



Ergon Energy Corporation Limited

Technical Specification for Pole Mounting Shunt Reactors

ETS02-01-02

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1. Purpose and Scope

This specification sets out requirements for the design, manufacture, testing at works and delivery of pole mounting shunt reactors for use on the Purchasers 12.7kV and 19.1kV single wire earth return distribution networks for reactive power compensation. The items covered by this specification are as follows:

Item No	Description	IINo
1	REACTOR, 12.7kV 25kVAr Single Phase Shunt, Pole Mounting	0854046
2	REACTOR, 19.1kV 25kVAr Single Phase Shunt, Pole Mounting	0854046
3	REACTOR, 19.1kV 50kVAr Single Phase Shunt, Pole Mounting	2405425

2. References

2.1 Applicable Standards

Reactors shall be designed, manufactured and tested in accordance with the following Australian Standards and all amendments issued prior to the date of closing of tenders except where varied by this Specification.

Standard	Title
AS 1028	Power reactors and earthing transformers
AS/NZS 1194	Winding Wires
AS 1627	Metal Finishing - Preparation and Pretreatment of Surfaces
AS/NZS 60137	Bushings for alternating voltages above 1000 V
AS 1580	Paints and related materials – Methods of test
AS 1767	Insulating oil for transformers and switchgear
AS 1824	Insulation co-ordination
AS 2312	Guide to protection of iron and steel against exterior atmospheric corrosion
AS 2374	Power Transformers
AS 2558	Transformers for use on single wire earth return distribution systems
AS 2700	Colours for specific purposes
AS/NZS3750	Paints for steel structures
AS 4360	Risk Management
AS 4680	Hot-dipped galvanised (zinc) coatings on fabricated ferrous articles.
AS/NZS ISO 9001	Quality management systems - Requirements

Should inconsistencies be identified between Standards and/or this specification, the Tenderer/Supplier shall immediately refer such inconsistencies to the Purchaser for resolution.

3. Drawings

3.1 Drawings by the Purchaser

There are no drawings attached to this specification.

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3.2 Drawings by the Tenderer

The tenderer shall submit with the tender full details of the dimensions of the reactor including typical general arrangement drawings. The successful Tenderers shall submit detailed drawings in accordance with the relevant clauses of this specification.

4. Service Conditions

4.1 Environmental Conditions

The shall be suitable for mounting outdoors on poles and shall be designed to comply with AS 1170 (Part 2), SAA Loading Code Part 2 - Wind Forces and to withstand the service conditions of Clause 1.2 of AS 2374 (Part 1) with the following additions:

Solar Radiation Level:	1 100 W/m ² with high ultra violet content
Precipitation:	Tropical summer storms with high winds, and an annual rainfall in excess of 1 500 mm.
Humidity:	Extended periods of relative humidity in excess of 90%
Pollution:	Areas of coastal salt spray and industrial pollution with equivalent salt deposit densities in the range 2.0 to 3.0 g/m ² .
Wind Velocity:	210 km/hr

4.2 System Conditions

Each unit shall be suitable for use under the following system conditions.

Nominal System Voltage	(kV)	12.7	19.1
Number of phases		SWER	
Impulse Withstand Voltage	(kV peak)	150	200
Power Frequency Withstand Voltage		50	
Highest System Voltage	(kV)	14.6	22.0
System Earthing		Effectively earthed	

4.3 Mounting

Each reactor shall be suitable for mounting on a vertical pole.

5. Design and Construction

5.1 General

The reactors shall comply with all relevant Australian Standards, except where otherwise specified herein. In particular, AS 1028 Power reactors and earthing transformers, shall apply.

5.2 Rating

The ratings shall be as specified in the item descriptions in Clause 1. These ratings refer to continuous duty of the reactors.

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5.3 Insulation Level

The equipment shall have the following insulation withstand levels:

Rated Voltage	Units	12.7kV	19.1 kV
Impulse Withstand Level	kV _{peak}	150	200
Power Frequency Withstand Voltage	KV _{rms}	50	70

5.4 Tank and Covers

The tanks shall be suitable for out door operation under the conditions specified in Clause 4, and shall be sufficiently rigid to withstand any stress to which they may be subjected to during service, maintenance or transport.

