**March 2021**

**EPRI Motor/Generator Rewind Seminar**

**Summary**

This three and one-half day seminar is for specialists and non-specialists who specify, contract, and accept motor or generator repairs and rewinds. It is a unique course focusing on the art and science of medium voltage motor windings. Just about all facts of motor stator windings are offered during the three and one-half days of presentations and discussions. The presenters, Elton Floyd and Chase Fell, as a team, present the material and facilitate discussion within the class. The discussion provides a way to share the experience and wisdom of the attendees which greatly enhances the understanding of the material being presented.

**Instructors**

**Elton Floyd** has over 50 years of experience in the electric power industry. His primary experience is with electrical rotating machinery, particularly with steam turbine generators and the large boiler auxiliary motors. He has had responsibility for technical support for other major power plant electrical and electronic equipment.. Elton is a registered Professional Engineer in the State of Texas.

**Chase Fell** is Vice-President of Engineering for Jay Electric Co. and Jay’s Precision Coil Co. of Birmingham, AL. He has previously worked at Anderson Consulting, Reliance Electric, ESSEX- Brownell Wire and Montevallo Electric. He holds a BSEE degree from the University of Alabama and a BA degree from Auburn University. Chase brings a wealth of experience to the seminar from actually repairing large industrial size induction and synchronous motors, DC motors, hydro generators turbine generators as well as coil manufacturing.

**Author**

**Jim Oliver** (1928 – 2019) assembled most of the course material while an EPRI contractor. Jim received a BSEE degree from the University of Maine, a MEE degree from Brooklyn Polytechnic Institute and has taken several business courses at NYU. For many years he was an engineer or an engineering consultant on electric machinery projects for American Electric Power, National Electric Coil, Bechtel Corporation, EPRI and later on with his own JARSCO Engineering Corp. He was a Fellow of the IEEE. For 30 years, Jim was involved with the instruction of the Motor/Generator Rewind Seminar.

This course is presented at the **TECO-Westinghouse Motor Company** in Round Rock, TX.

**About TECO-Westinghouse**

With over 100 years of experience in motor design and application, TECO-Westinghouse Motor Company (TWMC) is a premier supplier of AC and DC motors and generators. Their 500,000 square foot facility in Round Rock, Texas has both manufacturing and repair operations for large AC induction and synchronous motors, as well as DC motors. Ranging from fractional HP ratings to 100,000 HP, these high-quality machines are utilized in petroleum, chemical, mining, marine propulsion, steel, electric utility, and other industries throughout the world. The facility has coil, laminations, frame, rotor, and shaft manufacturing, and a 12-ft. VPI tank. It also has complete test facilities:full voltage, full speed run-up, heat run, locked rotor, sound level, vibration analysis, and insulation testing. TWMC also manufactures and supplies motor controls, engineering services, genuine Westinghouse and TECO-Westinghouse renewal parts, and provides large motor repairs. The TWMC Service Group focuses on after-market sales, repair service, product re-design and upgrades, engineering/technical assistance, and problem solving.

