

MATERIAL AND EQUIPMENT STANDARD**FOR****CURRENT LIMITING REACTORS****ORIGINAL EDITION****MAY 1993**

This standard specification is reviewed and updated by the relevant technical committee on July 2012. The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the "Company" rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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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.

Further more the I_S -Limiter could be studied and used in parallel or individually for connation of new and existing electric systems.

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.

In special cases the reactor could be used for starting of inertia electric motors.

Note:

This standard specification is reviewed and updated by the relevant technical committee on July 2012. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No 347 on July 2012. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 60027	"Letters, Symbols to be used in Electrical Technology"
IEC 60060	"High Voltage Test Techniques"
IEC 60060-1 Part 1	"General Definitions and Test Requirements"
IEC 60060-2 Part 2	"Test Procedures"
IEC 60060-3 Part 3	"Measuring Devices"
IEC 60076	"Power Transformers"
IEC 60076-1 Part 1	"General"
IEC 60076-2 Part 2	"Temperature Rise"
IEC 60076-3 Part 3	"Insulation Levels and Dielectric Tests"
IEC 60076-4 Part 4	"Tapping and Connections"
IEC 60076-5 Part 5	"Ability to withstand Short Circuit"
IEC 60137	"Bushings for Alternative Voltages above 1000 V"
IEC 60289	"Reactors"
IEC 60391	"Marking of Insulated Conductors"
IEC 60445	"Identification of Equipment Terminals and of Terminations of Certain Designated Conductors Including General Rules of an Alphanumeric System"
IEC 60446	"Identification of Insulated and Bare Conductors by Colors"

IEC 60529	"Classification of Degree of Protection Provided by Enclosure"
IEC 60551	"Determination of Transformer and Reactor Sound Levels"
IEC 60617	"Graphical symbols for Diagram"
IEC 60722	"Guide to the Lightning Impulse and Switching Impulse Testing of Power Transformer, and Reactors"
IEC 60726	"Dry Type Power Transformer"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI C57	"USA Standard Requirements, Terminology and Test Code for Current Limiting Reactors"
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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).
- Or other Testing authorities Company Engineering approval.

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:

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 60137 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 60137. For a heavily polluted atmosphere under the service condition stated in Appendix A 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. 60726 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 60076.5.

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 reactance.
- Outdoor/indoor application.
- Manufacturer's name.
- Manufacturer's serial 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.
- Reactance (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 reactance).
- Details regarding tapping if any.

6. INSPECTION, QUALITY CONTROL AND QUALITY RECORD

6.1 The equipment under this specification shall be factory tested. Certified copies of test reports and/or certificates shall be submitted to the purchaser.

The purchaser in the purchase order will specify the numbers of certified copies required.

6.2 Routine tests shall be performed on all completed reactors as detailed in IEC 60076-1 and the relevant IEC publications referred to therein.

6.3 Type tests and special tests, if requested, shall be performed on selected reactors according to the recommendations of IEC 60076-1. The results of such tests on identical reactors are acceptable.

6.4 The purchaser's inspectors shall be granted the right for inspection at any stage of manufacture

and testing.

6.5 Purchaser will require the presence of his nominated representative to witness the final inspection and tests. The supplier shall inform the date of such tests at least four weeks in advance.

7. TESTS AND CERTIFICATION

7.1 General Requirements for Tests

See Attachment 2.

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 60076-2
"Lightning Impulse Test	IEC 60076-3 IEC 60722

7.2.2 Routine tests

"Measurement of Winding Resistance"	IEC 60076-1 Sub-clause 8.2
"Measurement of the Impedance at Continuous Current"	IEC 60289 Sub-clause 17.5
"Measurement of Loss if applicable"	IEC 60289 Sub-clause 17.6
"Separate Source Withstand Test"	IEC 60076-3 Sub-clause 10
"Induced Over voltage Withstand Test"	IEC 60076-3 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 60076.5
"Measurement of Acoustic Sound Level"	IEC 60551

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 admiralty 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 3.

12. SHIPMENT

For general requirement for shipment see Attachment 4.

13. GUARANTEE

See Attachment 5.

