MATERIAL AND EQUIPMENT STANDARD

FOR

CURRENT LIMITING REACTORS

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For Attachments see the end of this Standard Specification.

0. INTRODUCTION

The purpose of the series reactor follows from the fact that the fault current which flows for a fault at any given point in a power system is determined by the impedance of the power system as seen from the point of fault.

The maximum fault current can therefore, be limited to an acceptable value by the provision of series reactors of appropriate value at suitable points in the power system. The provision of such fault limiting reactors can avoid the necessity of providing larger or specially braced conductors or circuit breakers of higher rating capable of withstanding the short circuit current which otherwise occur.

The use of series reactor may thus show appreciable advantages in capital cost and space requirements.

1. SCOPE

This Standard Specification covers the minimum technical requirements for design, manufacture, quality control, testing, finishing, packing and shipment of current limiting reactors intended for limiting the short time current, while during normal operation a continuous current shall flow through the equipment.

Only the general requirements of individual reactors are given in this Standard Specification. The specific requirements of individual reactors will be given in pertinent data sheet and or requisition.

2. REFERENCES

The edition of the following Standards and Codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the vendor/consultant

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 27	"Letters, Symbols to be used in Electrical Technology"
IEC 60	"High Voltage Test Techniques"
IEC 60-1 Part 1	"General Definitions and Test Requirements"
IEC 60-2 Part 2	"Test Procedures"
IEC 60-3 Part 3	"Measuring Devices"
IEC 76	"Power Transformers"
IEC 76-1 Part 1	"General"
IEC 76-2 Part 2	"Temperature Rise"
IEC 76-3 Part 3	"Insulation Levels and Dielectric Tests"
IEC 76-4 Part 4	"Tapping and Connections"
IEC 76-5 Part 5	"Ability to withstand Short Circuit"
IEC 137	"Bushings for Alternative Voltages above 1000 V"
IEC 289	"Reactors"
IEC 391	"Marking of Insulated Conductors"
IEC 445	"Identification of Equipment Terminals and of Terminations of Certain Designated Conductors Including General Rules of an Alphanumeric System"
IEC 446	"Identification of Insulated and Bare Conductors by Colors"
IEC 529	"Classification of Degree of Protection Provided by Enclosure"
IEC 551	"Determination of Transformer and Reactor Sound Levels"

IEC 617	"Graphical symbols for Diagram"
IEC 722	"Guide to the Lightning Impulse and Switching Impulse Testing of Power Transformer, and Reactors"
IEC 726	"Dry Type Power Transformer"

BS (BRITISH STANDARD)

BS 381C	"Specification for Color for Identification Coding and Special Purposes"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI C57	"USA Standard Requirements,Terminology and Test Code for Current Limiting Reactors"

Notes:

1) Where standards other than IEC are specified it is understood that the equivalent IEC Standard is acceptable.

2) The testing and certification by following authorities are acceptable where relevant:

- **Association of Short Circuit Testing Authorities (ASTA).**
- **European Organization for Testing and Certification (EOTC).**
- **Electrical Equipment Certification Services (EECS).**

3. UNITS

International system of units (SI) in accordance with IPS-E-GN-100 shall be used.

4. SERVICE CONDITIONS

4.1 Environmental Conditions

See Attachment 1.

4.2 Electricity Supply

For electric supply see data sheet.

5. GENERAL DESIGN

5.1 Tanks

5.1.1 Tanks shall be fabricated from mild steel boiler plate of adequate thickness and shall be of robust construction. Mild steel stiffeners, continuously welded to the tank, shall be provided as necessary.

5.1.2 Tank bases shall normally be provided with skids to permit movement of the tank in any direction, but where rollers are specified they shall be capable of being turned through 90.

5.1.3 At least 2 lifting lugs dependent on the mass, and 4 jacking-up positions shall be provided, Facilities shall be provided on the tank base for the attachment of sling shackles to enable the reactor to be hauled and slewed in any direction during installation.

