AKS Power Equipments Pvt. Ltd.
(Unit : UNIVERSAL MAGNETICS)
Manufacturer of Dry Type Transformers
Office & Factory : 26/5, Sarat Chatterjee Road,
Howrah – 711 104, West Bengal, India.

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COMPANY PROFILE

AKS Power Equipments Pvt. Ltd. (Unit : Universal Magnetics) has developed various types of highly reliable Dry Type Transformers by implementing value management technique in designing and manufacturing of Dry Type Transformers. Our company was founded by an NRI Electrical Engineer, in the year 1987 utilizing his valuable experience over twenty years in designing and development of Dry Type Transformers in U.K. & U.S.A. He had gathered experience in working with all National and International Standard related to designing and manufacturing of Dry Type Transformers for various applications with a high orientation towards quality and reliability. Of course, the major part of the success of our company attribute to transferring the value management technique of the western world to our country. The quality of the product is fully dependent not only on design and production technique but also by utilizing skilled and trained human resources with a good foundation of value management.

The development of Dry Type Transformers to fulfill the requirement of modern application itself should be considered as a unique value addition to power distribution system. This has introduced two very important features in the power distribution network – safety and maintenance free installation. Therefore, Dry Type Transformers itself may be considered as an outcome of value management technique adopted in power distribution system. Our continuous efforts to serve various industries, utility companies and residential building complex by fulfilling their precise requirement definitely demand high sense value methodology. Quality addition of our product has not only been accomplished by transferring western technology but also utilizing the superior quality raw materials available in our country and abroad. The Nomex Aramid Paper, made by DUPONT, U.S.A., as an insulating material on conductor is considered the best in transformer engineering and the windings impregnated in Class – C Silicone Varnish under vacuum pressure impregnation procedure are also considered the state of art in transformer engineering. We have adopted both techniques in our product to achieve almost **ZERO FAILURE** while serving various prestigious customers all over India during last twenty years. We are proud to claim our superiority over other manufacturers in the following areas :

1. We use Nomex Aramid Papers (DUPONT Make) as conductor a installation which has the highest thermal withstand capability as well as dielectric property over and above the normally specified by the customer.
2. We use Silicone Varnish for vacuum pressure impregnation (VPI) of coils (Class – C, 200°C) which belongs to highest thermal class. Most of our competitors use Epoxy Resin (Class – F, 155°C) whose thermal class rating is 45°C lower than Silicone Varnish. Therefore, by using Class – C, Nomex Paper insulation in the coil followed by vacuum pressure impregnation (VPI) in Silicone Varnish guarantees true Class – C, 200°C insulation property of the winding.
3. Customers normally specify transformers with Class – F insulation in compliance with easy availability in the market. While selecting our product with Class – C insulation they are purchasing the transformers capable of operating beyond their KVA requirement (approximately 20%) which may be utilized in the future to supply additional load. Again when an electrical power equipment runs below the specified temperature limit, it always should have longer life expectancy.
4. We manufacture LV Windings of our transformers with Copper Foils which is the state of art in transformer manufacturing. We have been very successfully manufacturing copper foil wound transformers over 20 years while many of our competitors have failed to acquire this technology. Foil wound transformers are extremely rugged in construction and have better short circuit withstand capability in comparison to multiple strip winding transformers. This type of winding gives lower eddy losses and lower hottest spot temperature in comparison to conventional multiple strip conductors wound coils.

We hereby conclude that we manufacture transformers assuring totally trouble free operation alongwith longer life expectancy, higher efficiency and built in overload capacity still staying competitive in price with other manufacturers by adopting Value Methodology in manufacturing.

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BRIEF MANUFACTURING PROCEDURE OF OUR DRY TYPE TRANSFORMERS

Core :

Material - Imported C.R.G.O., Grade M – 4, Silicon Steel properly annealed after shearing.

Construction - Full Mitred Construction for Low Loss.

Windings :

A. HV Winding – Bare Electrolytic Grade, Soft & Bright Annealed Copper Conductors are covered with two layers of 2 mil Nomex Paper by an automatic double tape covering machine at our Plant before winding of the coil.

B. Wound Cross Over Type HV coils are toroidally wrapped with two layers of woven glass tapes along with inter coil porcelain spacers to achieve the highest mechanical strength to cope with short circuit forces.

