USAID / SOUTH ASIA REGIONAL INITIATIVE FOR ENERGY (SARI/ENERGY)

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Ahmedabad, Gujarat, India

CAPACITY BUILDING PROGRAM ON TRANSFORMERS FOR AFGHANISTAN TECHNICIANS

USAID
FROM THE AMERICAN PEOPLE

SARI / Energy

FUNDAMENTALS OF TRANSFORMERS

PRESENTED

BY

PROF. V. G. PATEL

- Invention of transformer and general information about transformer.
- Usefulness and significance of transformer.
- Important aspects of transformer manufacturing.
- Specification of distribution transformers & 33/11 KV Power Transformers.

1. A person or thing that transforms.

2. A device, with no moving parts, which transfers an alternating current (AC) from one circuit (called the *primary winding*) to one or more other circuits (*secondary winding*) by electromagnetic induction, usually with a change in voltage. There is no electrical connection between two circuits.

3. An induction apparatus for changing electrical energy at one voltage and current to electrical energy at another voltage and current, through the medium of magnetic energy, without mechanical motion.

4. A device with two or more coupled windings, used to convert a supply of electric power at one voltage to (usually) another voltage.

5. A device used to transfer electric energy from one circuit to another, especially a pair of multiply wound, inductively coupled wire coils that affect such a transfer with a change in voltage, current, phase, or other electric characteristic.

   The primary and secondary impedances are in the same ratio as the squares of the numbers of turns in the primary and secondary coils.

6. An electric device consisting essentially of two or more windings wound on the same core, which by electromagnetic induction (with an alternating current), transforms electric energy from one set of one or more circuits to another set of one or more circuits such that the frequency of the energy remains unchanged while the voltage and current usually change.

7. The transformer may be defined as static piece of electrical apparatus which converts electrical power from one circuit to the other circuits of the same frequency. It can increase or decrease the voltage with correspon- ding decrease or increase of currents keeping the power same. This transfor- mation of energy is done due to the Faraday's laws of Electromagnetic induction through two winding, Primary and Secondary.

8. Transformers consist of two or more coils of conducting material, such as wire, wrapped around a core (often made of iron). The magnetic field produced by an alternating current in one coil induces a similar current in the other coils. If there are fewer turns on the coil that carries the source of the power than there are on a second coil, the second coil will provide the same power but at higher higher voltage. This is called a step-up transformer. If there are fewer turns on the second coil than on the source coil, the out - going power will have a lower voltage. This is called a step-down transformer.

SUMMARIZING

Transformer is static electrical equipment which transforms A.C. electrical power from (usually) one voltage to another voltage at the same frequency by induction.

From this definition

- Transformers are static equipment and do not have ‘rotor’.
- They transform electrical power from one circuit to another circuit at the same frequency but (usually) at different voltage.
- They operate on the principle of electro-magnetic induction.
- They operate only with alternating current. They do not function with DC supply.

INVENTION

OF

TRANSFORMER

Michael Faraday

built the first transformer in 1831, with single solid iron core device. He used it only to demonstrate the principle of electromagnetic induction and did not foresee its practical uses.

Lucien Gaulard

and

John Gibbs,

who first exhibited a device called a 'secondary generator' in London in

1881

and then sold the idea to American company

Westinghouse.

Russian engineer Pavel Yablochkov

in 1883 invented a lighting system based on a set of induction coils, where primary windings were connected to a source of alternating current and secondary windings were connected to several

"electric candles".
First single phase transformer
15 kVA 1500/300 V made by
Ganz Budapest in 1883
He first used the term TRANSFORMER

