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Training Module on

Insulators

GOAL

Uninterrupted Power Supply

Solution

Pay attention to Critical power equipments

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Insulators ??

SARI / Energy

Essential link for Electrification – Creates Insulation between Live Current & Ground

Requires High Reliability Quotient

Product failure means

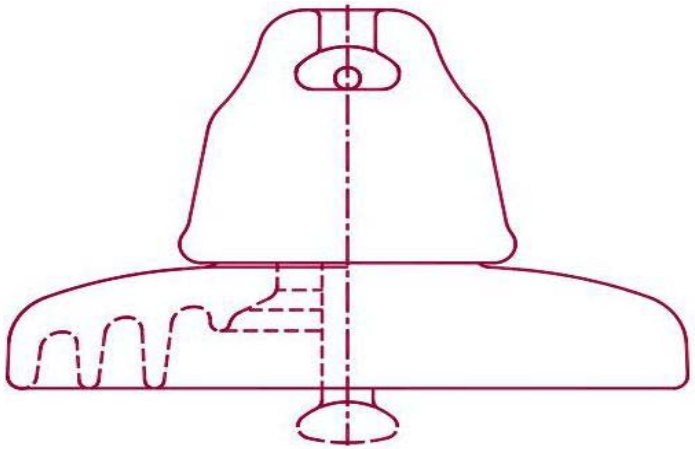
- Black out in Region
- Disruption in Railway traffic
- Loss of Human life

- Revenue loss to Utility
- Production loss to Industry
- Damage to other equipments