C. LV Coils are wound over High Temperature Glass Fibre Reinforced Cylinder using Electrolytic Grade Copper Foils with 7 or 10 mil thick Nomex Paper as inter turn insulation.

Vacuum Pressure Impregnation & Curing (Silicone Varnish):

A. Wound coils are preheated in thermostatically controlled electric oven for 4 hours at 135°C to remove moisture before impregnation.

B. Preheated coils are impregnated inside a Vacuum Pressure Impregnation Chamber in following steps :

i) **Coils are placed inside a Vacuum Pressure varnish tank.**
ii) **Full Vacuum is established inside the tank by pulling air from upper part of the tank.**
iii) **Silicone Varnish is allowed to enter inside the tank through the bottom from the varnish tank.**
iv) **After removal of vacuum pressure is applied from the top of the tank to force the varnish to penetrate further in the coil before allowing the varnish to return in the varnish container located at the bottom.**

C. Impregnated Coils are cured inside the oven for a long period for 12 hours under graduated temperature up to 220°C.

Assembly :

Core and Coil assembly is done by using all high temperature & high dielectric insulating materials in such a manner that entire assembly should achieve highest electrical and mechanical stresses along with best heat dissipation causing low temperature rise. This assembly also ensures excellent impulse voltage and short circuit current withstand capabilities along with enough flexibility to dismantle assembly even at site.

Tappings :

Off Circuit Tappings are normally provided on HV Windings on a Fibre Glass Terminal Board inside the enclosure. The tap changing is done manually by Copper Link after opening a hinge type enclosure panel for Indoor Unit or inspection cover, located on the top of the enclosure, for Outdoor Unit.

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SPECIAL FEATURES OF OUR DRY TYPE TRANSFORMER

Conductor Covering :

HV Conductors (E.C. Grade Copper) are double tape covered with 2 mil Thick Nomex Papers with 50 : 50 overlap. Double covering is done by automatic covering machine with one covering in clockwise and other one anticlockwise direction which offers the highest level of insulating properties.

Winding :

HV Coils are Sectional type with cross over windings where each section of coil is individually wrapped toroidally with 7 or 10 mil glass tapes. Inter-coil porcelain separators are secured on coil edges during the glass covering so that entire section of a coil obtains highest level mechanical and electrical strength after VPI Impregnation in the Silicone Varnish.

Transformers above 200 KVA Secondary Windings are made of Copper Foils with Nomex Paper Interlayer which are extremely rugged in construction and also capable of withstanding Short Circuit Current Situations as well as Voltage Surges more efficiently comparing to Multiple Strip conductors. This type of winding gives Lower Eddy Losses and Lower "Hottest Spot" Temperature which is better than conventional Multiple Strip Conductors wound coils.

Impregnation :

Wound coils are impregnated in Silicone Varnish by Vacuum Pressure System. As the Silicone Varnish is a Low Viscous Liquid than Epoxy Resin and cured thermally under graduated temp. inside the oven. During the long curing cycle for 12 hours, the varnish penetrate slowly deep inside the coil by natural capillary action contributing mechanical strength and dielectric properties of the coil.

Assembly :

Core and Coil assembly is done by using all high temperature & high dielectric insulating materials in such a manner that entire assembly should achieve highest electrical and mechanical stresses along with best heat dissipation causing low temperature rise. This assembly also ensures excellent impulse voltage and short circuit current withstand capabilities along with enough flexibility to dismantle assembly even at site.

We also have an unique production technique of assembling Fibre Glass Duct Sticks with Fibre Glass Support Blocks by interlocking these two so that under any situation these two may not get loose or fall apart.

Enclosure :

We can manufacture Totally Enclosed Outdoor Unit upto 750 KVA Rating with typical corrugated wall type enclosure for further heat dissipation with special core-coil assembly fully protected inside against any environmental conditions.

Over Load Capacity :

We design our transformers with 70°C, 90°C or 115°C Temperature Rise (As per customer's requirement) while using our standard Class - C Insulation 140°C with allowable Temperature Rise over 40°C Ambient as per I.S. (Insulating material - Nomex Paper which is capable of operating at 220°C continuously for 20 years minimum recommended by U.S. Navy & Underwriters Laboratory). Therefore, our transformer is capable of withstanding 10% to 25% Over Load Capacity continuously without sacrificing the normal life expectancy depending on specified temperature rise by customers.

Economical to Repair :

Economical to repair as any part of winding may be easily replaced and also scrap copper can be easily recovered from the burnt coils.

