OJEATC Wind Turbine Trainer

Controller

- Bottom of the tower
- Sits on ground ring and pad
- Transformer block outs are in place

Bottom of base

- Base of the tower
- About 70 feet tall

Nacelle

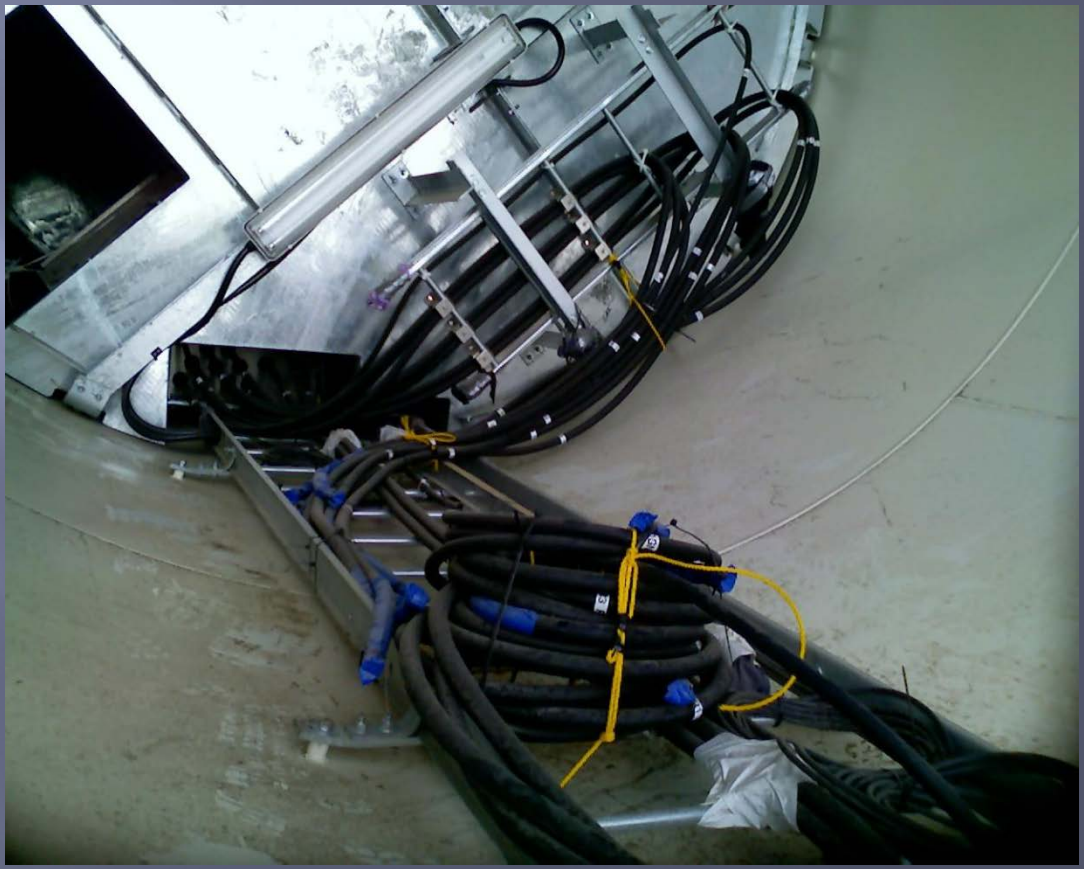
- Sits on top of the tower
- Rotor is placed on the front