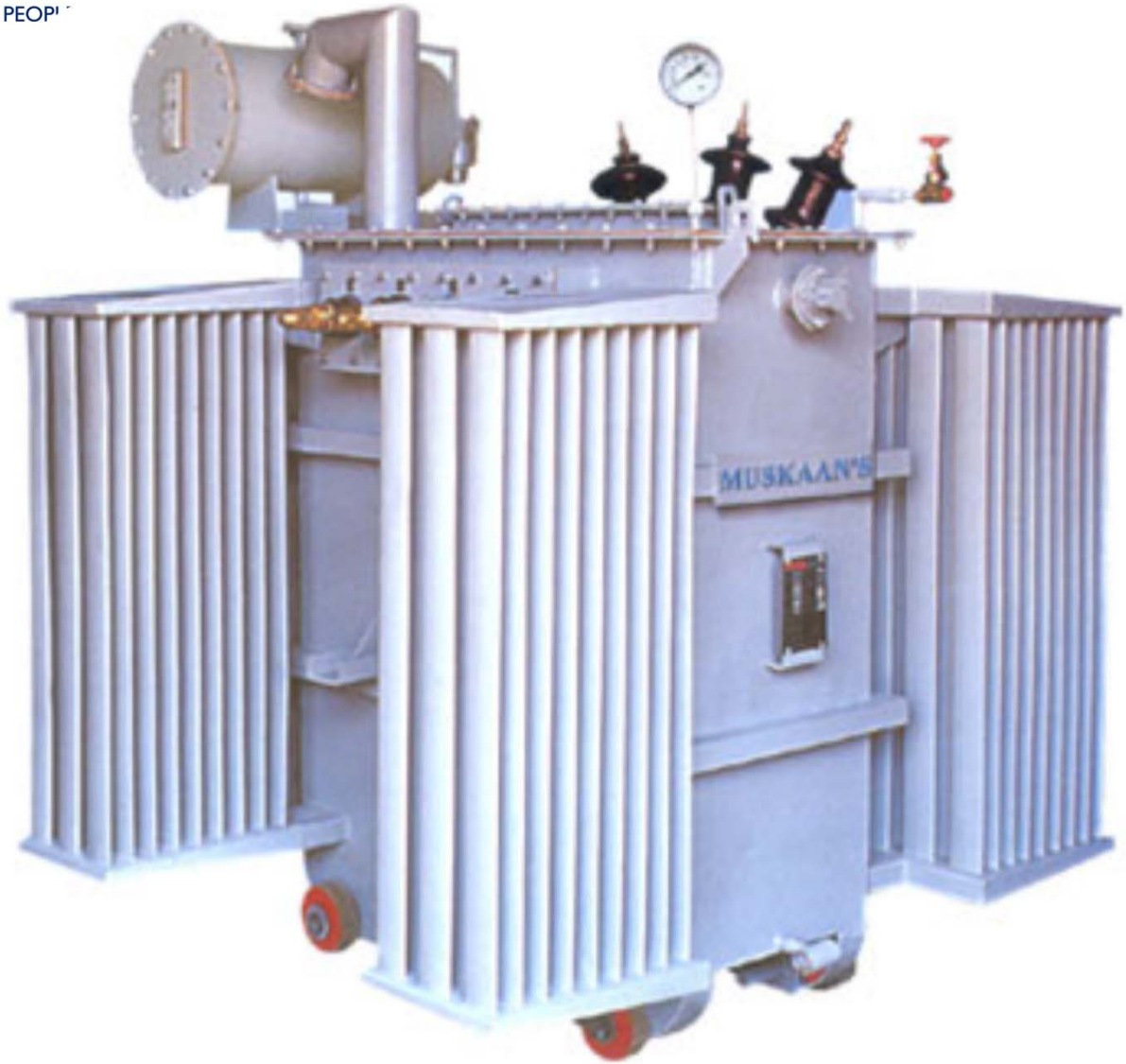
William Stanley,

an engineer for Westinghouse, who built the practical device in 1885 after George Westinghouse bought Gaulard and John Gibbs' patents. The core was made from interlocking E-shaped iron plates. This design was first used commercially in 1886.

