

**Course Name:** Superior & Waukesha Engine Course and Inspection/Maintenance Workshop

**Course Length:** 12 hours classroom + 20 hours of Hands-On maintenance

**Prerequisites:** None

**Target Audience:** Operators, mechanics, technicians, and maintenance & equipment specialists responsible for the safe day to day operation and care of Superior and Waukesha engines and compressors

**Goal:** Knowledge and comprehension of the Superior 825 and Waukesha VHP engine components, their function and basic operation. Hands-on experience and practice performing recommended weekly, monthly, and annual engine inspection and maintenance activities. Hands-on experience performing power head replacement and related valve adjustments.

<u>CLASSROOM ACTIVITIES/SCHEDULE</u>	<u>Time (Hrs)</u>
<b>DAY 1</b>	
<b>Engine-Compressor Course Introduction (0900)</b> <ul style="list-style-type: none"> <li>• Instructor and Student introductions</li> <li>• Review of course objectives and syllabus</li> <li>• Introduction to important safety and hazards</li> </ul>	<b>0.5</b>
<b>Superior Engine Product Overview (0500-SuperiorEngine)</b> <ul style="list-style-type: none"> <li>• Describes basic product line overview for Superior engines</li> <li>• Understands common layout and technical specifications</li> <li>• Understands product developments and upgrades</li> </ul>	<b>0.25</b>
<b>Waukesha Engine Product Overview (0500-WaukeshaEngine)</b> <ul style="list-style-type: none"> <li>• Describes basic product line overview for Waukesha engines</li> <li>• Understands common layout and technical specifications</li> <li>• Understands product developments and upgrades</li> </ul>	<b>0.25</b>
<b>Reciprocating Engine: Identify Major Mechanical Components (1100K-4SC)</b> <ul style="list-style-type: none"> <li>• Identifies the components and operation of the power train (frame, crankshaft, flywheel, power cylinders &amp; liners, power pistons, power heads (stack up height – head to block gasket), and power connecting rods.</li> <li>• Identifies the components and operation of the valve train (camshaft, pushrods, lifters, rocker arms, and power valves (intake, exhaust, and fuel).</li> </ul>	<b>2</b>

<p><b>Reciprocating Engine: 4 Stroke Cycle - Describe Sequence of Events and Performance Basics (1210K-4SC)</b></p> <ul style="list-style-type: none"> <li>• Describes the sequence of events for 4-stroke cycle engines, engine timing and pressure-volume graph (PV), normal and abnormal combustion.</li> </ul>	<b>1</b>
<p><b>Reciprocating Equipment: Describe Lubrication System for the Frame and Running Gear (1400K)</b></p> <ul style="list-style-type: none"> <li>• Explains the purpose of lubrication oil.</li> <li>• Identifies the main oil lubrication system flow path and its components.</li> <li>• Explains lubrication oil composition and viscosity</li> <li>• Identifies basic elements of oil sampling and analysis and the effects of equipment operation on oil impurities and life.</li> </ul>	<b>1</b>
<p><b>Reciprocating Engines: Describe Elements and Operation of the Cooling System (1330K)</b></p> <ul style="list-style-type: none"> <li>• Describes the different engine cooling systems including jacket water, scavenging air, and oil.</li> <li>• Describes basic coolant analysis.</li> <li>• Identifies cooling system components and flow paths.</li> <li>• Pressurized vs unpressurized systems</li> <li>• Vents and Return lines</li> <li>• Explains how to collect a coolant sample</li> <li>• Interpret the coolant analysis report</li> </ul>	<b>1</b>
<p><b>Reciprocating Engines: Describe Elements and Operation of the Air Delivery &amp; Exhaust Systems (1300K)</b></p> <ul style="list-style-type: none"> <li>• Describes the different types of engine air delivery and exhaust systems.</li> <li>• Identifies air and exhaust flow paths and components including both turbocharged versus naturally aspirated engines.</li> <li>• Explains the theory of operation of different air pressure manifolds.</li> </ul>	<b>1</b>
<p><b>Reciprocating Engines: Describe Elements and Operation of the Fuel Delivery System (1320K)</b></p> <ul style="list-style-type: none"> <li>• Explains the components and operation of the fuel delivery system including fuel supply, carburetion, fuel injection, and governors.</li> </ul>	<b>0.5</b>
<p><b>Reciprocating Engine: Identify Elements of a CD Ignition Systems (1750K)</b></p> <ul style="list-style-type: none"> <li>• Identifies the components, operation, and troubleshooting of typical capacitive discharge (CD) spark ignition systems.</li> <li>• Describes primary, secondary, and ionization voltage. Identifies spark maintenance, wear, and failure.</li> </ul>	<b>0.5</b>
<b>DAY 2 – Classroom</b>	
<p><b>Reciprocating Engine: Understand Concepts of Basic Engine Combustion (1250K)</b></p> <ul style="list-style-type: none"> <li>• Explains the following basic combustion concepts: the fire triangle, flame front velocity, LEL and UEL, stoichiometric mixtures, and the parabolic burning curve.</li> <li>• Explains the effects of combustion related to emissions formation, ignition timing, fuel quality, high energy ignition, and abnormal operating conditions.</li> </ul>	<b>2</b>