Tubes

- Pieces of the towers ready to be staged

Inside base

- Under first deck
- Stator and rotor cables



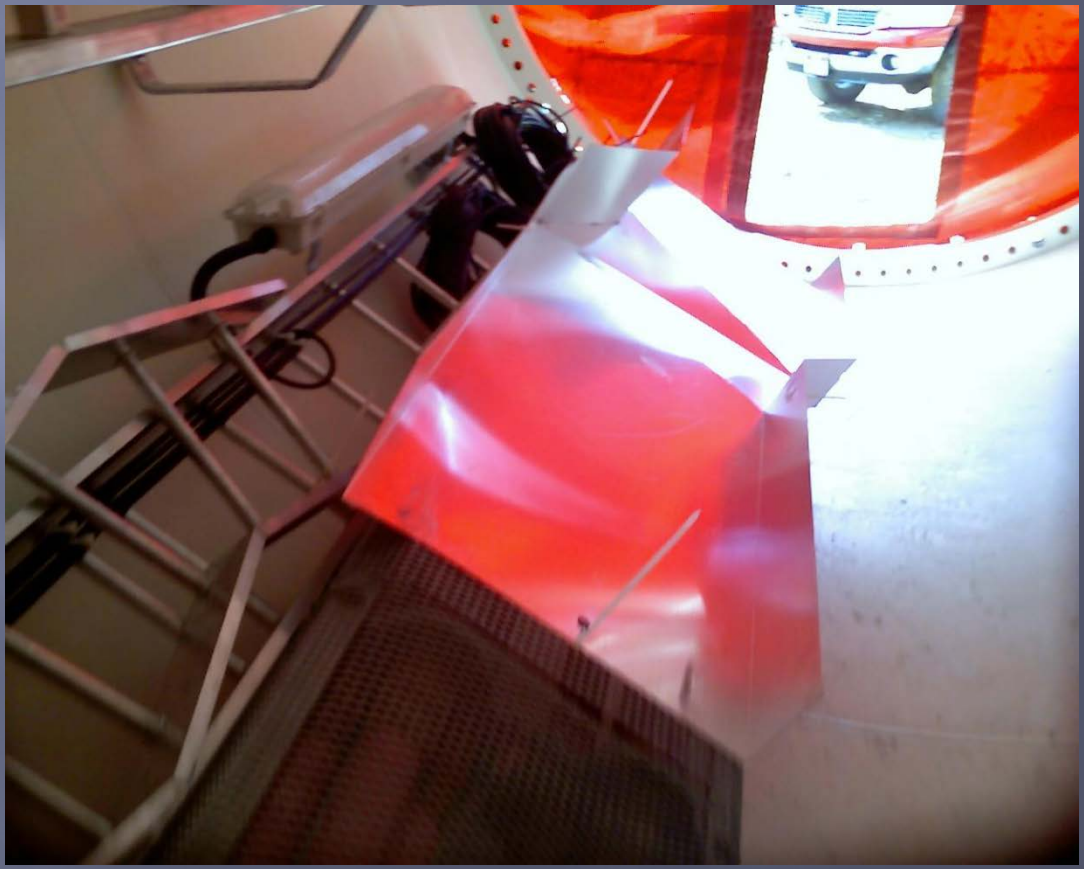
Top of base

- Straight buss insulators and braids staged
- To connect lower mid to top of base

Bottom Mid

Bottom of top

- Cover for buss and cable tray splice staged



Saddle deck

- Cable splice cover staged
- Lamps placed in all lights before lifting

Top of top

- Hoist for owners use

Top of nacelle

- Wind direction and speed
- Temp and permanent F.A.A. lights

Hub

- With various motors and control boards

Crane

- To set towers

Turbine Blades and Nose Cone

- Assembled on the ground

Setting the towers

- One by one the parts are placed

Conductors enter tower base

The point were the power conductors enter the tower from the transformer.

Control cabinet

STATOR CABLES

CONTROL CABLES

Cable tray

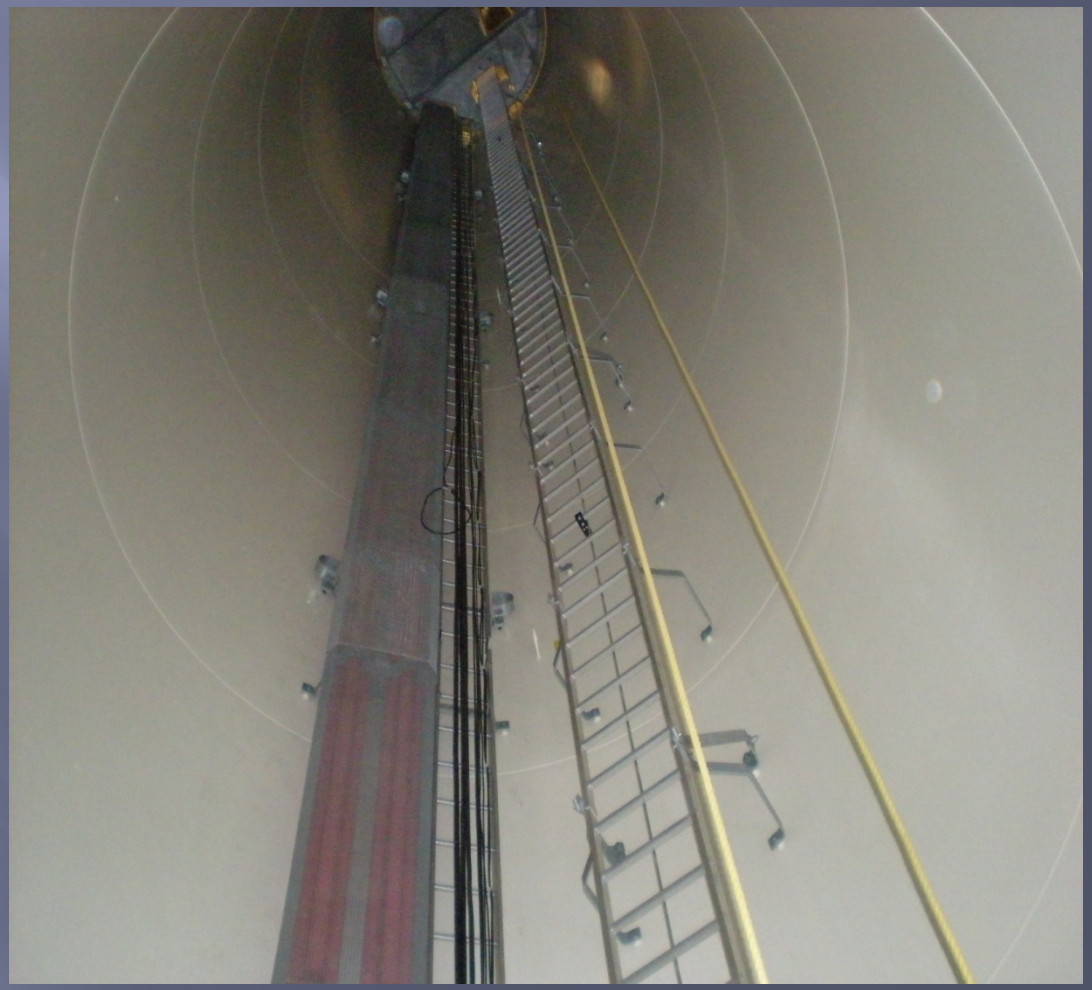
Under the control cabinet the cables are ran to the proper places

Next level

Travel rope is in place.