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ADVATAGES *Of* SILICONE VARNISH IMPREGNATED COILS OVER RESIN IMPREGNATED COILS & RESIN CAST COILS

A. Operational Advantages of Class – C Insulation : -

1. Thermal Class :

As Per I.S. 11171 – 1985 Dry Type Transformers	
Temperature Class of Insulation	Temperature Rise at 40°C Ambient
A	50°C
E	65°C
B	70°C
F	90°C
H	115°C
C	140°C

2. Higher Over Load Capacity :

Better if designed in compliance with Lower Temperature Rises of Class H (115°C) or Class F (90°C).

3. Life Expectancy :

Considerably higher even with high heat & humidity and polluted environment as Silicone Varnish is very stable.

4. Partial Discharge (Corona) :

Unlike Cast Resin coils no questions of failure in Silicone Varnish Impregnated Coils as the ***Double Nomex Covering*** itself has the full capability withstanding all dielectric stresses in the coil.

B. Physical (Manufacturing) Advantages : -

1. Varnishing :

Better penetration inside the winding is obtained due to Low Viscosity of Silicone Varnish.

2. Curing :

a) Silicone Varnish as one part liquid is cured inside the Heat Chamber for 12 hours under graduated temperature giving an opportunity for dipper penetration during long curing cycle.

b) Epoxy Resin as two part mixture of Resin & Hardener has a scheduled Pot Life which is start immediately after mixing them together without giving much opportunity for dipper penetration inside the coil during curing.

3. Repairing :

Easy & Economical to repair. Copper from Silicone Varnish Impregnated burnt coil could be recovered easily which is not possible for Epoxy Cast or Impregnated Coil.

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Comparison Chart
between
Silicone Varnish Impregnated Coils, Resin Impregnated Coils& Resin Encapsulated Coils

Silicone Varnish Impregnated Coils	Resin Impregnated Coils	Resin Encapsulated Coils (CAST Coils)
Silicone Varnish impregnated coils with Nomex & Glass Tapes covered conductors shall be considered as Class – C (140°C Rise).	Epoxy Resin Impregnated coils shall be considered as Class – F/H (90°C/115°C Rise) depending on the type of insulation on conductor.	Class – F Insulation (90°C Rise)
Silicone Varnish is very stable under high heat, humidity, polluted environment and sunlight.	Epoxy Resin is considered inferior to Silicone Varnish under such environmental conditions	Same as Resin Impregnated Coils
Silicone Varnish is a Low Viscous Liquid and cured thermally under graduated temp. inside the oven. During the long curing cycle for 12 hours, the varnish penetrate slowly deep inside the coil by capillary action contributing mechanical strength and dielectric properties of the coil.	Epoxy Resin Cures Chemically after mixing with appropriate hardener Therefore, the curing cycle of this mixture starts right after mixing two together which minimizes the opportunity for further penetration during curing.	Same as Resin Impregnated Coils
VPI impregnation along with Nomex covered conductors eliminates failure caused by Partial Discharge. All Standards have given waiver of Partial Discharge Test on impregnated coils.	Same as Silicone Varnish	Failure due to Partial Discharge is very common in Epoxy Moulded Construction. Therefore, all Standards are very rigid about performing Partial Discharge Test on this type of coils.
Economical to repair as a part of winding may be easily replaced and also scrap copper can be easily recovered from the burnt coils.	Damaged part of the winding may be replaced but scrap copper can not be recovered easily.	Very expensive to repair as the entire damaged coil to be replaced and the recovery of the scrap copper is not also possible.