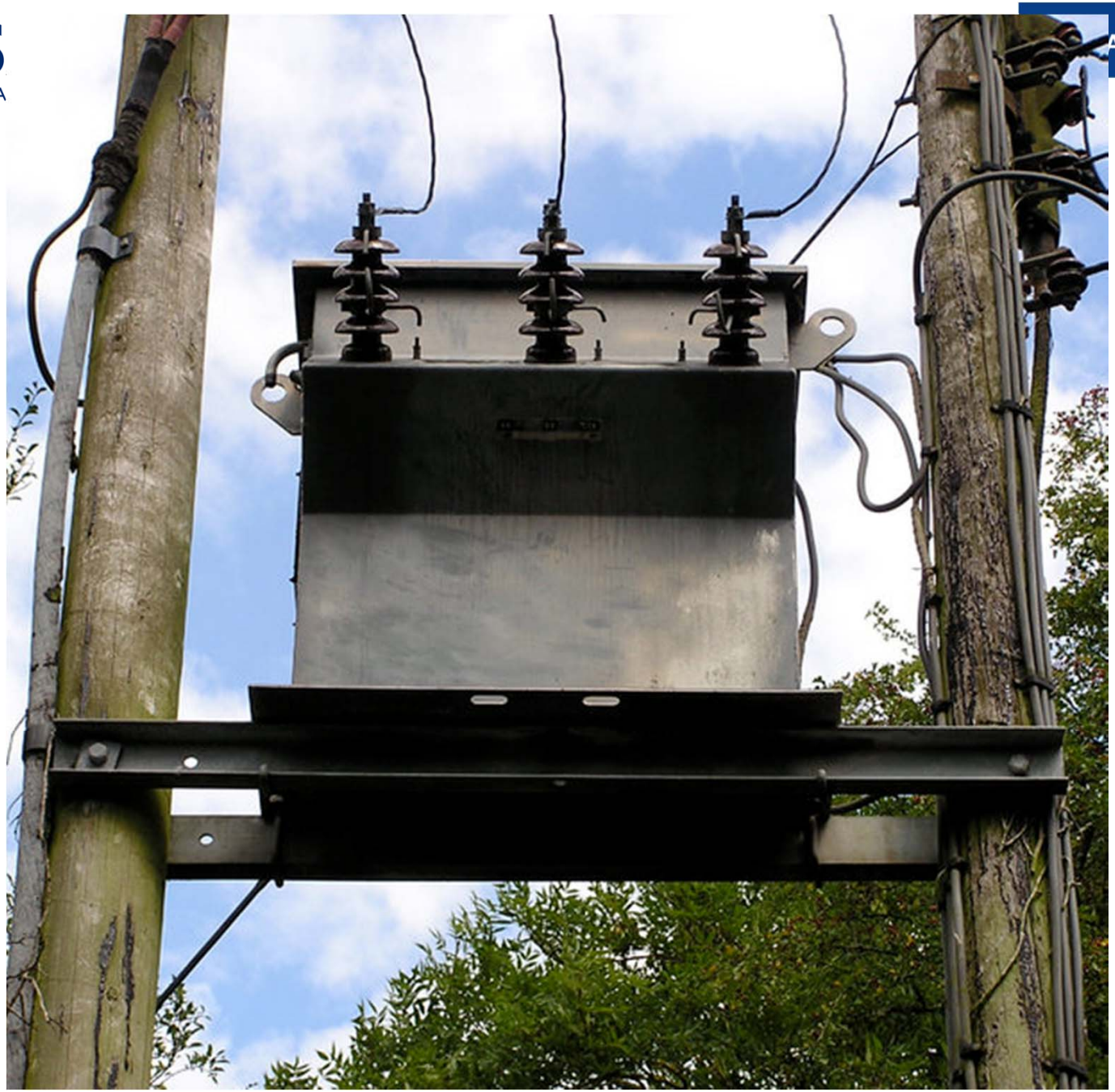
Russian engineer

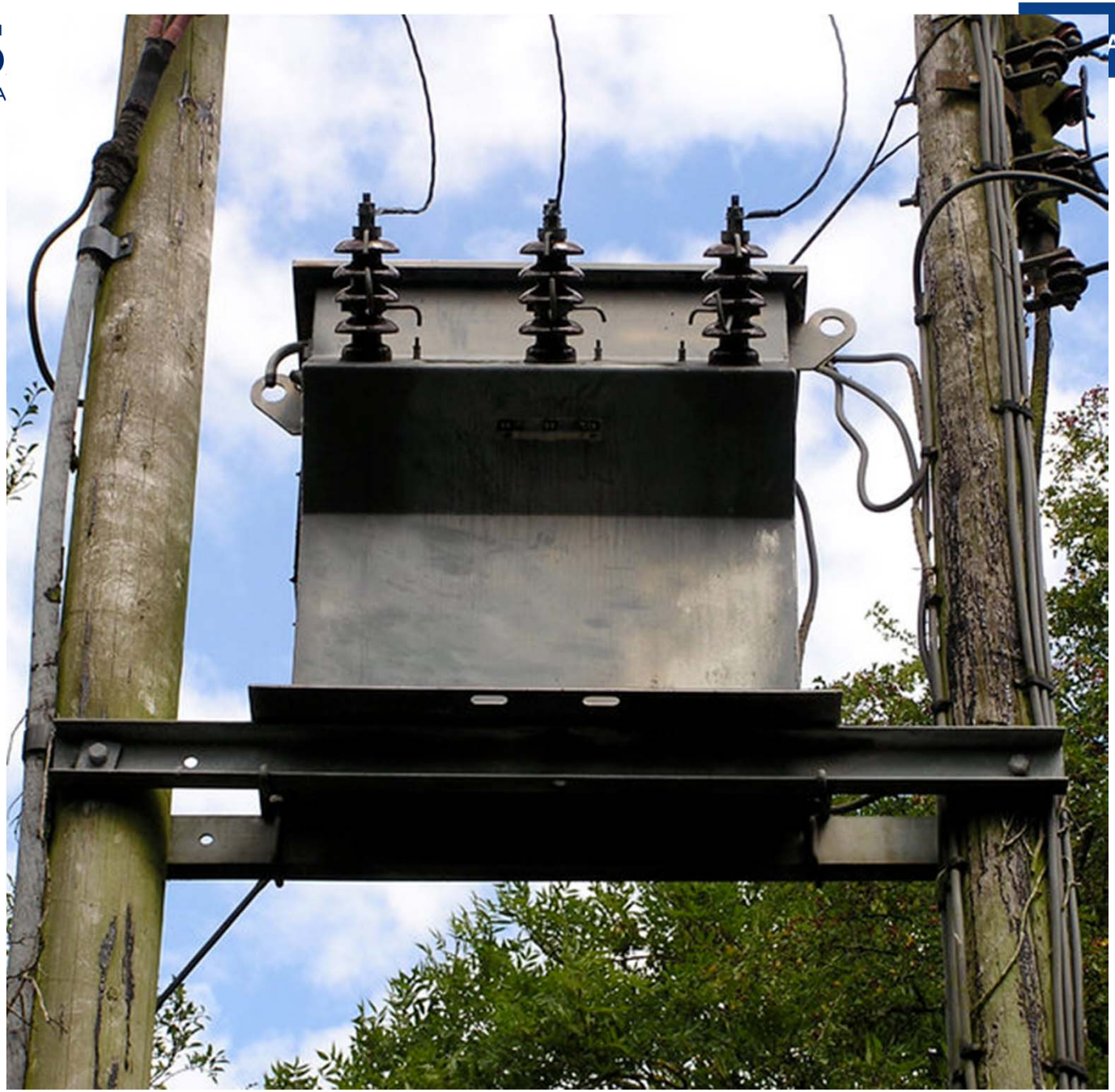