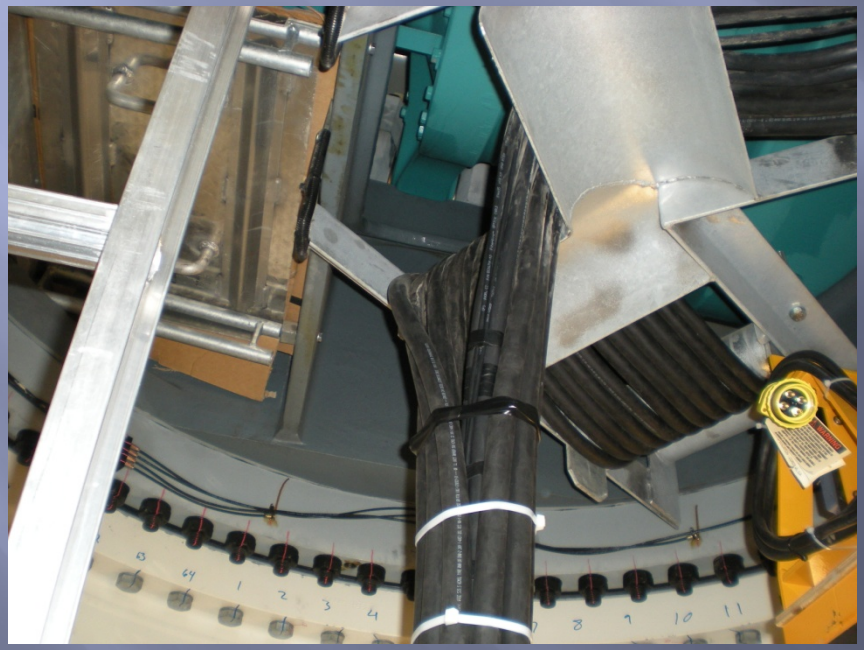
Control cable is on it's way down.

Ladder, safety wire, buss and covers can also be seen.



Yaw deck

CONTROL CABLES AT THE TOP



ENTERING THE DRUM

sun rise sun set

What is work like on wind farm?

Depending on the scheduling, hours start at 7:00 to 5:00 PM. Usually six days a week, sometimes 7 days a week.

Work conditions are outdoors and year round, so it his very hot or very cold with a couple nice weeks in between.

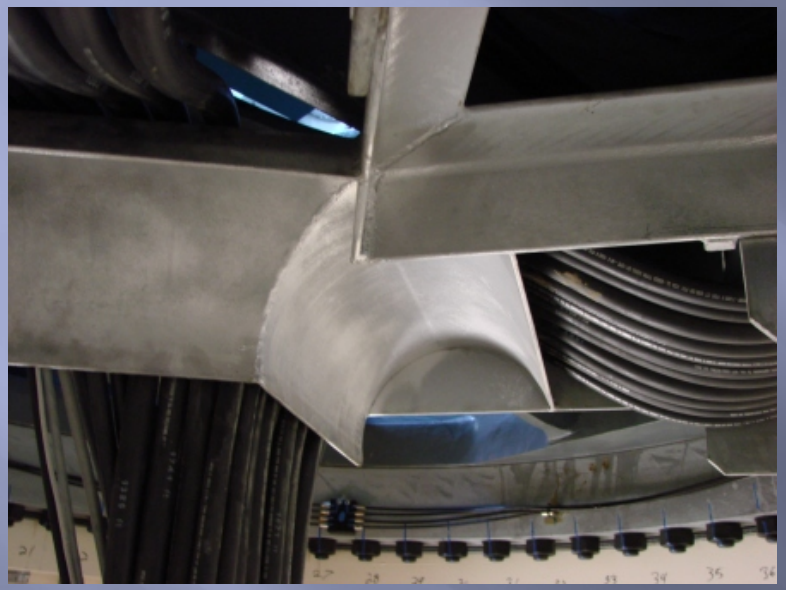
Cramped Conditions

Cramped Conditions

Inside Nacelle

Cable Management

Cable Management



Climbing the Ladderway

Working the Cable Tray

Out on the nose cone

Tower Sections are spliced together

The importance of proper torque

Manufacturers Quality Assurance/Quality Control Standards apply to all terminations, connections, and splices.

Each bolt of each splice is tightened to proper torque specifications, marked, checked, final checked and then checked again during commissioning phase.

It is that important.