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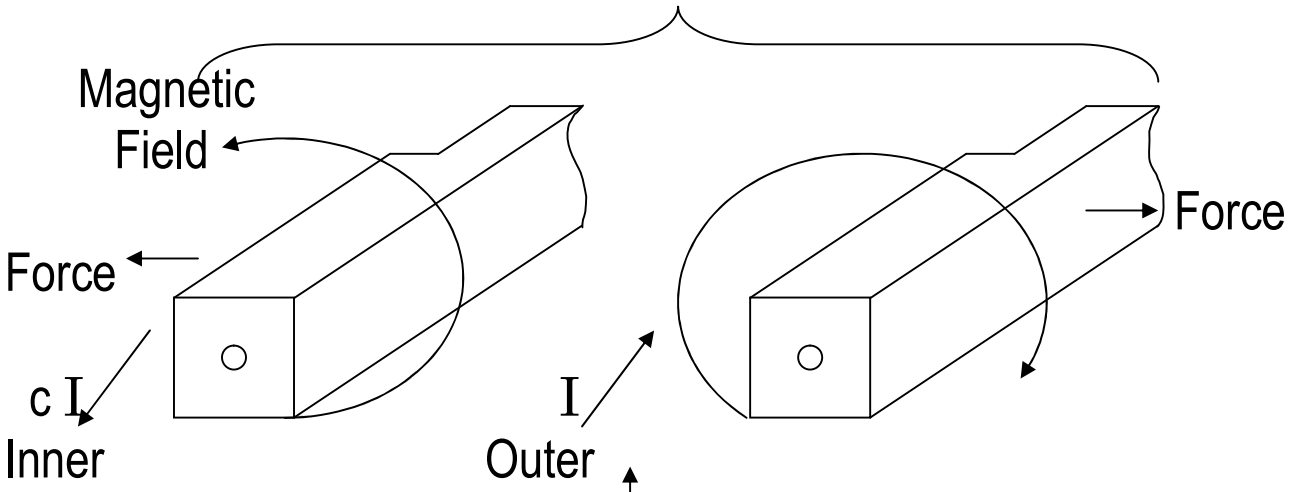
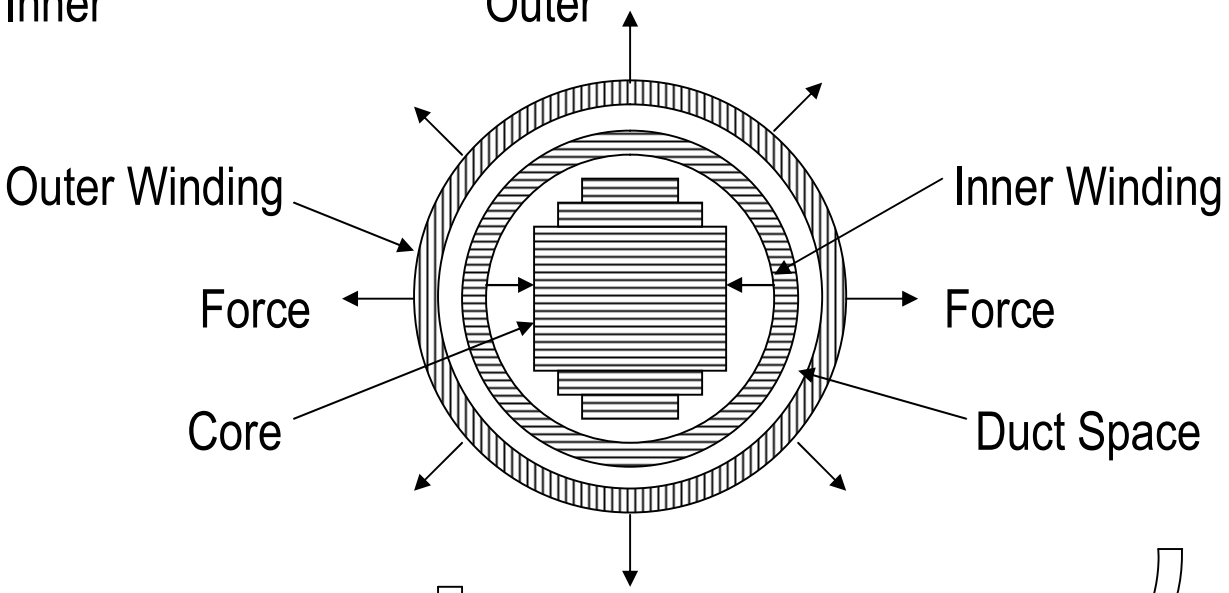
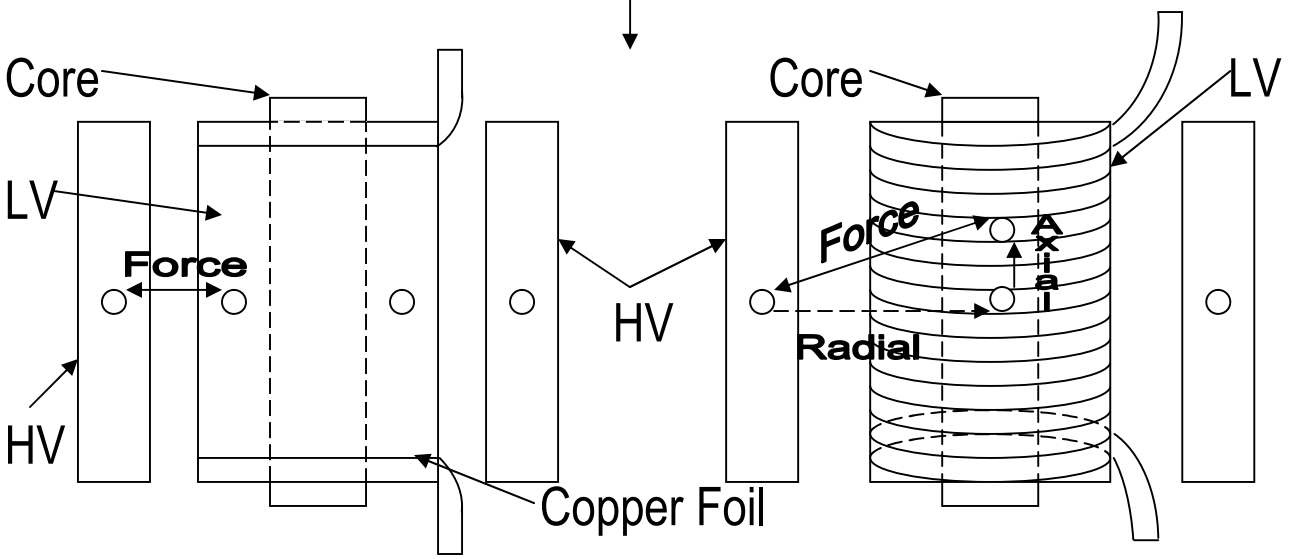
Comparison Between
Copper Foil Wound L.V. & Spirally Wound Helical Coil