14. SPARE PARTS

14.1 Together with the supply of reactor under this specification, a complete set of spare parts for commissioning and special tools if required, shall be supplied for each reactor. The supplied spare parts shall comply with the same specifications as the original parts and shall be interchangeable with the original parts without any modification. Spare parts shall be preserved, to prevent deterioration during transport and storage in a humid tropical atmosphere.

14.2 The vendor shall also supply a list of recommended spare parts for two years of operation.

14.3 List of recommended spare parts and interchangeability with spare parts of similar equipment shall be submitted by supplier. SPIR (Spare Part and Interchange ability Record) form shall be completed by vendor.

15. DOCUMENTATION

15.1 The vendor shall supply the necessary information with the quotation to enable evaluation of the submitted proposal. General documents/drawings are not acceptable unless they are revised to show the equipment proposed.

The documents to be supplied with the quotation shall at least include the following:

- a) Completed enquiry data sheet/s.
- b) Summary of exceptions/deviations to this standard specification.
- c) Brochures and catalogues containing description of typical reactors.
- d) Preliminary dimensional drawings.
- e) Approximate shipping weights and sizes.

15.2 The documents which shall be supplied at ordering stage shall at least include the following:

- a) Updated and completed enquiry data sheet/s.
- b) Drawings showing main dimensions, arrangement of components and cable termination methods.
- c) Wiring diagrams of all accessories, or devices.
- d) List of components or accessories, showing complete reordering information for replaceable parts.
- e) Installation, operation and maintenance instruction/s.
- f) Recommended spare parts list for two years of operation.
- g) Test reports and/or certificates for routine tests, type tests and special tests.

16. LANGUAGE

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

16.2 Offers in other languages will not be considered.

17. COORDINATION RESPONSIBILITY WITH OTHERS

17.1 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.

17.2 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.

17.3 Copies of all correspondence should be sent to purchaser.

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

APPENDICES

APPENDIX A

EXAMPLE OF TYPICAL DATA SHEET FOR REACTOR

Project Name:

.....

Area Classification*:

.....

Location:

In-Door..... Outdoor

Detail of Reactor:

.....

No. of Phases:

VoltageFrequency.....

Impedance Rating of each Phase:

Continuous Current Rating:

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

Type of Cooling: AN AF

Insulation Level:

.....

Detail of Taps:

.....

Type of Enclosure: Sealed Type Flanged Type

Temperature Indicator: Required not required

Ingress Protection:

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

*Installation in hazardous area isn't recommended, except in special case which shall be approved by Company Representative (only zone 2 is acceptable).

Other Protection:

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 AFTER ORDER	NUMBER OF WEEKS BEFORE DELIVERY
		NO. OF COPIES			
		ELECTRONIC FILE	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: saliferous, dusty corrosive and subject to dust storms with concentration of 70 - 1412 mg/cubic meter, H₂S may be present, unless otherwise specified in data sheet.

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

1.7 Maximum intensity of earthquake zone -----

Note:

Blanks to be filled by client.

**ATTACHMENT 2
TESTS AND CERTIFICATION**

2.1 General Requirements

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

2.1.2 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.

2.1.3 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.

2.1.4 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.

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

2.1.6 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 3**PACKING**

3.1 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.

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

3.3 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.

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

3.5 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.

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

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

3.8 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.

3.9 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 4
SHIPMENT**

- 4.1** According to manufacturer standard practice the current limiting reactor and all associated equipment shall be prepared for transportation for road, or sea shipment.
- 4.2** 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.
- 4.3** 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 5
GUARANTEE****5.1 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.

5.2 Replacement of Defective Parts

All defective parts shall be replaced by the supplier in the shortest possible time free of charge including dismantling 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.

5.3 Supply of Spare Parts

Furthermore the supplier shall guarantee the provision of spare parts to the purchaser for a minimum period of 10 years from the date of despatch.

5.4 After Sale Technical Services**5.4.1 Commissioning**

5.4.1.1 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.

5.4.1.2 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.

5.4.2 Training

5.4.2.1 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.

5.4.2.2 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.