The tank covers shall be appropriately shaped to prevent accumulation of moisture. All metal work shall be electrically bonded to the tank to permit earthing by the purchaser.

5.5 Sealing

The reactors shall be completely sealed so that there is no contact between the outside atmosphere and the oil in the tank. All joints shall be oil tight. Gasket shall be manufactured from materials resistant to corona discharges and transformer oil. Gaskets exposed to UV radiation shall be UV stabilised.

5.6 Core and Windings

The core and windings shall be suitably supported and mechanically braced to prevent distortion and to withstand mechanical shocks that may occur under working conditions.

The core shall be readily removable from the tank for inspection and maintenance.

The core shall be designed to limit the generation of harmonics and consideration should be given to the use of air gaps in the magnetic circuit to achieve the required ratings.

Full specifications for the core and the windings shall be submitted with the tender.

5.7 Bushings

Bushings shall be outdoor type and shall comply with the relevant requirements of AS//NZS 60137.

The HV bushings shall suit the insulation requirements under Clause 5.3.

The reactor shall operate with one end of the high voltage winding connected to earth and the other to the SWER line.

The end of the winding to be earthed shall be brought of the tank to an earth return (ER) terminal through an ESAA type 100 ampere LV transformer bushing. A copper earth strap of section 20mm x 1.5 mm or equivalent shall be provided and connected between the ER terminal and the reactor tank.

Each terminal palm on the bushings shall be provided with a 13mm hole.

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The taught string metal to metal clearances of bushings and surge arrester terminals (when mounted on the surge arrester bracket - refer clause 5.9.4 below) shall not be less than the values below:

Nominal system voltage to Earth (kV)	HV Terminal		ER Terminal
	12.7	19.1	
Clearance phase ground	280	380	60

The orientation of the bushings on the tank shall comply with fig B2 of AS 2558. All bushings shall be glazed in a Munsell grey colour.

5.8 Insulating Oil

The method of cooling of the reactors shall be ONAN.

The reactors shall be thoroughly dried out at the manufacturer's works and shall be delivered with oil filled to the normal level, and ready for service. The oil shall be mineral insulating oil meeting the requirements of AS 1767 and shall be certified to contain less than 1 ppm of PCB. The normal oil level shall be indicated inside the reactor tank by a horizontal band 50mm long stencilled in a contrasting colour.

5.9 Fittings

The reactors shall be supplied with fittings as detailed below:

5.9.1 Handling provisions

The reactors shall be provided with lifting lugs suitable for slinging of reactor complete with oil.

Provision shall be made for lifting of all parts which need to be removed for inspection and repair.

5.9.2 Earthing Terminal

A 12mm stud complete with stainless steel nut and spring washer shall be provided near the bottom of the reactor tank in an accessible position vertically below the ER bushing.

5.9.3 Rating and Connection Plate

Each reactor shall be provided with a rating plate in accordance with the requirements specified in Clauses 7 and 7.1 of AS 1028. The following additional information shall also be provided on the rating plate:

- Contract Number
- Purchaser's Item Identification Number
- Purchaser's Specific Plant Number – The Specific Plant Number (SPN) will be nominated in the purchase orders to the successful Tenderer and it will be an eight digit number prefixed by two alphas (e.g. RX 12345678 for the reactors).

5.9.4 Surge Arrester Bracket

A bracket for the mounting of a HV surge arrester shall be provided on the reactor tank. The bracket shall be designed so as to provide a minimum separation of 100mm between the HV bushing sheds and the surge arrester housing. The bracket shall have an unpainted corrosion resistance metal connecting zone which has the capability of conducting the surge arrester current.

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5.10 Mounting Arrangement

The reactor shall be fitted with a single pole mounting bracket in accordance with Figure B1 of AS 2558. Both the top and bottom bracket shall be suitable to carry the total weight of the reactor individually.

5.11 Tank Markings

The capacity of the reactor shall be stencilled in black numerals onto the tank where it can be easily seen from the ground with the reactor mounted on the pole. Each numeral shall be 75mm high and have a body width not less than 12mm. Additionally, the Purchaser's Item Identification Number and the Specific Plant Number shall be stencilled in a similar manner. The specific plant number will be nominated in the purchase orders to the successful Tenderer.