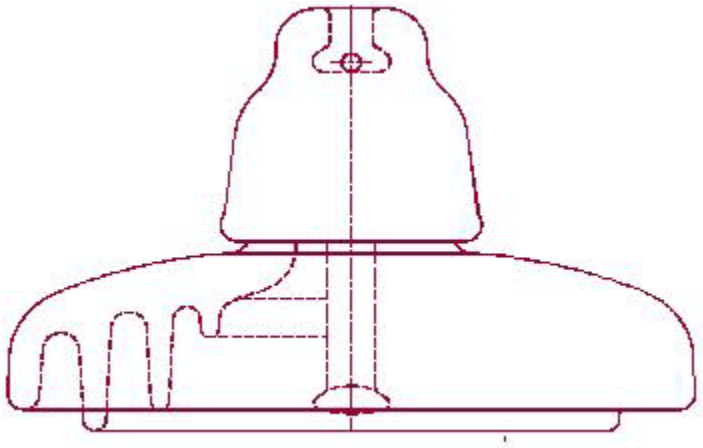
Expected Product Life 15-20 Years

DISC INSULATORS

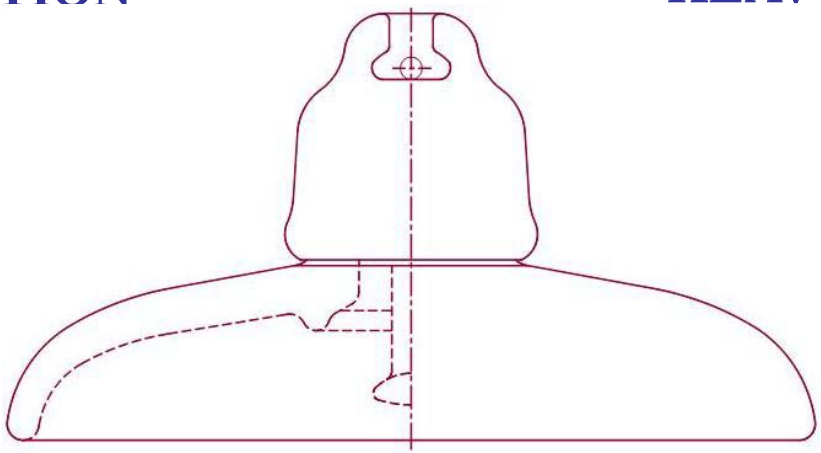
TYPES OF DISC INSULATORS



NORMAL LIGHT - MEDIUM POLLUTION



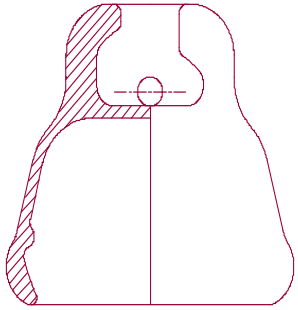
ANTIFOG HEAVY - VERY HEAVY POLLUTION



AERODYNAMIC SAND POLLUTION

COMPONENTS

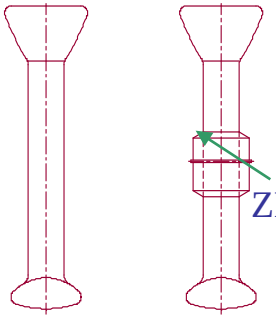
CAP



MALLEABLE CAST IRON / SPHEROIDAL GRAPHITE IRON

B&S DESIGNATION AS PER IS / IEC

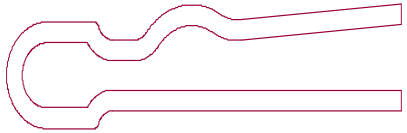
BALLPIN



FORGED STEEL

BALLPIN DIMENSION AS PER IS / IEC

LOCKING DEVICE



STAINLESS STEEL / PHOSPHOR BRONZE

BONDING AGENT (CEMENT MORTAR)