**Course Content: the following extensive list covers topics which are in this seminar**

* **Intro - Electric Machines**
* **Motor types**
	+ **Induction motor**
		- **Squirrel cage type**
			* **Fabricated bar rotor**
			* **Die-cast aluminum rotor**
		- **Wound rotor motor**
			* **Rotor resistor speed control**
			* **Rotor voltage speed control**
	+ **Synchronous**
		- **High-speed solid-rotor**
		- **Laminated rotor, copper cage**
		- **Solid steel rotor - pole caps**
* **Generator Types**
	+ **High-speed, solid rotor, turbo**
	+ **Low-speed, hydro type**
	+ **Doubly-fed wind generators**
* **Establish cause of failure**
* **Routine repairs**
* **Motor rewind specifications**
	+ **Sample specs 2300 & 4000 v**
	+ **Sample specs - 6.6, 13.3 kV**
	+ **sample spec - 600v motor**
	+ **MRX forms**
	+ **LEMUG motor rewind spec**
	+ **Shop Traveler**
	+ **Quality Control Management**
	+ **Economics – Rewind vs New**
* **Limiting motor temp. rise**
	+ **What do the standards say?**
	+ **Vent. pattern on winding temp.**
	+ **Rotor temp. rise during starting**
	+ **Calc. accel. time for high WR2**
* **Stator insulation systems**
	+ **Wire insulation**
	+ **Turn insulation**
	+ **Ground insulation**
	+ **Types of insulation systems**
		- **VPI insulation**
		- **Resin-rich insulation**
		- **Non-VPI or dry insulation**
* **Resin properties**
	+ **Helical coil bond strength**
	+ **High DC voltage resistivity**
	+ **Good for high temp. AC volts**
	+ **Thixotropy used for**
		- **No run-out after impregnation**
* **Coil transpositions**
	+ **Standard Roebel transposition**
	+ **540 degree Roebel**
	+ **Twisted-turn transposition**
	+ **Group transposition**
* **Coil Structure**
	+ **Brick construction**
	+ **Standard construction**
* **Coil redesign example**
	+ **Current density - flux density**
	+ **Void concern – Paschens Law**
	+ **Choice of number of circuits**
	+ **Equalizer connections**
	+ **Unbalanced magnetic pull**
* **Types of windings**
	+ **Integral slot windings**
	+ **Fractional slot windings**
	+ **Interspersed windings**
	+ **Wave windings**
	+ **Lap windings**
	+ **1 & 4 connection**
	+ **1 & 7 connection**
	+ **2-speed, single winding types**
	+ **PAM windings**
	+ **Various connection diagrams**
* **Making brazed connections**
* **Current density**
	+ **Amperes per square inch**
	+ **Circular mil per amp**
* **Coil manufacturing**
* **Winding a motor stator**
* **Insulation temp qualification**
* **Insulation voltage qualification**
* **Thermal cycling test**
* **Motor losses & efficiency**
	+ **Input/output**
	+ **Segregated Losses**
	+ **Retardation**
	+ **Load Testing**
	+ **Dynamometer**
	+ **Back-to-back**
	+ **Dual frequency**
	+ **Forward stall**
* **Coil and winding failures**
* **Coil and winding tests**
	+ **Conductor to ground tests**
	+ **High frequency tests**
* **Repair shop test capabilities**
	+ **Winding resistance**
	+ **Insulation resistance**
	+ **Polarization index**
	+ **Surge test**
	+ **AC/DC hipot**
	+ **Reduced voltage starting**
	+ **Operation at full speed, N.L.**
* **Other tests**
	+ **Winding analyzers**
		- **Baker**
		- **All Test Pro**
		- **PDMA**
		- **Partial discharge, Iris/Doble**
	+ **Broken rotor bar tests**
* **Stator core construction**
	+ **Core steel components**
* **Stator core testing**
	+ **Commercial core tester**
	+ **Loop test**
	+ **El Cid**
* **Rotor Construction; copper vs. aluminum windings**
* **Bearings**
	+ **Guide**
	+ **Thrust**
	+ **Sleeve**
	+ **Anti-friction**
* **Lubrication – Oil (additives, viscosity), grease types,**
* **Bearing failure causes, cures**
* **Motor application**
* **Operation and environment,**
	+ **On-line protection/monitoring**
* **Maintenance strategy**
	+ **Corrective**
	+ **Preventative**
	+ **Predictive**
	+ **Tired**
	+ **Trending**
* **Root cause analysis**
* **TECO – Vibration and**

**“Wall of Shame” - Hilarious**

**Registration**

The fee for the Rewind Seminar is $1,995.00 and includes hard copy manuals, electronic materials on CD, breakfast on each day of the seminar, and lunch on Tuesday, Wednesday and Thursday.

To register, return the completed registration form with payment to: Chase Fell, Jarsco Engineering, 5280 East Lake Boulevard, Birmingham, Alabama 35217. Credit cards are preferred. Checks should be made payable to JARSCO Engineering Corp.

Information

For information on the seminar, contact:

Chase Fell, Jarsco Engineering, 5280 East Lake Boulevard, Birmingham, Alabama 35217, United States

Chase Fell e-mail: chase.fell@jarsco.net phone: ( 205 ) 438-0085 Elton Floyd e-mail: elton.floyd@jarsco.net phone: (903) 513-0971

For information about TWMC, contact:
Lana DeLeon: Tel: 512-218-7409, E-mail: deleonl@tecowestinghouse.com

**Accommodations**

There are many hotels in Round Rock, some are listed here. Ask for the TECO-Westinghouse corporate rate when making reservations.

**Round Rock, TX 78681**

**Courtyard Marriott**

**2700 Hoppe Trail**

**I-35 at FM 3406**

**West Side of I-35**

**(512) 255-5551**

**SpringHill Suites by Marriott Austin**

**2960 Hoppe Trail**

**West side of I-35**

**(512) 733-6700**

**Hilton Garden Inn**

**2310 N Interstate 35**

**I-35 at FM 3406**

**West Side of I-35**

**(512) 341-8200**

**Holiday Inn Austin North**

***TECO Rate Incudes Breakfast Voucher***

**2370 Chisholm Trail**

**West Side of I-35**

**(512) 246-7000**

**Wingate Inn**

**1209 Interstate 35**

**I-35 N. of Hwy 79**

**East Side of I-35**

**(512) 961-1732**

**Hampton Inn \***

**110 Dell Way**

**I-35 N. of I-45**

**East Side of I-35**

**(512) 765-9999**

**\* Complimentary hotel shuttle for locations within 5 mile radius (TWMC is within this distance).**

**Travel**

Direct automobile travel to Round Rock, TX, or air travel to Austin Bergstrom International Airport. Round Rock is approximately 25 miles north of downtown Austin. TWMC is located at 5100 North IH-35, Round Rock, TX 78681.