<p><b>Reciprocating Engine: Describe Emission Control Technologies for Reciprocating Engines (1270K-4SC)</b></p> <ul style="list-style-type: none"> <li>• Explain basic air pollutants and emissions.</li> <li>• Understand how emissions are formed in gas engines.</li> <li>• Describes the components and operation of common emissions control technologies and upgrades including lean combustion, pre-combustion chambers/jet cells, high pressure fuel injection, and catalytic control (where applicable).</li> </ul>	<b>1</b>
<p><b>Question/Answer Session</b></p>	<b>0.5</b>
<p><b>Written Course Exam (Open Notes)</b></p>	<b>0.5</b>
<p><b>DAY 2 (pm) – Hands-On Workshop</b></p>	
<p><b>Hands-On Workshop Safety Briefing (0063K)</b></p> <p>Identifies hazards and understands safety procedures associated with performing hands-on activities in the training area or workshop.</p> <ul style="list-style-type: none"> <li>• Emergency evacuation and warning sounds in the workshop</li> <li>• Activity limitations or boundaries in place during the workshop activities</li> <li>• Required Personal Protective Equipment (hardhat, gloves, steel toe boots, hearing, etc.)</li> <li>• Pinch points (barring, process gas pressure, crane/lifting devices)</li> <li>• Basic hand tool safety (as applicable)</li> <li>• Lifting and Rigging procedures (where applicable)</li> <li>• Lock-Out / Tag-Out (LOTO) procedure (where applicable)</li> <li>• Incident/accident response and reporting</li> </ul>	<b>1</b>
<p><b>Specialty Tools (0501K)</b></p> <ul style="list-style-type: none"> <li>• Understands the application and use of specialty tools required for safe and proper maintenance activities for specific equipment or machines</li> </ul>	<b>1</b>
<p><b>Reciprocating Engines: Perform Daily Operation &amp; Inspection - <u>Demonstrate</u> (1801T)</b></p> <ul style="list-style-type: none"> <li>• Highlights daily operation and inspection for reciprocating engines.</li> <li>• Review Downtime and Unscheduled Maintenance Log to identify problems.</li> <li>• Water &amp; Oil System - Inspect for leaks and repair as needed</li> <li>• Sight Glasses &amp; Gauges. Clean or repair as needed.</li> </ul>	<b>1</b>
<p><b>Reciprocating Equipment: Perform Crankcase Service (1403T)</b></p> <ul style="list-style-type: none"> <li>• Crankcase. Pull covers and inspect interior.</li> <li>• Crankcase Vent. Inspect and clean.</li> <li>• Oil Reservoir. Drain water and sediment from bottom.</li> <li>• Crankcase Breather Elements - Clean and Inspect (if serviceable), Replace as Necessary.</li> <li>• Bicera Explosion Doors. Inspect and test.</li> <li>• Oil System Magnetic Plugs - Remove and clean</li> <li>• Crankcase oil screens, oil pan &amp; oil filter relief valve - Clean &amp; inspect (if oil change)</li> </ul>	<b>1</b>