Torque Training Component

Info Sheet

The photo above shows an IBEW-NECA trained JW electrician applying the appropriate amount of torque to the terminations of a breaker. There are several things to point out in the photo:

1. It is important to always pull the torque wrench toward you and not push it.
2. Use a smooth and fairly slow movement.
3. Preset the torque wrench to the manufacturer's requirements and keep your attention to the amount of level applying.
4. Do not torque energized conductors. Even if the customer ask for you to do so, remind them it is not safe and against 70E safety.

This photo shows an industrial breaker that is rated for 65 k AIC. It is a 200 amp, 3-pole breaker in a 480 volt power panel. At the bottom left of the breaker is a factory label that lists the torque requirements. The termination lugs are Allen heads, therefore the installer will use a combination of socket Allen head to square drive socket for the torque wrench.

Note that the factory label denotes different torque requirements for the Socket Head (Allen) versus the Slotted Head terminations. This particular breaker does not have slotted head terminations—it is common for the same label to be placed on several size breakers. In addition to the type of heads, the level of torque increases proportionally with the size of the termination head.

bolt head actually spins off and breaks away from the bolt assembly. At this point the level of torque for that bolt assembly has been achieved. One of the big ideas behind this design is obvious, to reduce the amount of man-hours of installation, therefore reducing the cost of the installation.

The advantage to this system is:

- Lower installation cost
- Correct level of torque applied
- No special torque wrenches required
- Less man-hours of installation
- No chance to over-torque

Breaker Torque Requirement

Cutler-Hammer

Industrial
Circuit Breaker Frame

HND 65k

1200 AMPS MAX 3 POLE
600 VAC
CAT # HND312T32W
STYLE # 1488D02G14 40°C
USE WITH....
RATING PLUG CAT 12NE8 * T
AMPS – 600,700,800,900,1000,1200
ADJ R PLUG CAT. A12NE81200T1
AMP SETTINGS 600,800,1000,1200
* INSERT AMPS TO COMPLETE
D9D918

Terminal Cat. No.	Wire Size AWG/MCM	Conductor Material	Torque Lb-in
TA700NB1	1 – 500 (2)	CU/AL	375
TA1000NB1	3/0 – 400 (3)	CU/AL	375
TA1200NB1	4/0 – 500 (4)	CU/AL	375
TA1201NB1	500 – 750 (3)	CU/AL	450
T700NB1	2/0 – 500 (2)	CU ONLY	360
T1000NB1	3/0 – 500 (3)	CU ONLY	360
T1200NB3	3/0 – 400 (4)	CU ONLY	275

As discussed earlier, the manufacturers of electrical equipment have designed and engineered their equipment with a particular level of torque required. These levels insure the appropriate "tight" connection to assure a low resistive connection and to combat again the assembly loosening in the future. The *NEC* points out that the installer should apply the torque levels as recommended by the manufacturer of the equipment. Therefore, the installer must review all documentation that ships with the equipment as it relates to torque.

Often times the information is a label directly placed near the termination location. The photo (in the left column) shows an actual label placed on a 1,200 amp breaker. The top portion of the label is non-related to torque requirements, but the bottom part spells out the exact amount of Lb-In that is required for: (1) Terminal used; (2) Conductor size; and (3) Conductor Material. Notice that the torque requirement for 500-750 MCM is 450 Lb-in. A small torque wrench will not be able to achieve this level of torque. Lesson 4 of this workbook covers the wide variety of available torque wrenches from CDI. You might want to take this time to review.

As listed in the breaker label, often times the termination of conductors uses multiple conductors. For example, Termination Cat. No T700NB1 requires two 2/0 AWG or 500MCM. The above photo shows two 2/0 AWG conductors terminated at the breaker. It is important to apply the correct amount of torque to these terminations to reduce the chance of a high resistance connection and build up of destructive heat. The bottom termination's slot is toward the back of the block and the top termination is toward the front of the block.

Info Sheet

TOWER CLIMB

Climbing the tower 3 times under 8 minutes and 30 seconds, adding five pounds on the second and third trip.

CLIMBING WALL

Using positioning device to do hands-free work

Aerial rescuing

Self aerial rescuing

LEAP OF FAITH

Jump from 12-foot platform using auto-descender

TRAINER DIMENSIONS

55 feet Tall

Platform at 48 feet

3 ladders with 100% tie-off cabling

AERIAL HANDS-FREE WORK EXERCISE

- 50 feet above ground
- Establish secure anchor point
- Maintain 100% tie-off
- While suspended, complete exercise with tools

TOWER RESCUE

- Simulated Tower Rescue with 160 lb training dummy
- Training offered to fire and rescue first-responders

Medium Voltage Splicing and Terminations

Todd Crisman

6 hours

NJATC Medium Voltage Splicing and Terminations Definitions

- Electrical Theory
- Types of Insulation
- Cable Construction
- Splice/Termination Performance

Insulation

- Butyl Rubber
- Cross-linked Polymer
- Dielectric
- Dielectric constant
- Elastomer
- EPR
- Gradient
- Insulation
- Neoprene
- Poly-PE
- Polymeric
- Polymers
- PVC
- Rubber link
- Vulcanize
- Extrude
- Thermoplastic
- thermosetting