5.1.4 Tank covers shall be provided with individual lifting eyebolts to suit the mass.

5.1.5 Short circuit capability

Current limiting reactors shall be capable of withstanding without injury the mechanical and thermal stresses caused by a short circuit with 105% rated system voltage maintained:

a) the mechanical and thermal stresses due to short circuit in current limiting reactors shall be within the safe operational limits and in no way shall harm the proper functioning of the equipment.

5.2 Tank Fittings

5.2.1 The following fittings shall be standard equipment for all reactors:

a) Closed type thermometer pocket with captive screwed cap.

b) Pressure relief vent of the diaphragm or "qualitrol" type. The bottom of the pressure relief vent shall be above the maximum conservator oil level. The relief pressure setting to be approx. 0.8 bar.

c) 2 lockable 40 mm filtering valves with screwed connector.

d) Earthing terminals for the main tank base and tank cover.

e) Earthing terminal for each detachable radiator cooler. All earthing terminal screwed threads to be preferably of size M 12.

5.3 Terminal Arrangements

5.3.1 The main reactor terminal assemblies shall be generally in accordance with the requirements of IEC 137 unless otherwise specified.

5.3.2 All cable boxes to have adequately sized weatherproof bolted and gasketed access covers.

The Purchaser shall specify the cabling arrangements at the enquiry stage.

5.3.3 Outdoor terminal bushings shall be fitted with removable double gap arcing horns and the bushing shed creepage distance shall comply with IEC 137. For a heavily polluted atmosphere under the service condition stated in Attachment No.1 the gap distances to be compatible with nominal operating voltage level.

5.3.4 The terminal bushing, irrespective of their location on the reactor shall be insulated for the full winding phase to phase voltage.

5.4 Reactor Winding

The design for series reactor shall be based on a magnetically shielded type construction.

Attention shall be paid to winding stabilization and core / coil clamping system. Winding of three phases shall be vertically stacked with center phase wound in reverse direction in order that mechanical forces between stacked reactor be in compression.

The terminal stubs shall be tin plated.

5.5 Temperature Rise

5.5.1 Temperature rise at rated continuous current: Temperature rise limits shall be in compliance with the requirements of IEC Publication No.726 for Dry Type Reactor.

5.5.2 Temperature after short time current loading. The calculated temperature of the winding after rated short time current loading shall not exceed the values prescribed for the windings under short circuit conditions in Sub-clause 2.1.4 of IEC Publication 76.5 .

5.6 Rating Plates

Each reactor shall be provided with a rating plate of stainless steel in a visible position showing the appropriate items indicated below: (The entries on the plate are to be indelibly marked).

- Purchaser's name and order No.
- Year of manufacture.
- Type of reactor.
- outdoor/indoor application.
- Number of this Standard.
- Manufacturer's name.
- Manufacturer's serial No. Diagram Dwg. No.
- No. of phases.
- Rated frequency.
- highest voltage of equipment.
- Rated continuous current.
- Rated short time current and duration.
- Over current time seconds.
- Insulation class.
- Reactor (measured value) per phase.
- Type of cooling.
- Total mass.
- Mass of insulating oil.
- Additional information to be given in specific cases.
- Rated lightning impulse withstand voltage across the winding when surge arresters are connected in parallel with the winding (for current limiting reactor).
- Transportation mass.
- Details regarding tapping if any.

6. INSPECTION, QUALITY CONTROL AND QUALITY RECORD

See Attachment 2.

7. TESTS AND CERTIFICATION

7.1 General Requirements for Tests

See Attachment 3.