DAYS 3 & 4 – Hands-On Workshop	
<p><b>Reciprocating Engines: Inspect Air Inlet and Exhaust Systems &amp; Replace Inlet Air Filters (1304T)</b></p> <ul style="list-style-type: none"> <li>• This task identifies the types of air filters and explains how to remove and install air filters.</li> <li>• Inspect, repair or replace (as necessary) - Air Filter, Cleaner, and Air piping</li> <li>• While running, collect operating pressure data in the inlet and exhaust system and generate an air map.</li> </ul>	<b>.5</b>
<p><b>Reciprocating Engines: Perform Turbocharger Inspection (Including Visual Inspection, Hand Check for Slop, Thrust, &amp; Rub) (1311T)</b></p> <ul style="list-style-type: none"> <li>• Conducts visual turbocharger inspection.</li> <li>• Conducts Hand Check for slop, thrust, and rub (where applicable).</li> <li>• Performs operational review of turbocharger (verifying pressures (oil and air), speed, drift down time).</li> <li>• Documents turbocharger inspection.</li> </ul>	<b>.5</b>
<p><b>Reciprocating Engines: Inspect and Replace Ignition Coils and Secondary Wires and Check Ignition Timing (1753T)</b></p> <ul style="list-style-type: none"> <li>• Check ignition timing. Adjust per Methane Number (if required)</li> <li>• Inspects ignition coils and secondary wires.</li> <li>• Replaces ignition coils and secondary wires.</li> <li>• Verifies operation of ignition coils, secondary wires, and checks ignition timing.</li> <li>• Ignition Coils. Remove secondary wire, inspect neck of coil for corrosion and clean as needed.</li> <li>• Drain, flush and refill governors</li> </ul>	<b>2</b>
<p><b>Reciprocating Engines: Remove and Install 4SC Power Head (1285T-4SC)</b></p> <ul style="list-style-type: none"> <li>• Removes power head and records "as found" conditions.</li> <li>• Inspects and prepares replacement power head for installation. (Stack up height – head to block gasket/check clearance</li> <li>• Installs power head and properly reset valve train clearances.</li> <li>• Documents and verifies proper operation of replacement power head</li> </ul> <p>Leak down test/valve recession</p>	<b>2</b>
<p><b>Reciprocating Engines: Inspect Pre-Combustion Chamber (PCC)/Jet Cell Operation and Repair/Replace Check Valves and Spark Plugs (1330T)</b></p> <ul style="list-style-type: none"> <li>• Describe process to determine if pre-combustion chambers (PCC)/jet cells and check valves are operating properly and common failure points.</li> <li>• Test, verify proper operation, and replace pre-combustion chamber fuel check valves.</li> <li>• Inspect, clean, and rebuild/repair (as needed) pre-combustion chamber fuel check valves.</li> <li>• Inspect, clean, and replace spark plugs (as needed).</li> </ul>	<b>1</b>

<p><b>Reciprocating Engines: Camshaft, Valve Train and Auxiliary Drive Inspection and Adjustment (1283T &amp; 1284T)</b></p> <ul style="list-style-type: none"> <li>• Inspects condition of camshaft and auxiliary drive chain, sprocket, gears, and bearings.</li> <li>• Inspects camshaft and auxiliary drive chains and Adjusts tightness.</li> <li>• Checks camshaft alignment and thrust clearance.</li> <li>• Inspects camshaft lobes and bearing condition.</li> <li>• Verifies and adjusts camshaft timing (including verification of Top Dead Center (TDC).</li> <li>• Documents "as left" condition.</li> <li>• Explains the problems caused by irregular camshaft timing and presents the procedure for checking and adjusting camshaft timing.</li> </ul>	<b>2</b>
<p><b>Reciprocating Equipment: Inspect Engine Frame and Crankshaft Alignment - Soft Foot and Web Deflections (1150T)</b></p> <ul style="list-style-type: none"> <li>• Prepares for Frame and Crankshaft Alignment Inspection (reviews OEM manual and work documentation, gathers proper tools and parts, and performs pre-work safety activities).</li> <li>• Verifies foundation bolts for proper torque and soft foot and records "as left" conditions.</li> <li>• Verifies frame/crankshaft alignment by performing Web Deflection and records "as left" conditions.</li> <li>• Check Engine to compressor coupling alignment - Demonstrate</li> <li>• Check Torque main bearing cap, connecting rod, and power cylinder head bolts</li> </ul>	<b>2</b>
<p><b>Reciprocating Equipment: Conduct A Crankshaft Web Deflection Survey – <u>Analyze Data</u> (1151T)</b></p> <ul style="list-style-type: none"> <li>• Explains the purpose of a web deflection survey.</li> <li>• Demonstrate how to prepare and collect crankshaft web deflection data.</li> <li>• Analyzes and interprets results of web deflection survey</li> <li>• Identifies corrective action (as required)</li> <li>• Documents web deflection survey</li> </ul>	<b>2</b>
<p><b>Reciprocating Engines: Perform Maintenance of Fuel Systems, Governor, and Carburetor (where appropriate) (1322T)</b></p> <ul style="list-style-type: none"> <li>• Governor. Check oil level and replace (if applicable) and throttle linkage.</li> <li>• Fuel Filter - Inspect and replace as needed.</li> <li>• Fuel System - carburetor diaphragms, fuel valve, throttle plate and 99 regulator - Clean and inspect</li> <li>• Fuel gas system - Replace fuel filter</li> <li>• Check &amp; adjust fuel gas admission valves</li> </ul>	<b>1</b>
<p><b>Reciprocating Equipment: Measure Bearing Clearances and Perform Main Bearing Bump Checks (1152T)</b></p> <ul style="list-style-type: none"> <li>• Measure clearances on main bearings, rod bearings, and pin bushings. Record clearance data.</li> <li>• Perform main bearing bump check to measure and record clearances.</li> </ul>	<b>2</b>
<p><b>Engine Test Stand Tour and Demonstration (where applicable)</b></p> <ul style="list-style-type: none"> <li>• Understand processes and procedures used to test engines on the dynamometer</li> <li>• Observe typical controls and shutdowns used on test engines</li> </ul>	<b>1</b>