5.12 Protective Coating

All internal and external surfaces shall be protected against corrosion to guarantee a service life of 35 year under the environmental conditions defined in Clause 4 of this specification. The final colour except when surface is galvanised and unpainted shall be storm grey, N42 to AS2700.

5.13 Comparison of Tenders

Tenders for technically conforming offers will be compared on the basis of total annual charges, calculated as follows:

$$\text{Total Annual Charges} = 10\% \text{ of tender price} + \text{total losses in kW} \\ \times \$6300$$

6. Performance and Testing

6.1 Routine Tests

The following routine and special tests as specified in AS1028 shall be carried out on each reactor:

- a) Measurement of winding resistance
- b) Measurement of reactance
- c) Measurement of loss
- d) Dielectric tests

6.2 Type Tests

The following type tests as specified in AS 1028 shall be carried out on each design.

- a) Temperature rise test
- b) Dielectric test

6.3 Witnessing of Tests

The purchase reserves the right to witness the routine tests. The supplier shall give the Purchaser not less than two weeks notice of when these tests will be carried out.

6.4 Test Certificates

Copies of type tests if available shall be submitted with the offer.

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One copy of the routine test results shall accompany each reactor delivered to the Purchaser. The other copy shall be forwarded by electronic mail to inventory.nameplatedata@ergon.com.au, along with the completed Attachment "E" returned as a MS excel document.

All test certificates shall state the manufacturer's serial number, the corresponding Purchaser's structured plant number, the order number, contract number, item number and guaranteed losses.

7. Risk Assessment

The Tenderer warrants (without limiting any other warranties or conditions implied by law) that all Goods have been produced, sold and delivered to the Principal in compliance with all applicable laws (including all workplace health and safety and electrical safety legislation, codes of conduct and the Principal's Workplace Health & Safety and Electrical Safety Conditions).

Tendered items shall be subjected to a formal risk assessment prior to acceptance. It is preferred that the tenderer performs the risk assessment themselves and provides the resultant documentation with their tender. Where risk assessment documentation is not provided with the tender, or does not meet the required standard, such tenders shall have their price loaded with the estimated costs associated with the purchaser conducting the assessments. Any documented risk assessment which accompanies the tender must meet the requirements of AS/NZS 4360 Risk Management, as a minimum standard. It is preferred that the risk assessment methodology uses an energy model to identify hazards. The risk assessment(s) must identify hazards to the corporation personnel, public and property associated with:

- The installation of the equipment
- The operation and maintenance of the equipment during life expectancy
- Dismantling/disposal of equipment at end of life
- The "Risk Assessment" schedule included with this specification is to be completed by the Tenderer. Note the schedule contains a generic set of questions designed to cover all the purchaser's plant and materials and the tenderer is only required to complete those items applicable to the product offered.

8. Quality Assurance

8.1 Purchasers Policy

It is the Purchaser's policy to procure goods, equipment and services from sources that demonstrate the ability to supply quality products.

8.2 Documentary Evidence

Tenderers are required to submit evidence that the design and manufacture of the cable is in accordance with AS/NZS ISO 9001 and shall include the Capability Statement associated with the Quality System Certification.

If the Tenderer is a non-manufacturing Tenderer, the documentary evidence shall include the quality system certifications of both the Tenderer and the manufacturer.

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9. Samples

9.1 Production Samples

Samples of typical units may be required during the tender assessment period. Samples would normally only be required from tenderers who have previously not supplied transformers to the Purchaser.

When samples are required, production samples shall be delivered freight free, suitably packaged and labelled including reference to the Contract Number.

The Purchaser may at its discretion either purchase the samples at the tendered price or return the samples to the respective tenderer after the contract has been awarded.

10. Packaging and Marking

10.1 General

Refer Logistics Specification.

11. Service Performance

Refer Logistics Specification.

12. Reliability

12.1 Service Life

Tenderers are required to comment on the reliability and performance of the materials offered for a service life of 35 years under the specified system and environmental conditions.