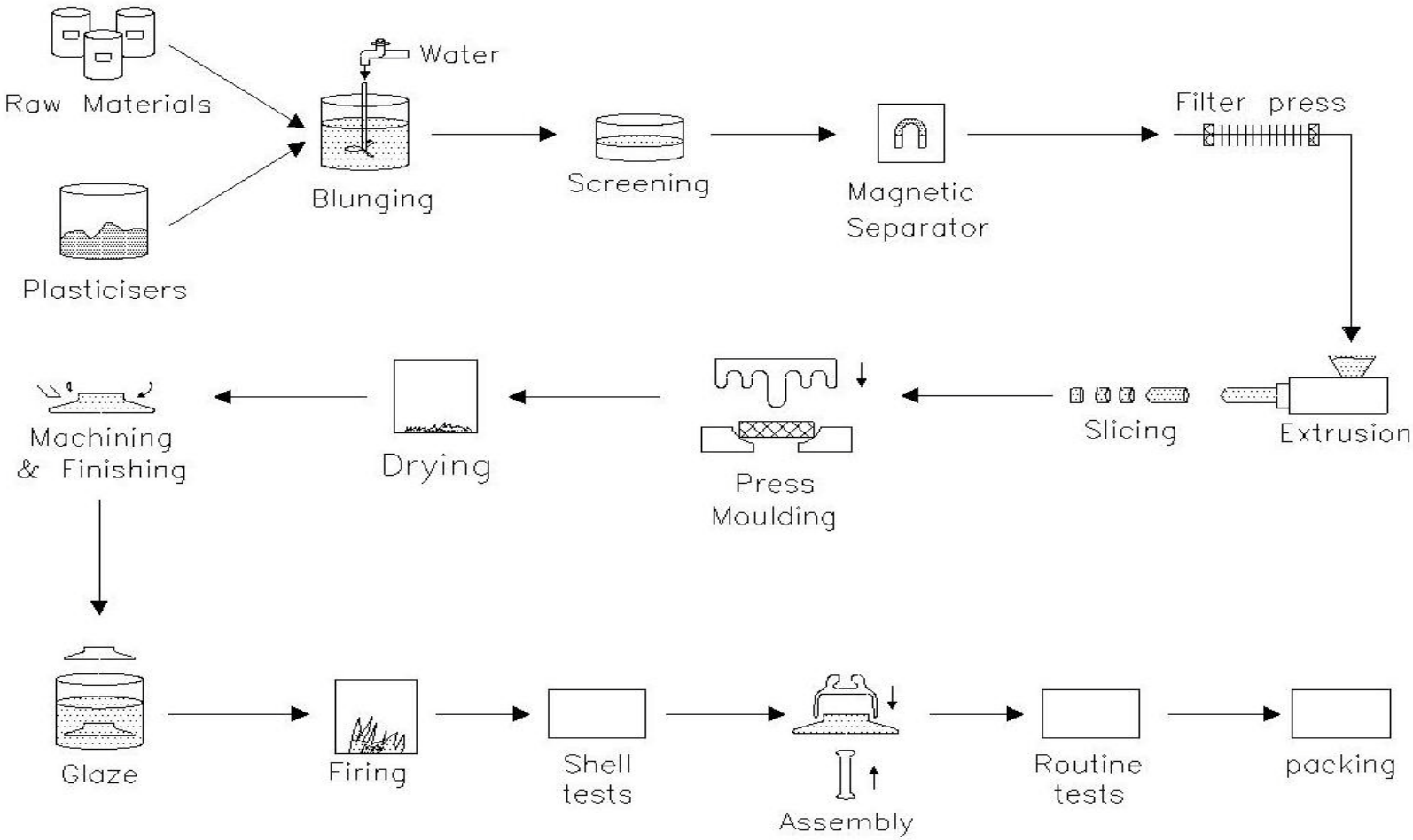
CEMENT : PORTLAND

SAND : FINE

WATER : COLD WATER

MANUFACTURING

Steps in the manufacture of Cap & Pin insulators



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PROCESS FLOW CHART

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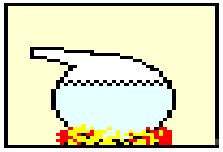
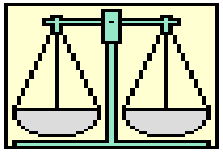
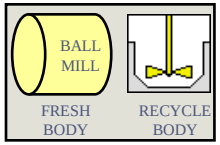
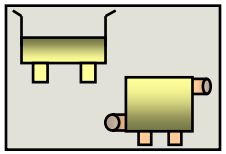
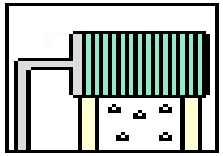