Cable Construction

- Annular conductor
- Bunch stranding
- Compact stranding
- Concentric stranding
- Conductor
- Jacket
- Sector conductor
- Segmental conductor
- Semi-con tape
- Shielding
- Strand shielding
- Stress cone

Splice/Termination Performance

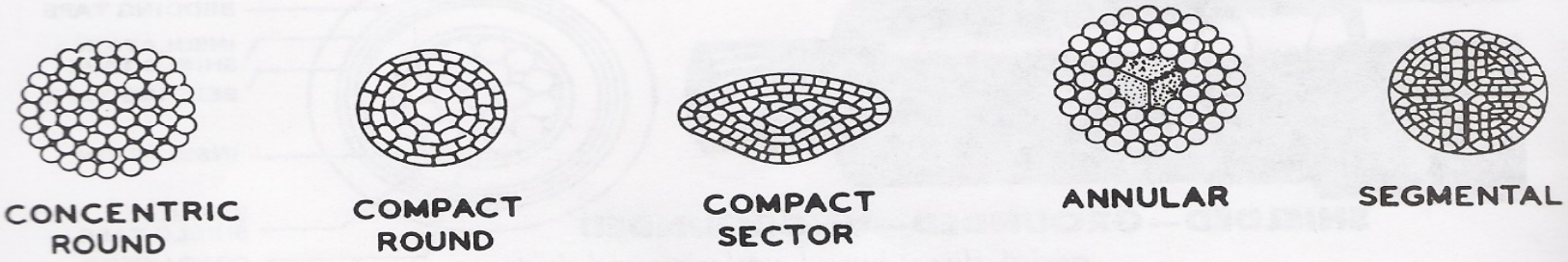
- Cable splicer
- Cable splicing
- Corona
- Corona cutting
- Corona level
- Creepage distance
- Erosion resistance
- Floating shield
- Ionic emmision
- Ionization
- Leekage distance x2
- Longitudinal stress
- Ozone
- Pencilling
- Pothead
- Radial stress
- Skin effect
- specifications

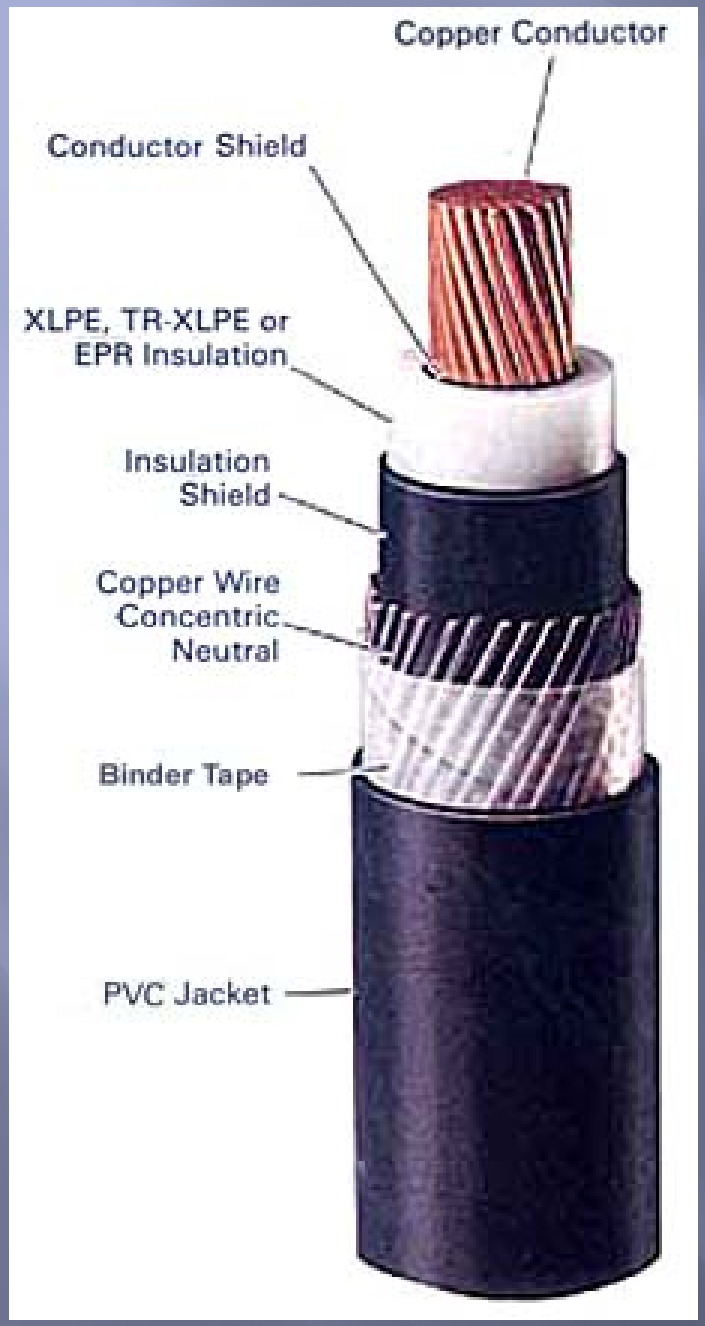
Splice/Termination Performance

- Splice
- Tangential stress
- Termination
- Tracking
- Tracking resistance
- Tracking induced erosion
- tracking