In a core type transformer with concentric cylindrical windings the current in Outer (HV) Winding flows in a direction opposite to that of Inner (LV) Winding which produces force of repulsion between two windings.

Magnetics Fields Add to One Another







Copper Foil Winding (Symmetrical)

Multiple Strip Winding (Asymmetrical)

Copper Foil Wound LV Coil	Multiple Strip Wound LV Coil
Construction – Symmetrical	Construction – Asymmetrical
Symmetrical Windings produce only radial forces having magnetic centre of forces in horizontal plane.	Asymmetrical windings creates radial and axial forces due to non-alignment of magnetic centre in horizontal plane.
"One Turn One Layer" using Nomex Paper Insulation between layers is very rugged mechanically with a very little chance of displacement or deformation after varnishing.	"Multiple Strip" winding is mechanically weaker than Copper Foil Windings because the turns with Multiple Conductors are wound spirally in a layer with a pitch.
Extremely stable under Dynamic Short Circuit Forces as the destructive axial forces is not exist.	Unstable under Dynamic Short Circuit Forces as the destructive axial forces is exist.
Lower Eddy Losses in LV Winding due to lower thickness of conductors, as the eddy losses in conductor are proportional to the square of the thickness of the conductor.	Higher Eddy Losses in LV Winding due to higher thickness of conductors, which often calls for transposition.
Lower "Hottest Spot" temperature in LV Winding as the Copper Foil plays a dual role – Conductor as well as Heat Sink by conducting the heat from innermost part of the winding to the outer edges.	Higher "Hottest Spot" temperature in LV Winding as Multiple Conductors do not play the role of Heat Sink.
Physical size of the winding is more compact than any other type of winding.	Physical size of the winding is larger than Copper Foil Winding.
In case of insulation failure in LV Winding, repairing is easy and economical as the foils could be reused.	In case insulation failure in LV Winding, repairing is very difficult and costly.

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KEY PROPERTIES OF NOMEX ARAMID PAPER

Nomex Paper has earned its importance as electrical insulation by a proven record of **RELIABILITY**. This achievement is made possible by its many valuable properties as follows :

- ♣ **Heat Resistance :** Nomex is heat resistance, with a rating of 220°C awarded by U.S. Navy, Underwriters and other authorities.

- ♣ **Strong Tough Resists Cut-Through Retains Properties When Hot :** Nomex possesses excellent strength and toughness and outstanding resistance to both hot and cold cut-through by cut- through by wires, burrs on conductors and fillings of steel steel or other metals. And Nomex retains these tough properties at elevated temperature.