TESTING OF INCOMING RAW MATERIALS

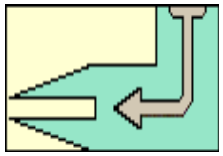

BATCHING

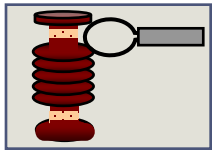


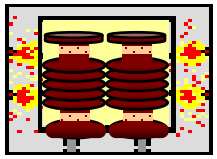
CERAMIC SLURRY PREPARATION

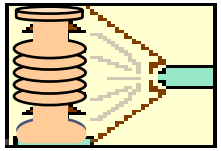

FERRO FILTER VIBRO SCREEN

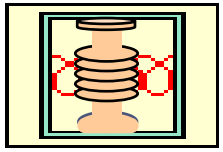

FILTER PRESSING

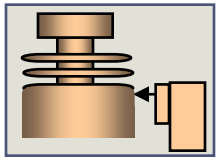

EXTRUSION

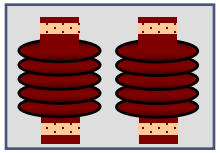

SORTING/ INSPECTION

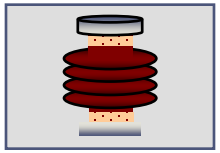

FIRING

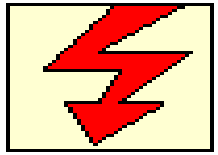

GLAZING

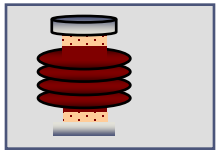

DRYING

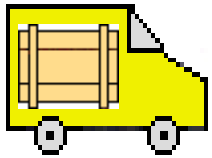

SHAPING

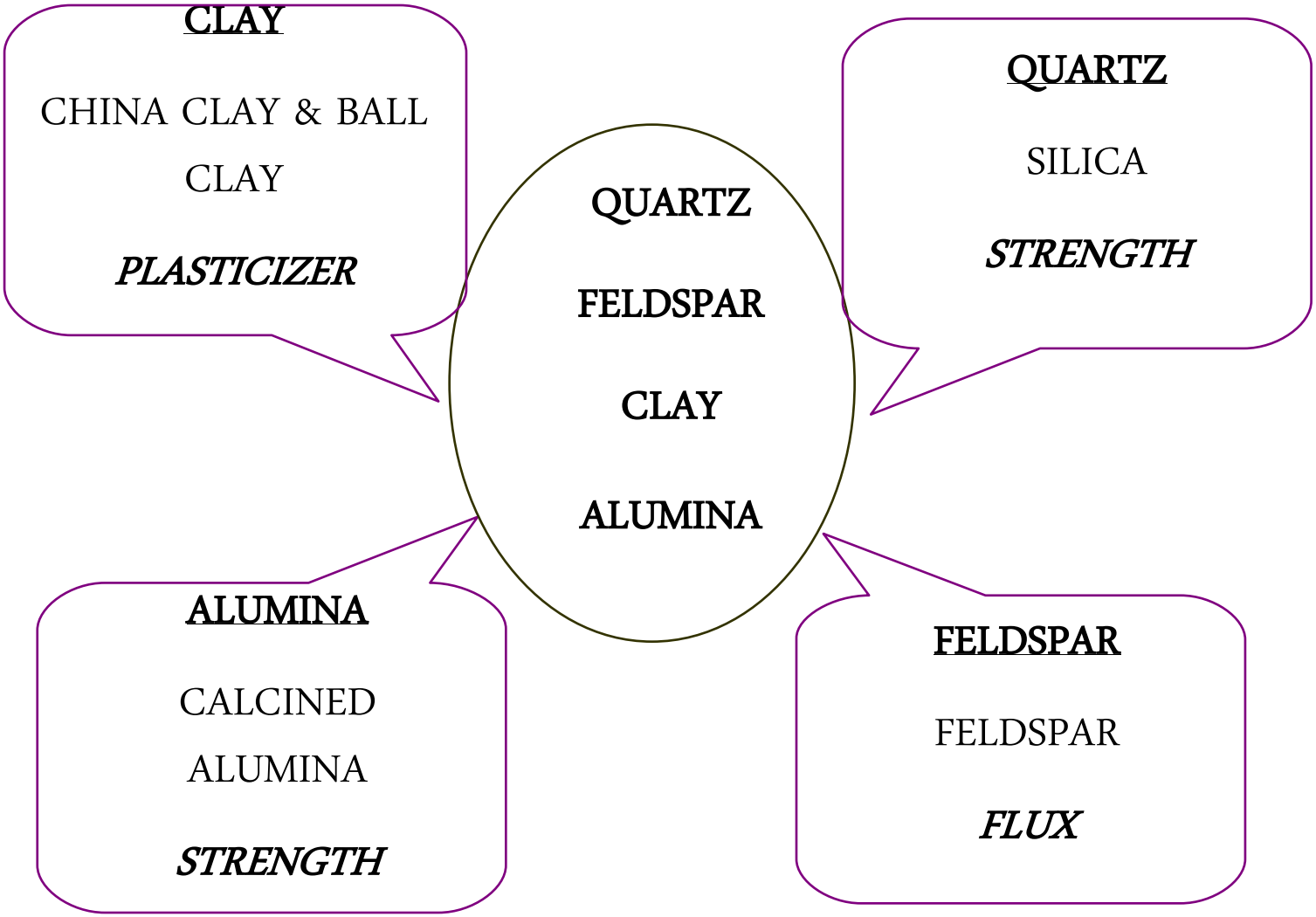

CUTTING & GRINDING


CEMENT & ASSEMBLY


TESTING


FINAL INSPECTION


PACKING & DESPATCH


CLAY
CHINA CLAY & BALL CLAY
PLASTICIZER
QUARTZ
SILICA
STRENGTH
QUARTZ
FELDSPAR
CLAY
ALUMINA
ALUMINA
CALCINED ALUMINA
STRENGTH
FELDSPAR
FELDSPAR
FLUX

TESTING

Need for tests

- INSULATORS HAVE TO WITHSTAND THE RATED LOADS UNDER SERVICE CONDITIONS (EDS OF 40% MINIMUM)
- INSULATORS HAVE TO WITHSTAND THE RATED VOLTAGE.
- INSULATORS SHOULD ALSO WITHSTAND THE TEMPORARY POWER FREQUENCY AND LIGHTNING OVERVOLTAGES.
- INSULATORS ARE ALSO SUBJECTED TO SHORT CIRCUIT CURRENTS IN SERVICE.
- POLLUTION PERFORMANCE OF INSULATORS IN SERVICE IS VERY CRITICAL IN HIGHLY POLLUTED AREAS.
- THERMAL STRESSES ALSO ACT ON INSULATORS IN SERVICE.

- STANDARDS CALL FOR THE FOLLOWING SEQUENCE OF TESTS:

- TYPE (DESIGN) TESTS

- ACCEPTANCE TESTS

- ROUTINE TESTS

THREE PROPERTIES OF INSULATORS PLAY IMPORTANT ROLE IN PERFORMANCE

- ⇨ MECHANICAL
- ⇨ ELECTRICAL
- ⇨ THERMAL

ALL INSULATORS ARE TESTED IN CONFORMANCE TO THE RELEVANT IS / IEC / STANDARDS AND CUSTOMER SPECIFICATIONS

Detail of tests

Design (type) tests	Stress
Visible discharge	Electrical
Impulse voltage withstand	Electrical
Wet power frequency withstand	Electrical
Temperature cycle	Thermal
Electro-mechanical failing load	Mechanical
Mechanical performance	Mechanical
Puncture	Electrical
Porosity	Electrical
Galvanizing	