7.2 Specific Requirements for Tests

The tests shall comprise but shall not be limited to:

7.2.1 Type tests

"Temperature Rise Test at Rated Continuous Current"	IEC 76-2
"Lightning Impulse Test	IEC 76-3 IEC 722

7.2.2 Routine tests

"Measurement of Winding Resistance"	IEC 76-1 Sub-clause 8.2
"Measurement of the Impedance at Continuous Current"	IEC 289 Sub-clause 17.5
"Measurement of Loss if applicable"	IEC 289 Sub-clause 17.6
"Separate Source Withstand Test"	IEC 76-3 Sub-clause 10
"Induced Over voltage Withstand Test"	IEC 76-3 Sub-clause 11.1

7.2.3 Special tests

The following special tests may be carried out on mutual agreement between purchaser and supplier:

"Short Time Current Test and Measurement Impedance at Short Time Current"	IEC 76.5
"Measurement of Acoustic Sound Level"	IEC 551

8. FINISH

After de-scaling and removal of rust by shot blasting and cleaning down, all the tank external metallic surfaces to be immediately given one coat of an oil and heat resisting zinc chromate/red oxide primer with an oil modified alkyd resin base incorporating a rust inhibitor. Two finishing coats of contrasting color, the final coat being a durable high gloss oil and weather resistant paint, dark admirality gray color.

- The internal metallic surfaces of tank, underside of the tank cover cable boxes, etc. to be similarly treated by shot blasting prior to painting.

After shot blasting and cleaning down, one coat of primer to be applied followed by a finishing coat of hard setting air drying paint.

- The type of paint shall be impervious to, resist the effect of and shall have no deliterious effect on the filling medium.

9. INFORMATION FOR MANUFACTURER/SUPPLIER

For information to be given to manufacturer/supplier see data sheet in Appendix A.

10. DOCUMENTATION TO BE SUPPLIED BY MANUFACTURER/SUPPLIER

For list of drawings, documents manuals and certificates to be submitted by manufacturer/supplier, see Appendix B.

11. PACKING

For general requirements for packing see Attachment 4.

12. SHIPMENT

For general requirement for shipment see Attachment 5.

13. GUARANTEE

See Attachment 6.

14. SPARE PARTS

See Attachment 7.

15. LANGUAGE

See Attachment 8.

16. COORDINATION RESPONSIBILITY WITH OTHERS

See Attachment 9.

APPENDICES

APPENDIX A
EXAMPLE OF TYPICAL DATA SHEET FOR REACTOR

Project Name :
.....

Area Classification :
.....

Location : .....In-door.....Outdoor.....

Detail of Reactor :
.....

No. of Phases : .....Volt-age.....Frequency.....

Impedance Rating of each Phase : .....

Continuous Current Rating : .....

Rated Short Time Duration :.....Second(s).....

Type of Cooling: AN AF

Insulation Level :
.....

Detail of Taps :
.....

Cover : Sealed Type Flanged Type

Temperature Indicator : Required Not required

Ingress Protection : For indoor For outdoor

Noise level :
.....

Reactor is needed for connection to :

Generator Busbar Feeder Group feeder

Details of Incoming Cable :
.....

Details of Outgoing Cable :
.....

Details of Incoming to External Bushing

.....

Details of Outgoing from External Bushing

.....

Sunshade	**Required**	**Not required**
Lifting Lugs	**Required**	**Not required**
Skid Mounting	**Required**	**Not required**

APPENDIX B

LIST OF DRAWING, DOCUMENTS, MANUALS AND CERTIFICATES TO BE SUBMITTED BY MANUFACTURER/SUPPLIER IN NUMBER AND THE TIMES INDICATED BELOW:

	DESCRIPTION	REQUIRED WITH QUATATION	CERTIFIED INFORM. REQ. WITH ORDER			NUMBER OF WEEKS BEFORE DELIVERY
			N0. OF COPIES		NUMBER OF WEEKS AFTER ORDER	
			REPRO-DICIBLES	PRINTED MATTER		
A	**DRAWING AND OTHER DOCUMENTS:**					
	a) ELECTRICAL EQUIPMENT:					
	1. DIMENSIONED OUTLINES AND FOUNDATION DETAILS					
	INCLUDING: CABLE ENTRIES AND CLEARANCES					
	2. DETAILS AND CROSS-SECTIONAL ARRANGEMENT					
	3. MOUNTING DETAILS					
	4. PERFORMANCE DATA (TYPICAL)					
	5. PARTS / MATERIAL LIST					
	6. RELEVANT CATALOGUES					
	7. NAME PLATES					
	8. LIST OF FINAL LABELS					
	b) TERMINATION:					
	1. CONNECTION DIAGRAM					
	2. TERMINAL BOX ARRANGEMENT					
	3. CONNECTION AND TERMINAL DESIGNATION					
	c) ELECTRICAL REFERENCE DOCUMENTS:					
	1. GENERAL DESCRIPTION					
	2. EQUIPMENT SPECIFICATION					
	3. PERFORMANCE DATA (ACTUAL)					
	4. DRAWINGS / PARTS / MATERIALS LIST					
B	**INSTRUCTION MANUALS :** (FOR ALL REQUIRED ITEMS)					
	1. INSTALLATION, COMMISSIONING AND INSPECTION					
	2. OPERATION AND MAINTENANCE					
C	**SPARE PARTS REQUIREMENTS:**					
	1. ILLUSTRATED SPARE PARTS					
	2. RECOMMENDED COMMISSIONING SPARE LIST					
	3. RECOMMENDED SPARES FOR THREE YEARS OPARATION					
D	**CERTIFICATION:**					
	1. PERFORMANCE TEST, MATERIALS CERTIFICATES AND					
	CURVES					

ATTACHMENTS (General)

ATTACHMENT 1
ENVIRONMENTAL CONDITIONS

1.1 Site elevation : ----- meters above sea level.

1.2 Maximum ambient air temperature : ----- degrees centigrade. (Bare metal directly exposed to the sun can at times reach a surface temperature of ----- degrees centigrade).

1.3 Minimum air temperature : ----- degrees centigrade.

1.4 Relative humidity : ----- percent.

1.5 Atmosphere : saliferrous, dusty corrosive and subject to dust storms with concentration of 70 - 1412 mg/cubic meter, H_2S may be present, unless otherwise specified in data sheet.

1.6 Lightning storm isoceraunic level : ----- storm days/year.

1.7 Maximum intensity of earthquake ----- richters.

Note:

Blanks to be filled by client.

ATTACHMENT 2
INSPECTION, QUALITY CONTROL AND QUALITY RECORDS

2.1 Inspection, Quality Control

2.1.1 The purchaser's inspector, or his authorized representative shall have free access to the manufacturing plant engaged in the manufacture of the equipment, to carry out necessary inspection at any stage of work.

2.1.2 Inspection may include the visit to quality control laboratories, work shops, testing bay etc.

2.1.3 The supplier shall make available technical data, test pieces and samples that the purchaser's representative may require for verification in conjunction with pertinent equipment.

If required the supplier shall forward the same to any person or location that the purchaser's representative may direct.

2.2 Quality Records

2.2.1 The supplier shall maintain appropriate inspection and test records to substantiate conformance with specified requirements.

2.2.2 Quality record shall be legible and relevant to the product involved.

2.2.3 Quality records that substantiate conformance with the specified requirements, shall be retained by manufacturer and made available on request by purchaser.

2.2.4 The supplier shall establish and maintain procedure for identification collection, indexing, filing, storage, maintenance and disposition of quality records.

2.2.5 Supplier shall submit to purchaser: reports, test schedules, and test certificates (in ----- copies) on completion of tests.

Note:

Blanks to be filled by client.

ATTACHMENT 3
TESTS AND CERTIFICATION

3.1 General Requirements

3.1.1 Test procedure as proposed by the supplier shall be agreed upon, and approved by the purchaser before any test is carried out.

3.1.2 Purchaser may require witnessed tests to be carried out in the presence of his nominated representative who should be informed at least ----- weeks in advance of the date of the tests and confirmed ----- weeks before the tests.

3.1.3 Test certificates and test reports shall refer to the serial No. of the equipment tested and must bear the purchaser's name, order No. and manufacturer's name and seal.

The certificates shall be approved by the purchaser before shipment instruction are given.

3.1.4 Approval by the purchaser's inspector or representative shall not relieve the vendor of his commitments under the terms of this specification or any associated order.