12.2 Evidence in Support of Reliability

Such comments shall include evidence in support of the reliability and performance claimed including information on Failure Mode and Effect Analysis.

13. Training

13.1 Training Material

The successful Tenderer is required to provide training material in the form of manuals to the Purchaser's requirements.

13.2 Detailed Information

Within ten (10) weeks of placing of the order, the successful tenderer shall supply to the Purchaser two (2) copies of a detailed installation, operation and maintenance manual incorporating the following information:

- A complete winding specification to the satisfaction of the Purchaser which will enable repairs to be carried out.
- A detailed list of all component parts including manufacturers part numbers.
- One copy of each of the drawings called for in Clause 15.4.

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- A detailed maintenance section which is designed to achieve the expected asset life, including reference to:
 - (a) Repair procedures for surface coatings
 - (b) Special precautions during disassembly and reassembly (including bushings)
 - (c) Relevant special requirements for reassembly (e.g. nut/bolt tensions, crimp connections, welding, etc.)
 - (d) Handling
 - (e) Disposal at end of service life.

13.3 Associated Costs

All costs associated with the provision of training shall be accounted for in the tender price for each item.

14. Environmental Considerations

Suppliers are required to comment on the environmental soundness of the design and the materials used in the manufacture of the items offered. In particular, comments should address such issues as recyclability and disposal at end of service life.

15. Information to be Provided

15.1 Specific Technical Requirements

Attachment 1 is a schedule of requirements for each tender item.

Attachment 2 is a schedule of the technical details tenderers are required to complete and return with their tender for all items covered by this specification.

Attachment 3 is a risk assessment schedule. Tenderers are required to complete **Attachment 3** and return it with their tender in accordance with the clause 7 of this specification.

15.2 Checklist of Supporting Documentation

Attachment 4 is a checklist of supporting documentation which is required to be submitted with the offer.

15.3 Documents to be provided during the course of the contract

Within four (4) weeks of the placing of the order, the successful tenderer shall supply three (3) copies of the following:

A dimensioned outline drawing for each rating of reactor with:

- a) Centre-lines and centres of gravity
- b) An electrical clearance table
- c) Overall dimensions
- d) Surge arrester mounting bracket
- e) Rating and terminal marking plate.

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16. Attachment 1 – Technical Details

Ref.	Particulars	Units	Item1	Item2	Item 3
1	Nominal system voltage	kV	12.7	19.1	19.1
2	Highest system voltage	kV	14.6	22.0	22.0
3	frequency	Hz	50		
4	Number of phases		1		
5	System earthing		swr		
6	Cooling		ONAN		
7	Reactor rating	kVAr	25	25	50
8	Impulse withstand	kVp	150	150	200
9	Pf withstand	KV rms	50	50	70
10	Tank type		Sealed , outdoor		
11	Type of mounting		Pole bolts		
12	Type of bushing		ESAA		
13	Finish		Storm grey, N42 to AS2700		
14	Max allowable 3 rd harmonic component of current		3%		

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17. Attachment 2 – Guaranteed Particulars

Ref	Particulars	Units	Response
1	Rated voltage	kV	
2	Continuous kVAr rating at nominal system voltage	kVAr	
3	Continuous kVAr rating at highest system voltage	kVAr	
4	Temperature rise of windings on continuous operation at system voltage	°C	
5	Combined losses at normal voltage @75 deg C	kW	
6	Equivalent resistance of reactor at 75 degC	%	
7	Impedance of reactor	%	
8	kVAr base for 6 and 7 above	kVAr	
9	Impulse withstand level of windings	kVp	
10.1	Max. harmonic content of rated current as a % of rated current (a) 3 rd harmonic	%	
10.2	(b) 5 th harmonic	%	
10.3	© 7 th harmonic	%	
11	Maker's name		
12	Place of manufacture		
13	Applicable Australian Standard		
14	Type of reactor		
15	Type of core insulation		
16	Type of core material		
17	Type of tank		
18	Winding conductor and type		
19.1	ESAA Bushing type - HV		
19.2	- ER		
20	Make of bushings		
21	Max internal pressure	MPa	
22	Quantity of oil required for each unit at 20 °C	litres	
23.1	Manufacturer of oil		
23.2	Grade of oil	Standard	
24.1	Weight of core and coils	kg	
24.2	Weight oil	kg	
24.3	Total weight	kg	
25	Current density in windings	A/mm ²	
26	Overall dimensions - Height	mm	
	- Width	mm	
	- Depth	mm	