Detail of tests

Acceptance tests	Stress
Temperature cycle	Thermal
Mechanical performance	Mechanical
Electro-mechanical failing load	Mechanical
Puncture	Electrical
Porosity	Electrical
Galvanizing	
Routine tests	**Stress**
Visual examination	
Mechanical routine	Mechanical
Electrical routine	Electrical

MECHANICAL TESTS

- HYDRAULIC PROOF TEST ON SHELLS
- ROUTINE MECHANICAL TEST
- RESIDUAL STRENGTH TEST
- IMPACT TEST
- MECHANICAL PERFORMANCE TEST
- ELECTRO-MECHANICAL FAILING LOAD TEST
- THERMAL MECHANICAL PERFORMANCE TEST
- MECHANICAL TEST ON COMPLETE STRINGS
- VIBRATION TEST ON COMPLETE STRINGS

ELECTRICAL TESTS

- HIGH FREQUENCY TEST ON SHELLS
- POWER FREQUENCY ROUTINE ELECTRICAL TEST
- UNDER OIL PUNCTURE TEST
- POWER FREQUENCY WITHSTAND TEST
- IMPULSE WITHSTAND TEST
- STEEP FRONT WAVE TEST
- POLLUTION TEST
- POWER ARC TEST

THERMAL TESTS

- TEMPERATURE CYCLE TEST
- THERMAL-MECHANICAL (AGEING) TESTS
- SHORT CIRCUIT (POWER ARC) TESTS

OTHER TESTS

- VISUAL INSPECTION
- DIMENSIONAL VERIFICATION TESTS
- AXIAL AND RADIAL RUNOUT TESTS
- GAUGE CHECKS ON HARDWARE
- LOCKING DEVICE TESTS
- GALVANIZING TESTS ON HARDWARE
- POROSITY TESTS

SPECIAL TESTS ON DISC INSULATOR UNITS

- STEEP FRONT OF WAVE FLASHOVER TEST
- POWER ARC TEST
- POLLUTION TEST
- RIV TEST

(upon specific request from the customers)

TESTS ON DISC INSULATOR STRINGS

- DRY LIGHTNING IMPULSE VOLTAGE WITHSTAND FLASHOVER TEST
- WET SWITCHING SURGE WITHSTAND TEST
- DRY & WET POWER FREQUENCY WITHSTAND AND FLASHOVER TEST
- VOLTAGE DISTRIBUTION TEST
- POLLUTION TEST
- RIV AND CORONA TEST
- VIBRATION TEST
- MECHANICAL STRENGTH TEST

INSULATOR SELECTION

SELECTION OF RATING OF DISC INSULATORS FOR VARIOUS SYSTEM VOLTAGES

E&M RATING OF DISC INSULATORS TO BE USED IN VARIOUS SYSTEMS IS BASED ON THE FOLLOWING FACTORS AND PARAMETERS:

- CONDUCTOR WEIGHT AND SAG
- TOWER CONFIGURATION
- STRING CONFIGURATION
- HORIZONTAL ANGLE
- TOWER LOCATION & LANDSCAPE
- WIND PRESSURE
- ICE AND SNOW LOADS
- ABNORMAL LOADS DUE TO GALLOPING, CONDUCTOR SNAPPING ETC.

SELECTION OF RATING OF DISC INSULATORS FOR VARIOUS SYSTEM VOLTAGES

TYPICAL RATINGS USED IN INDIAN SYSTEMS

- 33 kV SYSTEMS - 45 KN & 70 KN
- 66 kV SYSTEMS - 70 KN & 90 KN
- 132 kV SYSTEMS - 70 KN & 120 KN
- 220 kV SYSTEMS - 90 KN & 120 KN
- 400 kV SYSTEMS - 90 /120 KN & 160KN
- 500kV DC SYSTEMS - 160 / 210 KN DC
- 800kV AC SYSTEMS - 120 / 210 KN
- 1200kV AC SYSTEMS - 320 / 420 KN

SELECTION OF RATING OF DISC INSULATORS FOR VARIOUS SYSTEM VOLTAGES

TYPICAL RATINGS USED IN INTERNATIONAL SYSTEMS

◆ UPTO 345 kV SYSTEMS	-	70KN,120 KN &160 KN
◆ 500 kV SYSTEMS	-	120 KN & 160 KN
◆ 800kV SYSTEMS	-	160 / 210 KN
◆ 1200kV SYSTEMS	-	320 / 420 KN