3.1.5 The equipment may be rejected if measurement and inspection reveal any discrepancies between quoted figures resulting in purchase order and those measured actually.

3.1.6 Any charges incurred by the tests quoted under heading of specific requirements for tests to be quoted as a separate item and are not to be included in the cost of the equipment.

Note:

Blanks to be filled by client.

ATTACHMENT 4
PACKING

4.1 Equipment must be carefully packed to provide necessary protection during transit to destination and shall be in accordance with any special provision contained in the order.

4.2 Special attention must be given to protection against corrosion during transit, and silica gel or similar dehydrating compound shall be enclosed.

4.3 The method of cleaning preserving and the details of packing including moisture elimination, cushioning, blocking and crating shall be such that to protect the product against all damages or defects which may occur during handling, sea shipment to the port and rough road haulage to site and extended tropical open air storage generally as client general conditions of purchase see Attachment No.10

4.4 All bright and machined parts must be given the protection against corrosion.

4.5 Ancillary items forming an integral part of the equipment should be packed preferably in a separate container if the equipment is normally cased or crated.

Alternatively the ancillary items should be fixed securely to the equipment and adequate precautions taken to ensure that the item do not come loose in transit or be otherwise damaged.

4.6 The supplier shall provide methods of handling to prevent damage and or deterioration during transit.

4.7 Where deemed necessary each shipping section shall be furnished with removable steel angles.

4.8 The requirements of above items shall not relieve the supplier of any of his responsibilities and his obligations for delivery of equipment in a sound undamaged and operable conditions at site.

4.9 Identification for Shipment

The marking and labels of products should be legible durable and in accordance to specification.

Identification should remain intact from the time of initial despatch at work to the final destination.

Marking shall be adequate for identifying a particular equipment in the event that a recall or inspection becomes necessary.

ATTACHMENT 5
SHIPMENT

5.1 According to manufacturer standard practice the current limiting reactor and all associated equipment shall be prepared for transportation for road, or sea shipment.

5.2 The reactor package shall be provided with a permanently attached readily visible identification tag(S) bearing the equipment number of the reactor(s) to which it belongs.

5.3 The greatest care must be taken to ensure that shipping and associated documents with exact description for custom release are accompanied with the shipment.

ATTACHMENT 6
GUARANTEE

6.1 Clearance of Defects

The supplier shall guarantee his equipment during commissioning and for one year operation starting from the completion of seven days continuous service test in site at full load against the following defects:

- All operational defects .
- All material defects.
- All constructional and design defects.

6.2 Replacement of Defective Parts

All defective parts shall be replaced by the supplier in the shortest possible time free of charge including dismanteling reassembling at site and all transportation cost. The above mentioned period shall not however be longer than 18 months from the date of dispatch from the manufacturer's works.

6.3 Supply of Spare Parts

Furthermore the supplier shall guarantee the provision of spare parts to the purchaser for a minimum period of ----- years from the date of despatch.

6.4 After Sale Technical Services

6.4.1 Commissioning

6.4.1.1 The supplier shall quote if required for the services of competent engineer(s) and or technician(s) to assist in installation commissioning and testing of the equipment at site on a per diem basis.

6.4.1.2 The quoted rates shall be irrespective of duration and frequency and the supplier shall guarantee the services of the engineer(s) and technician(s) on the specified date within a minimum of ----- weeks advance notice by the purchaser.

6.4.2 Training

6.4.2.1 The purchaser may require the supplier to arrange for training of his personnel in the manufacturing plant and or in site for the operation and maintenance of the equipment offered.

6.4.2.2 The supplier shall quote (if required) for the cost of any of above mentioned services on a per person per diem basis. The program for the training shall be prepared by mutual agreement. An advance notice of ----- weeks minimum, is required by purchaser for the commencement of training program.

Note:

Blanks to be filled by client.

ATTACHMENT 7
SPARE PARTS

7.1 All spare parts shall comply with the same standards, specification and tests of the original equipment and shall be fully interchangeable with the original parts without any modification at site.