NAME OF TENDERER: _____

ADDRESS OF TENDERER: _____

SIGNATURE: _____ FOR AND ON BEHALF OF TENDERER

DATE: _____

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18. Attachment 2 – Guaranteed Particulars

Ref	Particulars	Units	Response
1	Rated voltage	kV	
2	Continuous kVAr rating at nominal system voltage	kVAr	
3	Continuous kVAr rating at highest system voltage	kVAr	
4	Temperature rise of windings on continuous operation at system voltage	°C	
5	Combined losses at normal voltage @75 deg C	kW	
6	Equivalent resistance of reactor at 75 degC	%	
7	Impedance of reactor	%	
8	kVAr base for 6 and 7 above	kVAr	
9	Impulse withstand level of windings	kVp	
10.1	Max. harmonic content of rated current as a % of rated current (a) 3 rd harmonic	%	
10.2	(b) 5 th harmonic	%	
10.3	(c) 7 th harmonic	%	
11	Maker's name		
12	Place of manufacture		
13	Applicable Australian Standard		
14	Type of reactor		
15	Type of core insulation		
16	Type of core material		
17	Type of tank		
18	Winding conductor and type		
19.1	ESAA Bushing type - HV		
19.2	- ER		
20	Make of bushings		
21	Max internal pressure	MPa	
22	Quantity of oil required for each unit at 20 °C	litres	
23.1	Manufacturer of oil		
23.2	Grade of oil		
24.1	Weight of core and coils	kg	
24.2	Weight oil	kg	
24.3	Total weight	kg	
25	Current density in windings	A/mm ²	
26	Overall dimensions - Height	mm	
	- Width	mm	
	- Depth	mm	

NAME OF TENDERER: _____

ADDRESS OF TENDERER: _____

SIGNATURE: _____ FOR AND ON BEHALF OF TENDERER

DATE: _____

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19. Attachment 2 – Guaranteed Particulars

Ref	Particulars	Units	Response
1	Rated voltage	kV	
2	Continuous kVAr rating at nominal system voltage	kVAr	
3	Continuous kVAr rating at highest system voltage	kVAr	
4	Temperature rise of windings on continuous operation at system voltage	°C	
5	Combined losses at normal voltage @75 deg C	kW	
6	Equivalent resistance of reactor at 75 degC	%	
7	Impedance of reactor	%	
8	kVAr base for 6 and 7 above	kVAr	
9	Impulse withstand level of windings	kVp	
10.1	Max. harmonic content of rated current as a % of rated current (a) 3 rd harmonic	%	
10.2	(b) 5 th harmonic	%	
10.3	(c) 7 th harmonic	%	
11	Maker's name		_____
12	Place of manufacture		
13	Applicable Australian Standard		
14	Type of reactor		
15	Type of core insulation		
16	Type of core material		
17	Type of tank		
18	Winding conductor and type		
19.1	ESAA Bushing type - HV		
19.2	- ER		
20	Make of bushings		
21	Max internal pressure	MPa	
22	Quantity of oil required for each unit at 20 °C	litres	
23.1	Manufacturer of oil		
23.2	Grade of oil		
24.1	Weight of core and coils	kg	
24.2	Weight oil	kg	
24.3	Total weight	kg	
25	Current density in windings	A/mm ²	
26	Overall dimensions - Height	mm	
	- Width	mm	
	- Depth	mm	

NAME OF TENDERER:

ADDRESS OF TENDERER: _____

SIGNATURE: _____ FOR AND ON BEHALF OF TENDERER

DATE: _____

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20. Attachment 3 – Risk Assessment

The Tenderer shall complete the relevant items (as applicable):