- ♣ **Low Shrinkage :** At unrestrained sheets or installed in equipment Nomex exhibits very low shrinkage.

- ♣ **Nomex Aramid Paper Compatible With :**
  - ♠ Oils
  - ♠ Silicones
  - ♠ Polyesters
  - ♠ Metals
  - ♠ Glass
  - ♠ Solvents
  - ♠ Curing Agents
  - ♠ etc.

- ♣ **Flame Retardant :** Nomex Paper will not support the combustion in air.

- ♣ **Safe to Use Safe to Dispose of Waste or No Dust or Solvent Danger :** Extensive testing has proven Nomex to be safe to work with with in all types of operations. Waste disposal is also hazard free.

- ♣ **Excellent Dielectric Properties :**
  - ♠ High Dielectric Strength.
  - ♠ Low Dielectric Constant.
  - ♠ Stable with Temperature.
  - ♠ Stable with Moisture.

- ♣ **Chemical Stability :** The Comparability of Nomex Aramid Paper and Pressboard with virtually all classes of electrical varnishes and adhesives (polyamides, silicones, epoxies, polyesters, acrylics, phenolics, synthetic rubbers etc.) is as well as other components of electrical equipment, is demonstrated by the many UL-recognized systems comprising Nomex, as well as long standing commercial experience.

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INFORMATION ABOUT HIGH TECHNOLOGY SILICONE VARNISH

(Make – Dow Corning, U.S.A.)

DOW CORNING ® 997 VARNISH

Type	Silicone resin in solvent.
Physical Form	Dark brown liquid
Special Properties	Easy to use ; excellent electrical properties ; good bond strength ; moisture resistance ; designed to meet MIL – I – 24092B
Primary Use	Impregnant and coating material For various electrical coils – Including transformers, motors and generators.

Description :

Dow Corning® 997 Silicone Varnish is a silicone impregnating varnish that offers processing ease and versatility, and features good dielectric properties and moisture resistance. In service, it exhibits good retention of bond strength. Its reliability has been proved by years of extensive use throughout the electrical equipment industry.

Other outstanding features of DOW CORNING ® 997 varnish include :

- Long service life – reliable even at 220°C (428°F) hottest spot temperature.
- Ease of use – varnish is readily thinned to meet specific application requirements.
- Little tendency to bubble during cure.
- Flexible cure schedule
- Designed to meet requirements of MIL – I – 24092B

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OVER LOAD CAPACITY OF DRY TYPE TRANSFORMERS
[Quoted From G. E. Catalogue]

Table below shows the average winding temperature rise and relative life expectancy for various equivalent constant loadings, based on maximum 40 Deg.C. Ambient.

Equivalent Constant Loading (%)	Average Winding Temperature Rise (Deg.C)	Relative Life Expectancy (Times Normal Life)
100	**150**	**1**
93	**133**	**2**
85	**115**	**15**
68	**80**	**> 100**

Therefore, the transformers manufactured using Class 'C' (140 Deg.C. rise with 40 Deg.C. Ambient as per I.S.) insulation with a actual designed temperature rise 115 Deg.C. we may expect 15% Over Load continuously.

Nomex Paper is rated for continuous operation at 220 Deg.C. (UL approved) with Normal Life Expectancy of 20 years with following break up.

	Average Temperature Rise (By Resistance)	Hot Spot Temperature	Ambient Temperature	Total Temperature
	150°C	**30°C**	**40°C**	**220°C**
Our Design	**115°C**	**15°C**	**40°C**	**170°C**

Difference between Insulation Capacity and Designed Value
220 Deg.C. – 170 Deg.C. = 50 Deg.C.

Therefore, using the G. E. Chart we may consider Over Load Factor of 20% without sacrificing the insulation Normal Life Expectancy.

Further more the Nomex is certified to operate at ***300 Deg.C. for One Year*** and as high as upto 400 Deg.C. for several hours. Therefore, the operation in express of 220 Deg.C. does not create a major damage to its normal operation.