Mikhail Dolivo

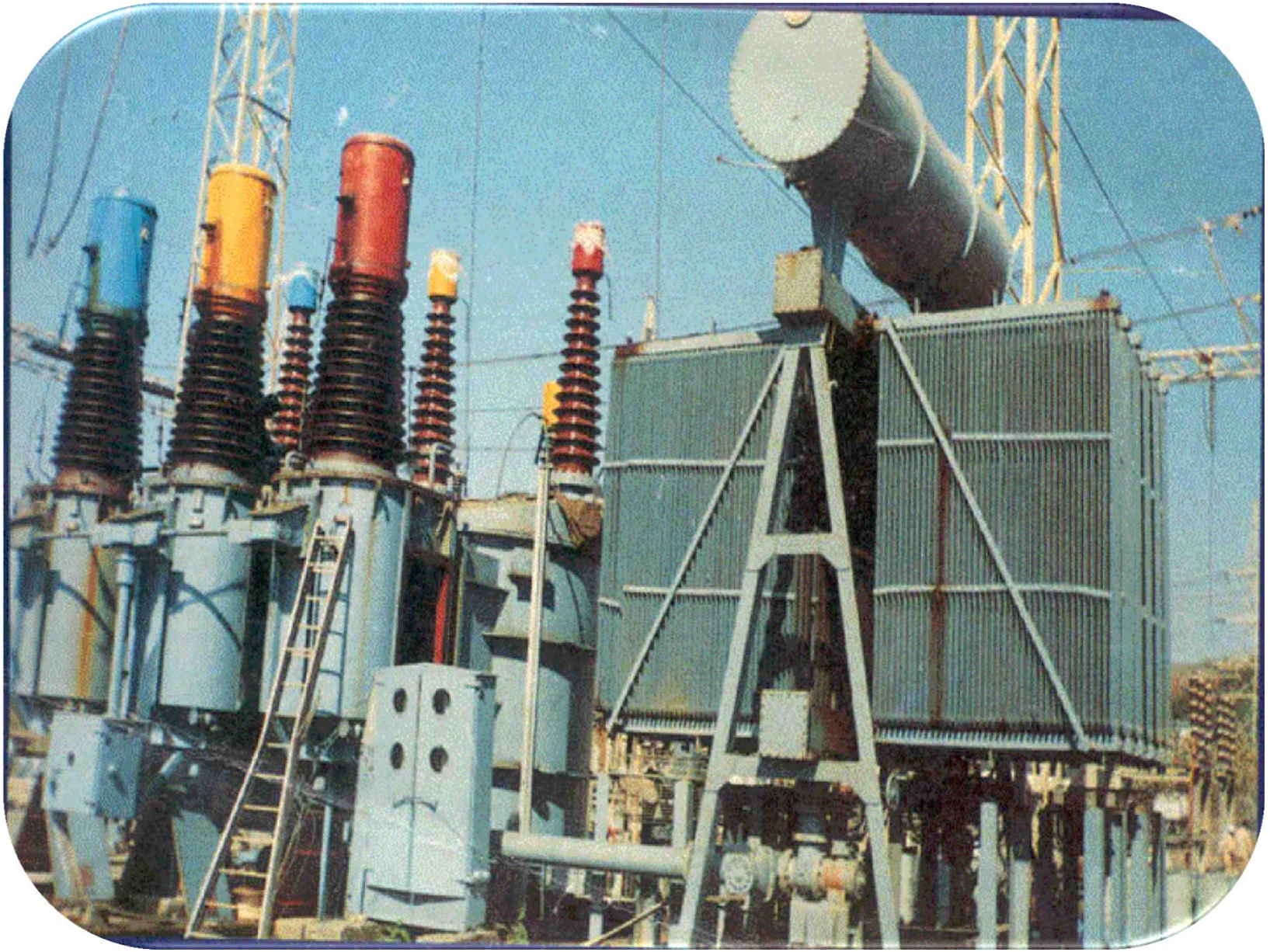
in 1889 developed the first three - phase transformer.

