment analysis**, where applicable. A maximum 5-business day response time is required for root cause and corrective action analysis of SCARs and complaints and a maximum 30 day response time is required for payment of the credit. Root cause and corrective action analysis of credits is not required. **NOTE:** Any root cause and corrective action that can not be met within 5-business days may receive an extension which must be requested through a phone call or e-mail to the TTM Supplier Quality Manager, or delegate. Credit requests will not receive an extension and will be late if received after the due date.

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10.8 Advance Deviation Request (ADR)

10.8.1 An ADR must be requested if material violates a TTM specification requirement, including the TTM part record. The following procedure must be used:

10.8.1.1 Contact Receiving Inspection/Supplier Quality with the following information:

10.8.1.1.1 Reason for request

10.8.1.1.2 Purchase order #

10.8.1.1.3 TTM Part #

10.8.1.1.4 Lot #

10.8.1.1.5 Quantity

10.8.1.1.6 Material Type

10.8.1.2 If an Advance Deviation is granted, Advance Deviation Request # (ADR #) will be issued. This number must be recorded on the peel labels as well as the vendors Certificate of Conformance and/or packing slip. In addition, a colored sticker (other than green), or other visible method, must be included on each package indicating the ADR number and the expiration date.

10.8.1.3 If the above procedure is not followed, the material may be returned to the supplier at their expense.

10.8.1.4 A corrective action may be issued when the ADR is requested.

10.8.1.5 All elements of this specification apply for materials that are samples, developmental, etc. If an element can not be met, an ADR must be requested. The reason for this is all materials are manufactured using normal production processes.


10.9 Change Notification

10.9.1 TTM, Chippewa Falls Division requires a written notification 60 days prior to a requested change.

10.9.2 The supplier shall furnish TTM Supplier Quality with written notification of changes that may affect the form, fit, function or processing at TTM.

10.9.3 TTM will provide a written response of receipt of the change notification.

10.9.3.1 Once the supplier receives the written response that the change notification was received by TTM, the supplier is free to implement the change after 60 days unless the change is rejected in writing by TTM. The date also may be extended beyond the 60 days if qualification is required.

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10.9.4 TTM will write a formal response to the change notification and it will be submitted to the supplier within 30 days of receipt of the change notification.

EXAMPLES OF CHANGE NOTIFICATION

**NEW RAW MATERIAL
NEW SUPPLIER
PROFILE CHANGE
FORMULATION CHANGE
INTERNAL PRODUCT SPEC CHANGE
TEST METHOD
NEW EQUIPMENT INSTALLATION
PACKING CHANGE
CHEMISTRY CHANGE
MANUFACTURING FACILITY CHANGE
NEW MATERIAL CURRENTLY NOT IN USE
ETC.**

10.9.5 This notification shall take place prior to implementation and will be subject to approval.

11 QUALITY REQUIREMENTS

11.1 Laminate fallout rate

11.1.1 The required fallout rate due to supplier defects is 0.5% or less. The supplier scorecard will reflect the actual monthly rate and points will be awarded based on the actual fallout rate.

11.2 Continuous Improvement

11.2.1 All suppliers should be working to continually improve their quality to TTM. Upon request, the supplier should be able to provide their top three (3) issues they are working on to improve quality to TTM as well as their status.

12 SHUTDOWN

13 MAINTENANCE

13.1 Routine Operator Maintenance

13.2 Miscellaneous Maintenance

14 TRAINING

15 TROUBLESHOOTING GUIDE/RESPONSE FLOW CHECKLIST

16 CONTROL PLANS