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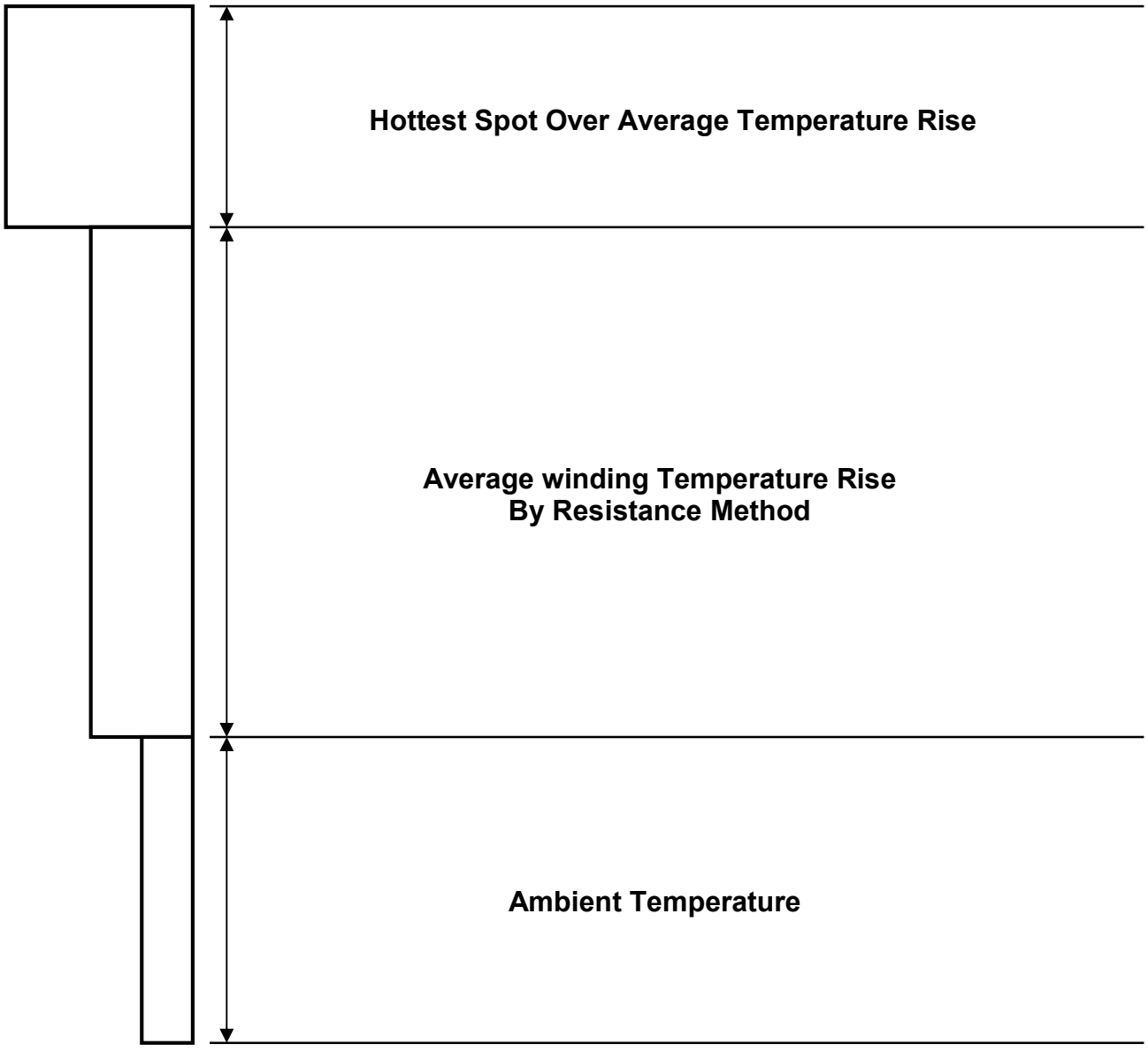
DETERMINATION OF THERMAL CLASS FOR AN ELECTRICAL INSULATION



Most of the International Electrical Standards have changed their ways of classifying the Thermal Class from conventional alphabet to Insulation System Temperature as follows ***(From ANSI Standard)*** :

Insulation System Temperature	Average Winding Temperature Rise (By Resistance)	Hottest Spot Winding Temperature Rise
150°C	**80°C**	**110°C**
185°C	**115°C**	**145°C**
220°C	**150°C**	**180°C**

Simple basic reason for that the Thermal Failure of Insulation is caused by the ultimate temperature. Therefore, if the Hottest Spot Temperature Rise could be reduced from the maximum specified limit, transformer may be safely operated with average winding temperature rise.