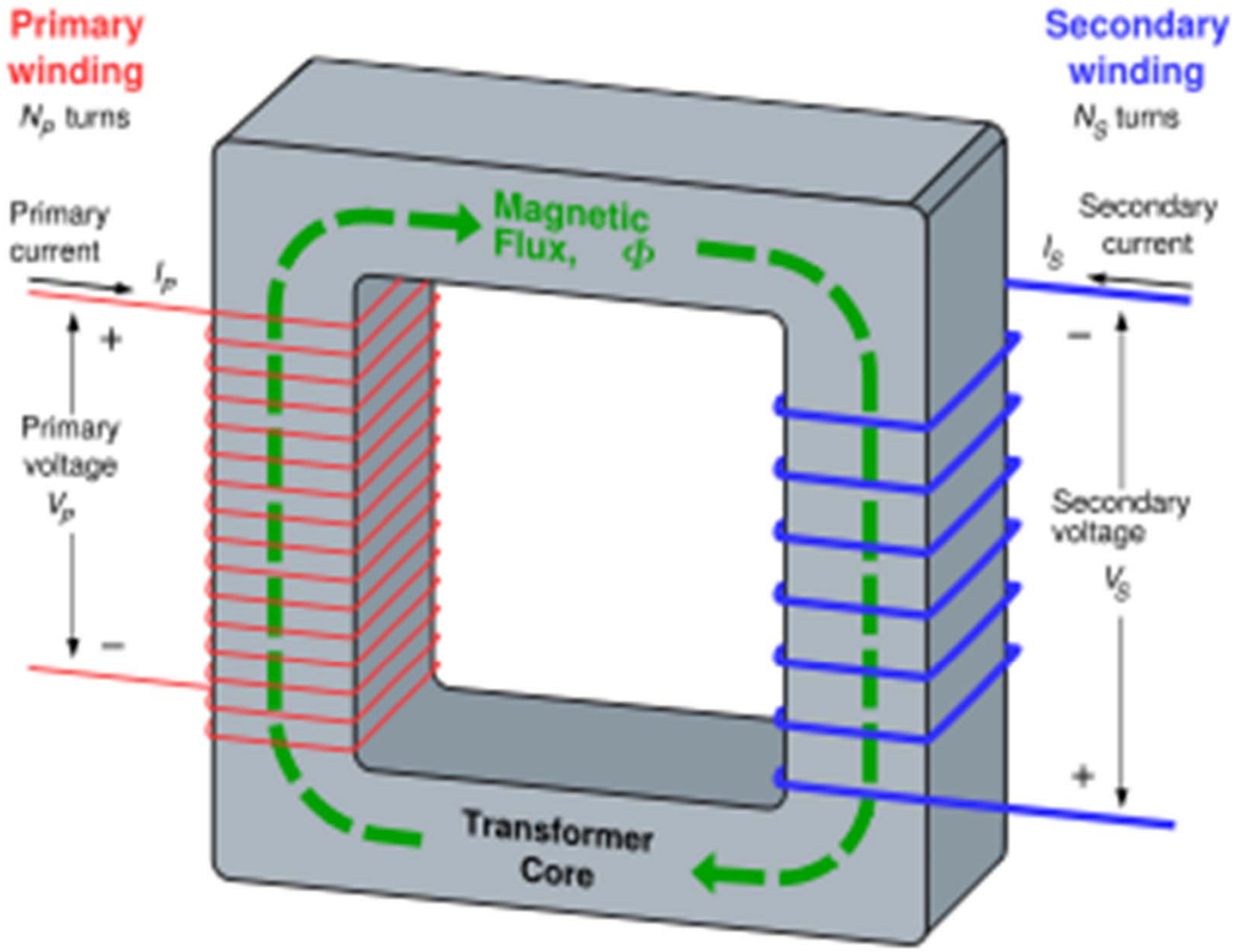


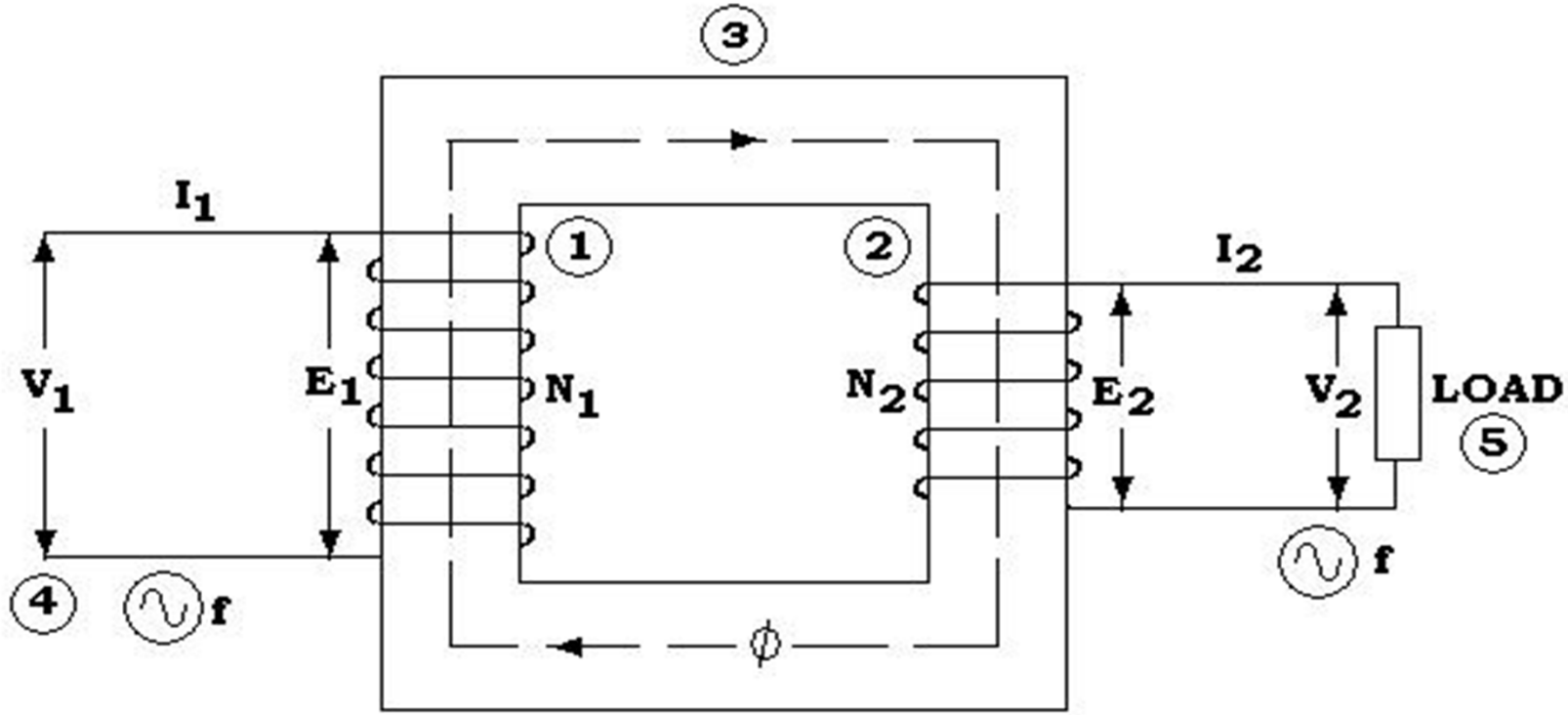
1250 KVA 11/.433 KV TRANSFORMER
(OUTDOOR TYPE)








Primary winding
N_p turns
Secondary winding
N_S turns
Primary current
I_P
Magnetic Flux, Φ
Secondary current
I_S
+
Primary voltage
V_p
−
−
Secondary voltage
V_S
+
Transformer Core