For a map, please visit the following website: www.tecowestinghouse.com/visit-us/.

**Agenda – For 2021, the seminar will be held on July 20-23.**

**Tuesday – July 20, 2021**

 **8:00 Introduction, Announcements, Class Survey**

 **9:15 Types of motors, induction, synchronous, wound rotor, high speed**

 **Induction Motor Design Fundamentals: Rotating Magnetic Field, Torque, Speed, and HP.**

 **10:00 Break**

 **10:20 Establish Cause of Failure— Evaluation of the Problem**

 **10:45 Motor/ Generator Rewind Specifications, 2300 – 4000 volt**

 **11:00 Motor/ Generator Rewind Specifications, 4000 – 13,200 volt**

**Noon Lunch**

**1:00 Shop Traveler**

 **Shop QC Program**

 **1:30 Presentation on TWMC facilities, capabilities, products, personnel**

 **2:00 Plant tour**

 **5:00 End Day 1**

**Wednesday – July 21, 2021**

 **8:15 Economics of Rewinding**

 **Insulation Temperature Classes**

 **Effect of ventilation pattern on temperature**

 **Rotor temperature rise, calculating acceleration time.**

 **9:00 Stator Winding Insulation Systems;**

 **Stator Coil Components: Wire, Conductor Insulation.**

 **Selection of Turn Insulation, Ground Insulation**

**10:00 Break**

**10:15 Available Insulation Systems**

 **Why the concern for voids?**

**10:30 Resin Properties**

 **Transpositions to reduce losses**

 **Coil build-up, redesign example**

**11:00 Coil Design, Choice of no. of circuits,**

 **Equalizer connections, unbalanced magnetic pull**

**11:15 Integral slot windings, lap windings, wave windings**

 **Fractional slot windings**

 **2-speed, 1-winding**

**Noon Lunch**

**1: 00 Winding Reactance, Winding Diagrams**

 **Concentric windings, rotor-stator slot combinations**

 **Coil Manufacturing; Winding a motor**

**2:00 Break**

**2:15 Coil Connections, End Winding Bracing, and Blocking**

 **Rotor temperature rise during starting**

 **Low Voltage Motor Rewind Specification**

**3:00 Motor Standards – IEEE-841, NEMA, API-541**

**3:15 Rewinding Turbine Generators – stators, rotors**

 **Selecting vendors, end winding stability**

 **High speed balance, acceptance testing**

**5:00 Adjourn**

**Thursday – July 22, 2021**

**8:15 Motor Losses and Efficiency**

 **Insulation temperature qualification, Insulation voltage qualification.**

**8:30 Motor testing, Load testing, Core testing, Winding testing, Shop tests**

**Five tests for broken rotor bars. Other tests**

**Noon Lunch**

**1:00 Stator core construction, core steel**

 **Core loss components**

**1:45 Stator Core and coil failures**

**2:30 Break**

**2:15 Stator winding evaluations**

**2:30 Break**

**2:45 Rotor Construction – Copper vs. aluminum windings, Rotor failures**

**3:15 Bearings: guide, thrust, sleeve, anti-friction**

 **Lubrication – oil (additives, viscosity) – grease (types, classifications, compatibility)**

**5:00 End of day**

**Friday – July 23, 2021**

**8:00 Bearing Failures – Causes & Cures**

**9:00 Break**

**9:20 The Motor’s World – contamination, temperature, system, foundation, alignment, grounding**

**10:00 Motor Operation and Maintenance**

**10:30 Maintenance Strategy – Corrective, Preventative, Predictive, Tiered, Trending**

**11:00 On-Line Protection and Monitoring**

**11:30 Root cause analysis**

**12:00 Adjourn**

**Motor Rewind Seminar**

 **July 20-23, 2021 – Round Rock, TX**

**Registration**

**I am registering for the Motor Rewind Seminar, July 20-23, 2021**

**\_\_\_$1,995 -Registration form and Check Payable to JARSCO Engineering LLC**

**\_\_\_$1,995 -Registration form and Purchase Order to JARSCO Engineering LLC**

**\_\_\_$1,995 -Registration form to JARSCO Engineering LLC and pay by Credit Card.**

**Method of Payment**

**\_\_\_Company check payable to JARSCO Engineering LLC**

**\_\_\_Check enclosed (payable to JARSCO Engineering LLC)**

**\_\_\_MasterCard \_\_\_VISA \_\_\_American Express**

**Cardholder's name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Card number\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Expiration date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Security Code from back of card\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Signature of cardholder\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Attendee\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Title/ Department\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Organization\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Address\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**City/ State/ Zip\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Phone\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Fax \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**E-mail Address\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Return form and your payment to:** Jarsco Engineering, 5280 East Lake Boulevard, Birmingham, Alabama 35217, United States
Chase Fell e-mail: chase.fell@jarsco.net; phone: (205 ) 438-0085; Elton Floyd e-mail: elton.floyd@jarsco.net; phone: (903) 513-0971