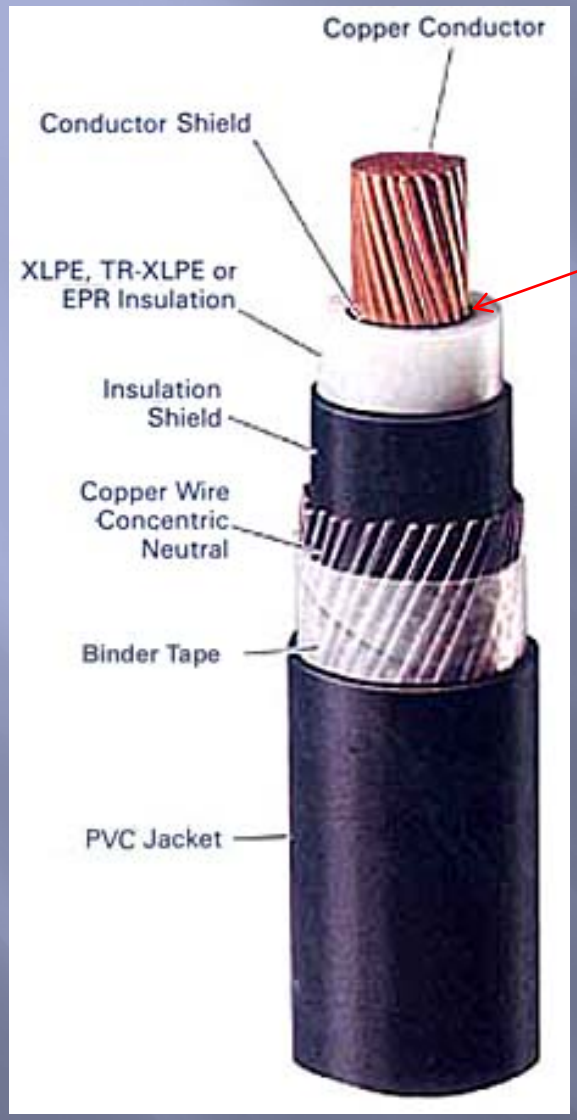
Types of Stranding

- Concentric Round
- Compact Round
- Compact Sector
- Annular
- Segmental



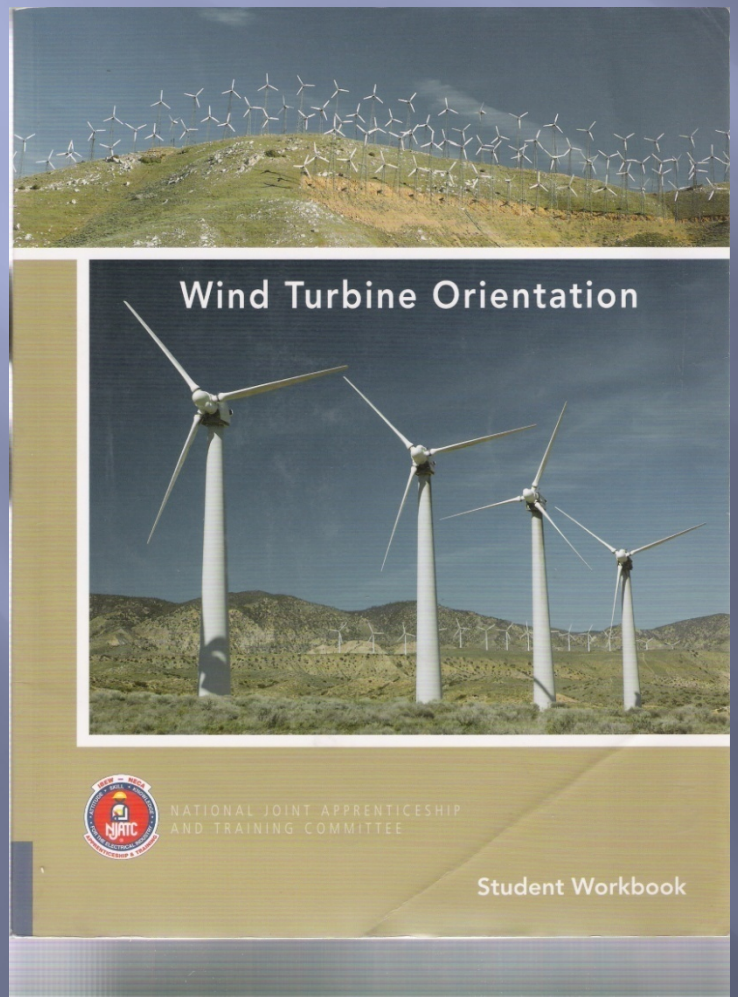


The Medium Voltage Cable



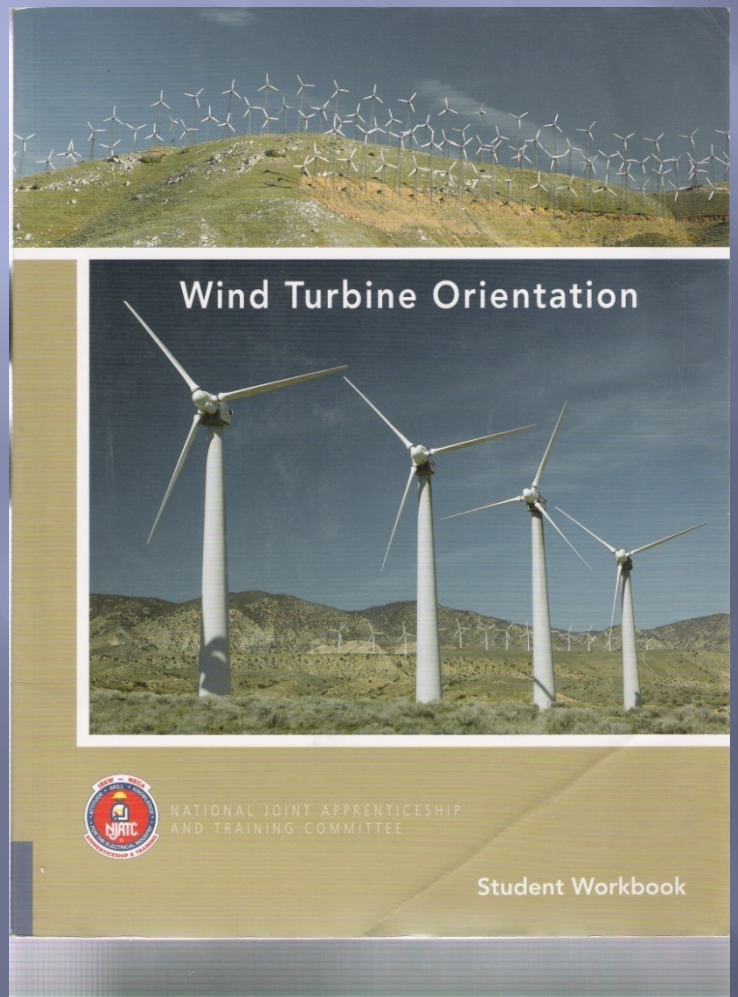
The Strand Shielding – the purpose of this is to correct the ionization of air and creation of ozone that could