REF.	PARTICULARS	RESPONSE
1.	Have Risk Assessments been carried out on equipment tendered which meet the requirements of AS/NZS 4360 (Yes/No)	
2.	Have copies of such risk assessments been included with the tender (Yes/No)	
3.	What is the weight of the components to be moved (for example - cable box covers/drawout circuit breaker trucks)?	
4.	How often do the components have to be moved?	
5.	Are space restrictions associated with:	
5.1	Manual/materials handling tasks	
5.2	Installation/maintenance	
5.3	Operating procedures?	
6.	Is there provision for the use of mechanical lifting devices?	
7.	Is the load stable?	
8.	What is the level of coupling? (poor/fair/good) (eg. are operating handles fitted with grips)	
9.	What are the push/pull/rotational forces required to operate the equipment:	
9.1	When new?	
9.2	During life expectancy?	
10.	Do "above ground" work surfaces have adequate fall protection (eg. slip resistant surface, hand rails)?	
11.	Do the work positions require undesirable postures such as:	
11.1	Bending	
11.2	Stretching	
11.3	Twisting	
12.	What postures are required to be sustained over what period of time?	
13.	What movements are repetitive and for what duration?	
14.	What are the sound pressure levels (expressed in dB(A))?	
15.	What hazardous substances are used/produced (including after failure) such as:	
15.1	Dust	
15.2	Gas	

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21. Attachment 3 – Risk Assessment...(Cont'd)

REF.	PARTICULARS	RESPONSE
15.4	Emissions	
15.5	Mist	
15.6	Liquid	
15.7	Solids	
16.	Are the hazardous substances controls compatible with normal operational requirements?	
17.	Is a Safety Data Sheet for all hazardous substances provided?	
18.	What are the expected hazardous changes/by-products associated with the deterioration of a substance?	
19.	Is there any possible contact with energised components?	
20.	What are the levels of radiation emitted?	
21.	When in service, are any normally accessible areas hot/cold enough to be a hazard?	
22.	Are there any biological hazards?	
23.	Are there any mechanical hazards (eg. nip in points, exposed moving components)?	
24.	Are mechanical hazards appropriately controlled (eg. guarding, lock-outs)?	
25.	Are load limits established and clearly identified?	
26.	Are gauges clearly visible and easily interpreted?	
27.	Are control movements consistent with established Australian conventions (eg. switch "UP" position is "OFF")?	
28.	What is the degree of whole body or hand/arm vibration? (Hz)	
29.	Are projectiles generated?	
30.	Are special tools required/identified/supplied?	
31.	What are the hazards associated with equipment failure?	

NAME OF TENDERER:

ADDRESS OF TENDERER: _____

SIGNATURE: _____ FOR AND ON BEHALF OF TENDERER

DATE: _____

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22. Attachment 4 – Technical Document Checklists

This schedule details parameters referred to within the body of the specification for which a response by the supplier is required. Has the following information been included in the Tender documentation?

PARTICULARS	CLAUSE	ANSWER (Yes/No)
General arrangement drawings of reactors	3.2	
Specifications for core and winding	5.6	
Type test certificates	6.4	
Risk assessment	7 & Attachment 3	
QA certification of Manufacturer/Supplier including Capability Statements	8.2	
Comments on reliability	12	
Availability of training material	13	
Technical details	Attachment 2	

NAME OF TENDERER:

ADDRESS OF TENDERER: _____

SIGNATURE: _____ FOR AND ON BEHALF OF TENDERER

DATE: _____

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23. Attachment 5 – Rating Plate Details

CONTRACT NUMBER				
Ergon Energy Structured Plant Number (Available from Purchase Order):				
MAKE-TX	MANUFACTURER			
MASS-TOTAL	TOTAL WEIGHT (KG)			
REACTOR-TYPE	TYPE OF REACTOR			
SERIAL_NUMBER	SERIAL NUMBER			
TX-IRON-LOSS	TX IRON LOSSES (KW)			
TX-RATING-1	1ST RATING OF TX (KVA_r)			
TX-REACTANCE	TX REACTANCE (%)			
VOLT-PRI-KV	PRIMARY VOLTAGE (KV)			
YOM	YEAR OF MANUFACTURE			