7.2 They shall be correctly marked in accordance with client reference and manufacturer part numbers, giving also the purchaser's order number.

7.3 Spare parts shall be preserved to prevent deterioration during shipment and storage in humid tropical climate.

7.4 List of recommended spare parts and interchangeability with spare parts of similar equipment shall be submitted by supplier.

ATTACHMENT 8
LANGUAGE

8.1 All correspondence drawings, documents, certificates, including testing operation and maintenance manuals and spare part lists etc. shall be in English.

8.2 Offers in other languages will not be considered.

ATTACHMENT 9
COORDINATION RESPONSIBILITY WITH OTHERS

9.1 In case the equipment ordered should be mounted on, aligned, connected, adjusted, or tested with the equipment of other manufacturer(s) the supplier shall contact directly the said manufacturer(s) and supply and obtain all dimensional and technical informations and arrange for any interconnecting equipment and combined test that may be required.

9.2 The supplier shall be responsible for correct and timely communication with the said manufacturer(s) and for any delay and/or cost claims arising from such communications.

9.3 Copies of all correspondence should be sent to purchaser.

9.4 The name and address of the manufacturer(s) will be given as soon as their orders have been confirmed.

ATTACHMENT 10
GENERAL CONDITIONS OF PURCHASE

This document will be submitted by purchaser at the time of ordering.

ATTACHMENT 11
SAMPLE OF PURCHASER'S DRAWING TITLE BLOCK

DRAWING NO.	DESCRIPTION

REFERENCE DRAWINGS

D					
C					
B					
A					
REV	DATE	DESCRIPTION	REF	CHK	APP

THE NAME

OF

RELEVANT COMPANY

DRAWING TITLE :

DRN. BY	SCALE	MICRO FILM CODE	PROJECT NO.	CHK. BY	APP. BY

JOB NO.	AREA CODE	DWG. NO.	SHEET	REV.

Note:

Appropriate Nomenclature and Registered mark shall be used for quotation and order.

ATTACHMENT 12
INSTRUCTIONS OF PURCHASER ABOUT DRAWINGS

12.1 Purchaser's drawing title block, "the sample of which is given in Attachment 11 shall be shown in the right lower corner of the drawings.

12.2 Drawings are to be protected and packed. Negatives must be dispatched in a strong card board cylinder.

12.3 Drawings must be rolled and not folded.

12.4 All drawings, documents and literatures shall be forwarded under cover of a fully detailed letter to purchaser whose addresses given in Attachment No.14.

Note:

Blank to be filled by client.

ATTACHMENT 13
MATERIAL, LAYOUT AND LETTERING OF LABELS
(NOT APPLICABLE)

Label material to be "Traffolite" 5 mm. Thick having two outer layers letter to be engraved into the white layer to give black lettering on a white background.

LETTER TYPE

TYPE	HEIGHT	WIDTH mm	STROKE	CASE		LETTERS / 25 mm	SAMPLE
A	5	WIDE	LIGHT	UPPER	CASE	7½ ± 1.2mm. TOL	ABCDEFGHIJKLM
B	5	WIDE	HEAVY	"	"	7½ ± 1.2mm. TOL	
C	5	NARROW	LIGHT	"	"	11 ± 1.2mm. TOL	
D	5	NARROW	HEAVY	"	"	11 ± 1.2mm. TOL	
E	3	WIDE	LIGHT	"	"	10 ± 1.2mm. TOL	
F	3	WIDE	HEAVY	"	"	10 ± 1.2mm. TOL	
G	3	NARROW	LIGHT	"	"	15 ± 1.2mm. TOL	
H	10	WIDE	HEAVY	"	"	3½	
J	12	WIDE	HEAVY	"	"	2½	