breakdown the insulation. This exists because of the difference of potential between the air voids and the conductor. The strand shielding is composed of a semiconductive material.

Lesson12 – Cable Splicing Introduction



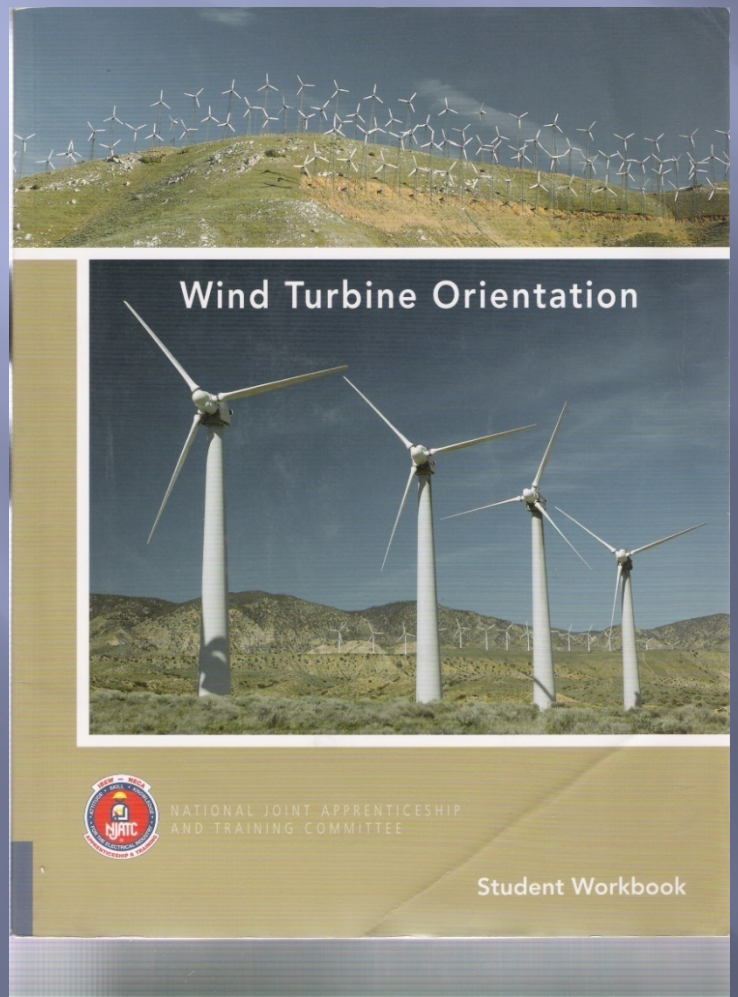
- National Electrical Code
- Insulation levels
- Cable Selection
- Tracking/Surface Current