1. Primary winding with N1 turns
2. Secondary winding with N2 turns
3. Core with magnetic flux ø
4. Supply
5. Load

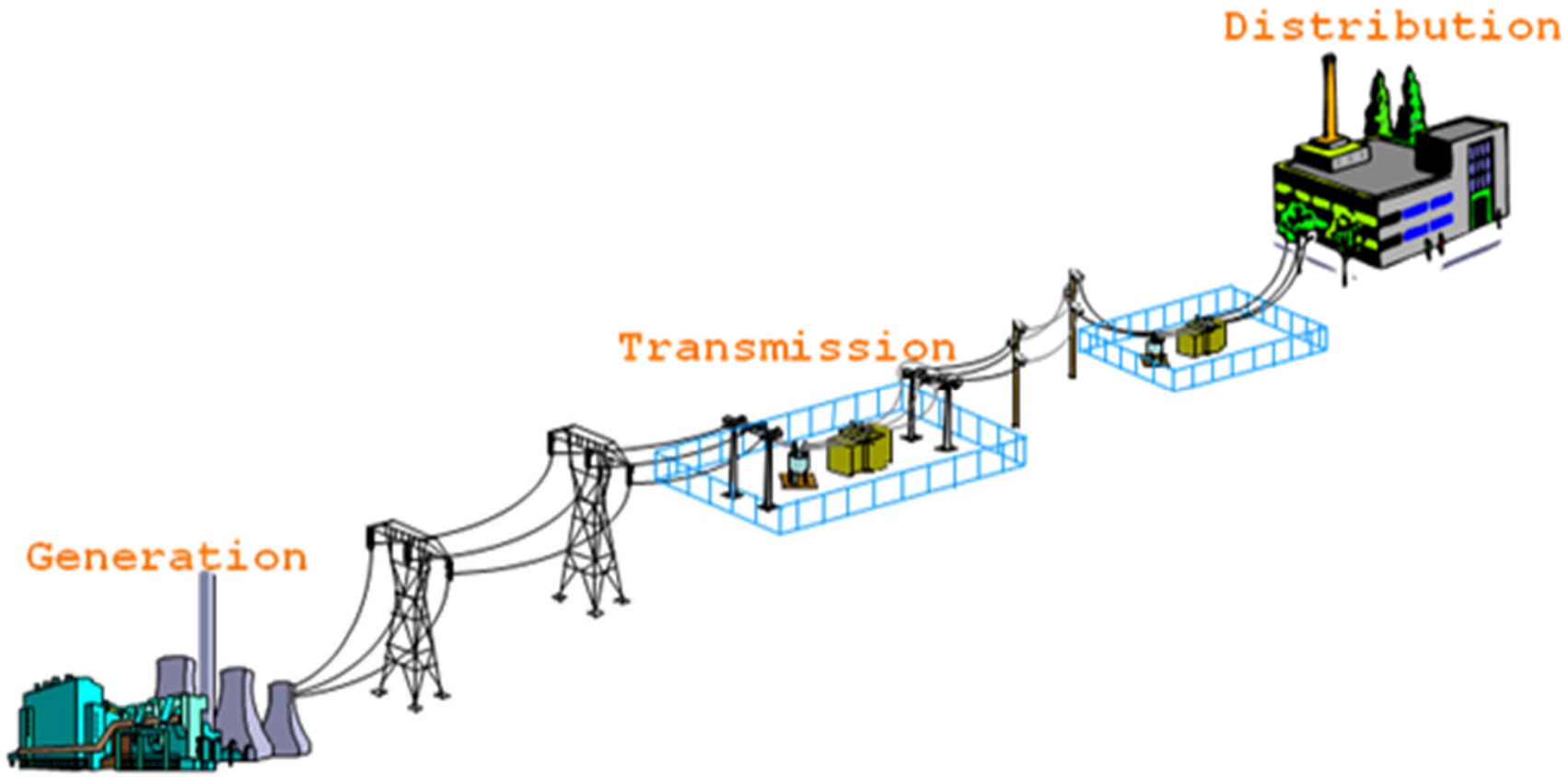
PRINCIPLE OF A SINGLE-PHASE TRANSFORMER

INTRODUCTION

We know that electrical power is generated in generating station. We transmit electrical power to certain selected places for distribution.

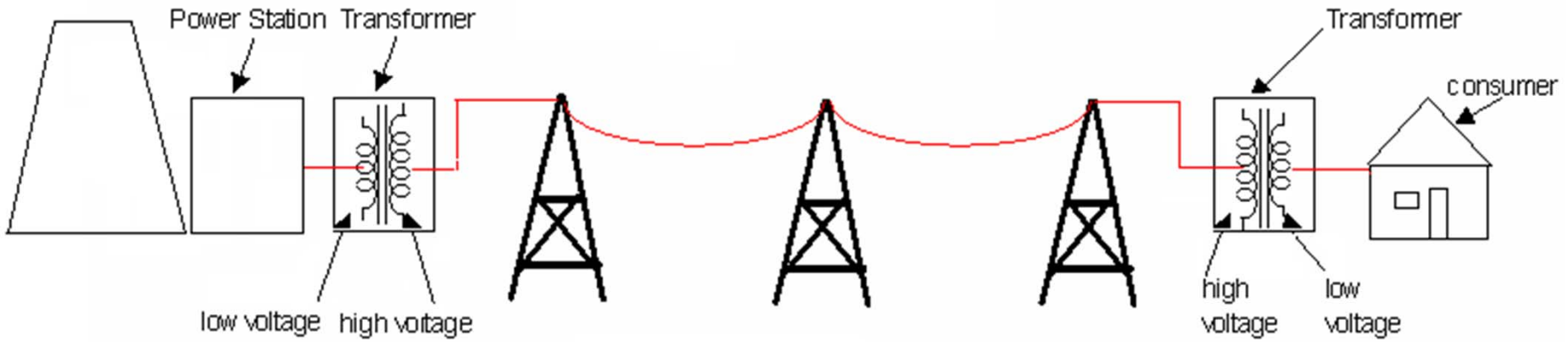
MAIN COMMAIN COMPONENTS OF POWER SUPPLY SYSTEM
PONENTS OF POWER SUPPLY SYSTEM

Generation, Transmission and Distribution



Need for transformer

- Generation voltage 11 KV
- Transmission Voltage 66 KV/132KV
- Distribution Voltage 11 KV & below
- To step up transmission voltage and step down to distribution voltage



➢INTRODUCTION:

- Transformer is an important link in power system between generating station and transmission sub station, between transmission sub transmission and sub transmission sub station, between sub transmission sub station and primary distribution sub station, finally between primary distribution and the consumers.
- Capacity few KVA to hundreds of MVA.*
- Variety of constructional and operating features.