HANDLING

- Unload the crates carefully from the lorry.
- Do not roll the crates from the lorry. Use fork lift trucks for unloading or pick up one crate at a time by hand and place them on the floor.
- Do not dump the crates on the floor. Stack them properly.
- Do not stack more than 5 crates one over the other. Ensure the stacking does not damage the insulators on the bottom crate.
- Open the crates carefully without damaging the insulators.
- Visually examine the insulators for transit damages, if any.
- Check the cement uniformity in the exposed area around the ballpin

- Clean the insulators thoroughly with clean cotton waste. Do not use steel wool or other abrasive material.
- Check that the locking device of the insulator is in position to allow insertion of ballpin. (Locking device to be pulled backwards)
- Insert the ballpin of one insulator into the cap of the next insulator.
- Move the locking device into locking position. (Locking device to be pushed forward into the cap)
- Spread the legs of the locking device to ensure accidental unlocking.
- Check the string hardware for proper design and dimensions.

- Fix the required hardware to the insulator string.

- Lift the insulator string in such a way that the ballpins of the insulators do not bend.

- Please ensure that no external load is placed on the disc insulator string apart from the self-weight of the string, while lifting.

- Please ensure that the insulator string is not used as a ladder. Do not climb on the insulator strings.

- After fixing the string to the tower align the line end and tower end arcing horns in position.
- Ensure that all bolts and nuts are tightened properly and all locking devices are secured correctly in the locking position.

INSTALLATION

- Normally no inspection in field is required for disc insulators as every single insulator despatched from the factory is subjected to routine visual inspection, electrical and mechanical tests.

- However in order to check for damages during transit and handling the following steps may be adopted:

- Check the insulators visually for any transit damages like chipping, glaze defects, excess white spots etc..

- Check the soundness of the insulator using MEGGER.
  The resistance value should be greater than 50 M Ohm.

- The insulators assemblies (insulators and hardware fittings) shall be installed according to the specifications and drawings issued by the customer/user in a proper manner, according to the best practice of transmission line construction.

- The customer/user shall clean the insulators before their installation. The insulating portions shall be thoroughly clean and the metal portion free of corrosion or other damage to the galvanizing.

- Broken or damaged insulators shall not be installed.

- Do not make strings with various makes of insulators.

- Use proper stringing equipments for stringing of the insulators.

TROUBLESHOOTING

- **DECAPPING**
- **PUNCTURE (POROSITY)**
- **CORRODED METAL PARTS**
- **DIMENSIONAL DEVIATIONS**

Trouble	Cause	Remedy
De-capping	Improper selection of raw materials. Inadequate facility for testing of raw materials Use of incorrect quality of cement Improper assembly methods Incorrect curing process	Select proven raw materials based on experience Use sedigraph, XRF and other equipments Use the right quality of cement and ensure proper cement mortar ratio Use proven curing methods and adequate time for curing

Trouble	Cause	Remedy
Puncture (Porosity)	Improper grading of raw materials. Inadequate facility for manufacturing Improper vitrification Improper grading of insulators in a string Improper clearances in installation	Select quality raw materials Use highly efficient manufacturing methods with precise quality control on all stages of manufacture. Use state-of-the-art kilns with excellent controls Ensure proper shell testing and routine testing of assembled insulators Use proper design of hardware Ensure sufficient clearances between equipments

Trouble	Cause	Remedy
Corroded metal parts	Use of poor quality materials for cap and ballpin Incorrect procedure for galvanizing Lack of proper equipment for checking of galvanizing	Select certified SGI and forged steel for caps and ballpins. Proper method of galvanizing with precise control of temperature and dipping time Use industry standard and good quality equipment for checking the galvanizing.

Trouble	Cause	Remedy
Dimensional deviation	Improper method of manufacturing Improper assembly Improper curing Incorrect routine testing methods	Use of precisely machined tools and moulds for manufacture Use of precise assembly jigs with alignment control and vibration Proper routine testing methods and ensuring sufficient curing prior to testing Strict quality control during the final inspection on 100% of insulators prior to despatch

RECOMMENDATIONS

- Select insulator with high creepage distance – Use antifog in place of normal for heavily polluted zones
- Use manufacturers with infrastructure, equipment & test facilities.
- Periodic inspection of line.
- Longer life insulators.

CONCLUSIONS

- Excellent facility for raw material evaluation
- Proper infrastructure for manufacturing
- Trained / skilled manpower
- Good engineering team (Electrical / Ceramic)
- Excellent quality assurance system
- Experience / track record

For more details contact:anitagupta@ieema.org