Lesson13 – Splicing Materials and Tools



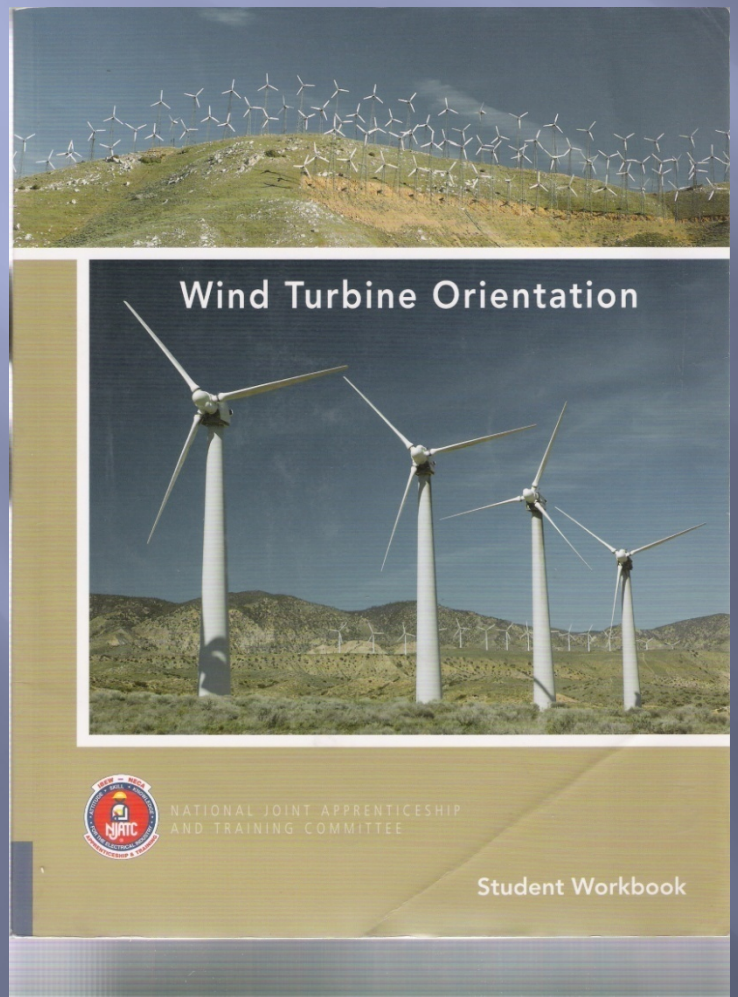
- Types of Insulations
- Tools
- Information Sheet

Lesson14 – Cable Preparation



- Workmanship
- Cable breakdown
- Cable cleaning

Lesson15 – Shielded Tapes and Purpose



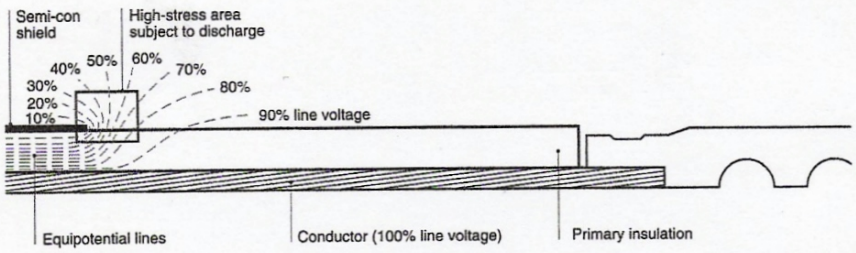
- Strand shielding
- Insulation shielding
- Purpose of shielding
- corona

Electrical stress control

Shielded power cables require electrical stress control when terminated. When the insulation shield is removed from a cable, the electrical field is concentrated at the cutback point, causing high electrical stress. If the stress is great enough, it can cause the air to break down, resulting in corona. High-stress areas also cause internal discharges. Corona or internal discharges will ultimately destroy the cable insulation, causing premature failure.

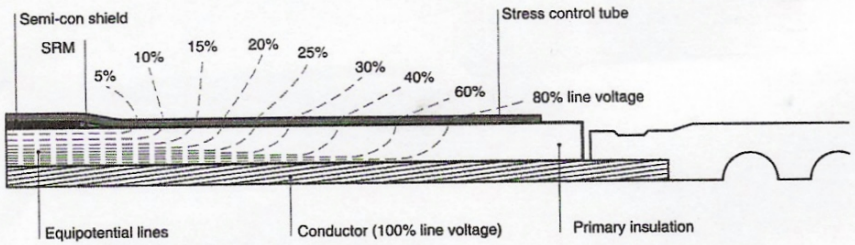
Cable termination without stress control

The diagram below shows an energized cable termination without stress control. The electric field intensity is greatest where the equipotential lines (line of constant voltage) are concentrated. Note the concentration near the edge of the semi-con shield. Stress control is required here to reduce the electrical stress below levels at which the air would break down or discharges would occur in the insulation.



Cable termination with Tyco Electronics' unique stress control system

With Tyco Electronics' stress control tube installed, the equipotential lines are spread out, distributing the electrical field and reducing the electrical stress to the cable insulation's operating level, as shown in the diagram below. This is achieved by the unique resistive and capacitive properties of the heat-shrinkable material. Note that no diameter buildup is required as in a conventional stress cone that utilizes its geometry to reduce stress.



SOME OF OUR PROGRAM GRADUATES