Transformers are ordered, designed (as per I.S. 2026 & I.S. 1180), manufactured, tested, transported, installed, commissioned, operated & maintained. The various activities are inter-related and demand expertise about different aspects of power transformers. The knowledge about the electrical power systems and associated phenomena is useful.

The transmission network is inevitable. Long and high voltage transmission lines are necessary to transmit huge blocks of power from the sources of generation to the load centers, to interconnect power houses for increased reliability of supply, greater system stability and lesser stand by power plant and hence cheaper electric energy. In between the powerhouses and receiving sub stations, and the ultimate consumers, no. of transformers having capacity of hundreds of MVA to hundreds of KVA or even less (distribution transformers) are installed.

As per one analysis, in a large electrical network, the total capacity of transformers in MVA is 5.5 times the generating capacity of generators in MW till power is used by end users. With introduction of windmills and other non-conventional electricity generation, this ratio of 5.5 reduces to about 5.

At sending end, step-up transformers and at receiving end, step-down transformers are installed. Any thing going wrong any where with any transformer, a very huge area will be affected. Therefore it becomes very important to monitor the transformer health, which is responsible for uninterrupted power supply. The transmission lines and circuit breakers also contribute for the same, but practically the weak link is transformer.

IT IS ESTIMATED THAT HEAT PRODUCED BY ONE KG. OF NUCLEAR FUEL IS EQUAL TO THAT PRODUCED BY 4500000 KG. OF GOOD QUALITY COAL.

PROCEDURE

FOR

MANUFACTURING

TRANSFORMER

IN INDUSTRY

INFORMATION

ABOUT

TRANSFORMER

MANUFACTURING

How a transformer is made in industry?

❖DESIGN

❖MANUFACTURING

MANUFACTURING

(A) INSULATION SECTION

(B) WINDING SECTION

(C) CORE BUILDING SECTION

(D) CORE-COIL ASSEMBLY SECTION

(E) OVENING

(F) TANKING SECTION

(G) TESTING SECTING

(H) DISPATCH

SPECIFICATIONS FOR TRANSFORMER

Rating	:	750 KVA OUTDOOR type
Voltage HV	:	11000 V Unearthed
Voltage	:	433 V
No. of Phases	:	3
Frequency	:	50 Hz
Winding	:	Copper Wound
Vector Group	:	Dyn11
Neutral	:	To be brought out for earthing
Tapping	:	± 5% @ 2.5%
Tapping Mode	:	Off Load Tap Changer
Cooling	:	ONAN
Termination HV	:	Cable Box for 70 Sq.mm. XLPE 11 KV Cable
Termination	:	Suitable for receiving 1200A TPN Copper Bus Duct
Paint	:	Epoxy

Kindly provide / specify the following:

- No Load & full Load losses
- Impedance
- Temperature rise
- Standard Accessories being provided by you.
- Approximate Overall dimensions
- Buchloz & Alarm trip
- Alternatively quote for 1000 KVA Transformer with Temp alarm & trip Indicator & Buchholz Relay

SPECIFICATION OF TRANSFORMER (PURCHASER WILL SPECIFY)

APPLICATION	POWER TRANSFORMER
RATING (MVA)	20/25
VOLTAGE RATIO (KV)	132/33
NO. OF PHASES	3
FREQUENCY (HZ)	50
VECTOR GROUP	YNyn0
TAPPING MODE	OLTC
	+/-10%@1.25%
IMPEDANCE (%) (TOL)	10%@25 MVA BASE
TERMINATION (HV)	BARE BUSHING
TERMINATION ()	BARE BUSHING
COOLING	ONAN/ONAF
TEMPERATURE RISE /WINDING `C	50/55

GUARANTEED TECHNICAL PARTICULARS (TRANSFORMER MANUFACTURER WILL PROVIDE)

BIL		HV	
	KVP	550	170
	KVRMS	230	70
N.L.L (TOL) KW		17.5 KW	
L.L (TOL) KW		94 KW	
A.L (TOL) KW		1.5 KW	
APPROX. WEIGHT			
CORE & WINDING (KG)		21500	
TANK & FITTINGS (KG)		11500	
OIL (KG / LITER)		10000/11235	
TOTAL WEIGHT (KG)		43000	
APPROX. OVERALL DIMENTIONS (LXBXH) (MTR)		7 X 4.5 X 5.5	
EFFICIENCY [%]		U.P.F	0.8 P.F
100% LOAD		99.56	99.45
75% LOAD		99.63	99.53
50% LOAD		99.67	99.59
25% LOAD		99.63	99.53
REGULATION [%] 100% LOAD		0.88	6.60
MAX EFFICIENCY [%]		49.68	
AT LOAD%		43.15	

THANQ