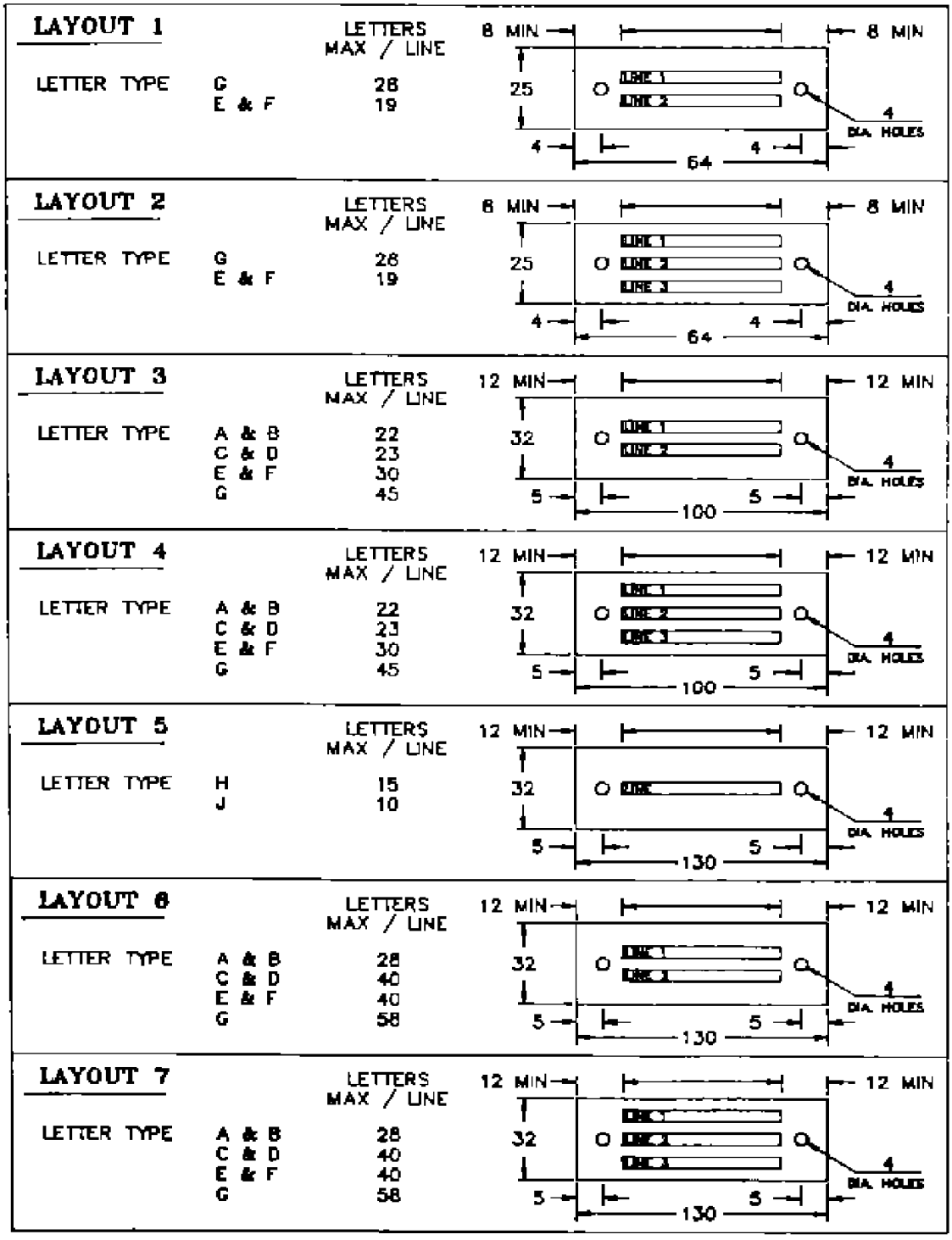
Note:

Height is in millimeters.

(to be continued)

ATTACHMENT 13 (Continued)

LAYOUTS
(NOT APPLICABLE)



All dimensions are given in mm.

min ≡ minimum

ATTACHMENT 14
FULL ADDRESS OF PURCHASER

.....

.....

.....

.....

P.O.BOX No. ..... CODE No. .....

TELEPHONE No. .....

TELEX No. .....

FACSIMILE No.....

Note:

The blanks to be filled by client.