PROFESSIONAL DEVELOPMENT
SEMINAR SERIES

GPS-160 GENERATOR PROVISIONING & INSTALLATION

LEARNER'S GUIDE

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WELCOME

Professional Development Seminar Series

Standby power systems are increasingly in demand. Commercial, industrial, municipal and healthcare facilities are just a few of the markets that require backup power. Provisioning and installation is a crucial component for these systems.

The ever-changing requirements of the power generation industry, coupled with requests for additional training, has prompted Generac Power Systems to develop this training program.

Titled the Generac Power Systems Professional Development Seminar Series, this program consists of individual training modules that provide both theoretical and practical information. Each module is 90 minutes in length and each incorporate proven learning methodology to ensure a positive experience. These modules are designed to broaden the learner's understanding of topics such as:

- Current Technologies
- Sizing
- Codes & Standards
- Switching Technologies
- Reliable Design Characteristics
- Paralleling
- Engines and Alternators
- Controls
- Emissions

THE MODULE IN PERSPECTIVE

PURPOSE:

This seminar examines engine-generator configurations and the selection of optional items such as block heaters, base tanks, enclosures, etc. It explores standard configurations versus custom options that may be required based on site-specific criteria. The seminar also introduces good design practice guidelines for the installation of engine-generator sets based on site and application specific details. There will be an emphasis on cooling system selection, unit placement and piping requirements.

TIME:

- 90 minutes of Classroom Instruction
- 30 minutes for Final Assessment

LEARNING OBJECTIVES:

Upon completion of this seminar, participants should be able to:

- List and describe the typical types of outdoor installations.
- Describe suggested practices and methods to ensure proper air flow in and around generator systems used indoors, outdoors, and within enclosures.
- List and describe the mechanical and physical considerations related to indoor and outdoor exhaust systems.
- Identify and describe three types of generator cooling systems.
- Describe different techniques used to reduce sound levels of generator systems.
- List and describe the typical mounting components used when securing a generator to a base.
- Describe the installation, storage, and piping requirements for both diesel and gaseous fuel systems.
- Describe the functional differences between lead acid and NICad starting batteries.
- Describe the functional differences between a float-equalized charger and engine-mounted charging alternator.
- List and describe cold weather-related issues and ways to resolve them.
- Describe typical types of circuit breakers used on generator systems.
- List and describe the typical preparation and installation requirements involved in commissioning a generator system.

CONTINUING EDUCATION:

Upon successful completion of this seminar, participants will be awarded a certificate of achievement identifying the seminar title, 2.0 PDHs (Professional Development Hours) and 0.2 CEUs (Continuing Education Units).
Successful completion of a PDSS seminar requires that the participant have:

1. Attended the complete seminar
2. A minimum score of 80% on the Final Assessment

TRAINING AT A GLANCE

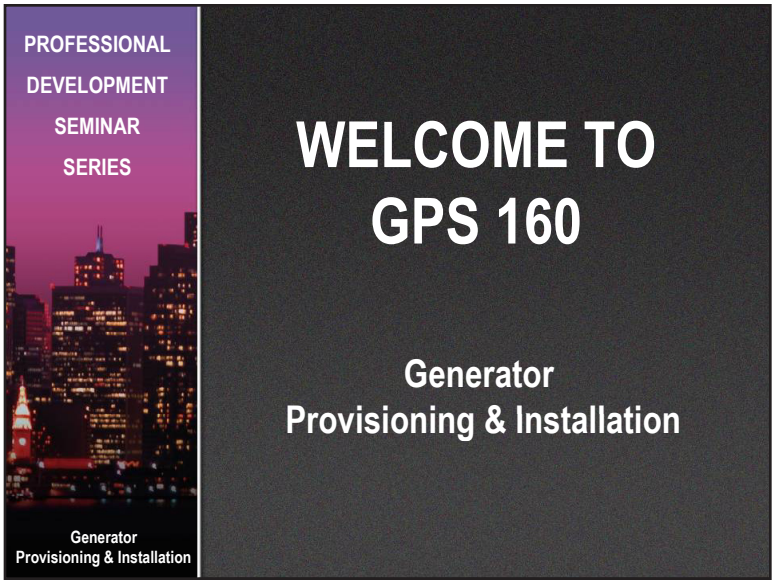
TIME	LESSON	DESCRIPTION
5 minutes	Introductions	Get to know other participants and the trainer. The trainer welcomes participants and conducts an opening activity.
80 minutes	Lesson 1 Generator Provisioning and Installation	An examination of engine-generator configurations and the selection of optional items such as block heaters, base tanks, enclosures, etc. Standard configurations versus custom options will be explored. Also an introduction to good design practices for the installation of engine-generator sets based on site-specific and application-specific details. An emphasis will also be placed on cooling system selection, unit placement and piping requirements.
5 minutes	Conclusion	The trainer will review the objectives of the class and discuss how each objective was accomplished. An evaluation will be given out with which participants can provide feedback about the course. An assessment will also be given to each participant to evaluate the skills and knowledge they received from the course.

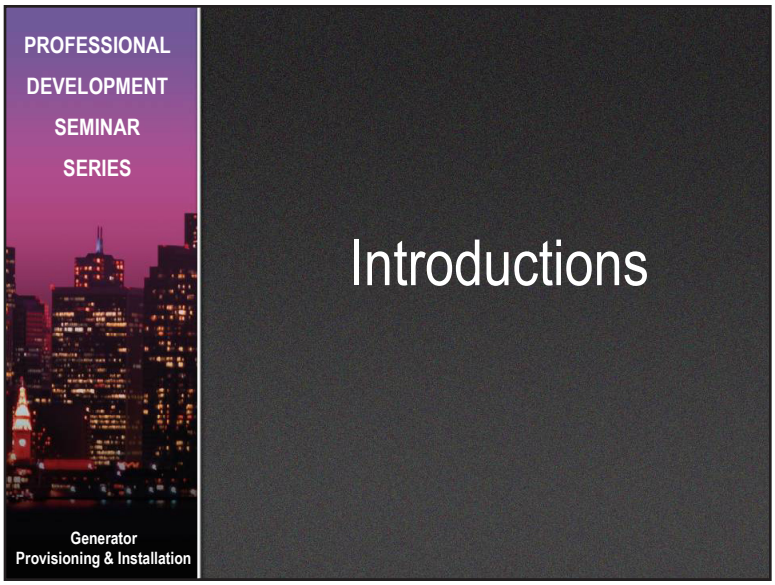
INTRODUCTION

TIME: 5 minutes

OBJECTIVE:

The introduction is an opportunity for the trainer and participants to become familiar with each other. This period will discuss the topics to be covered, capture initial questions and introduce generator provisioning and installation.





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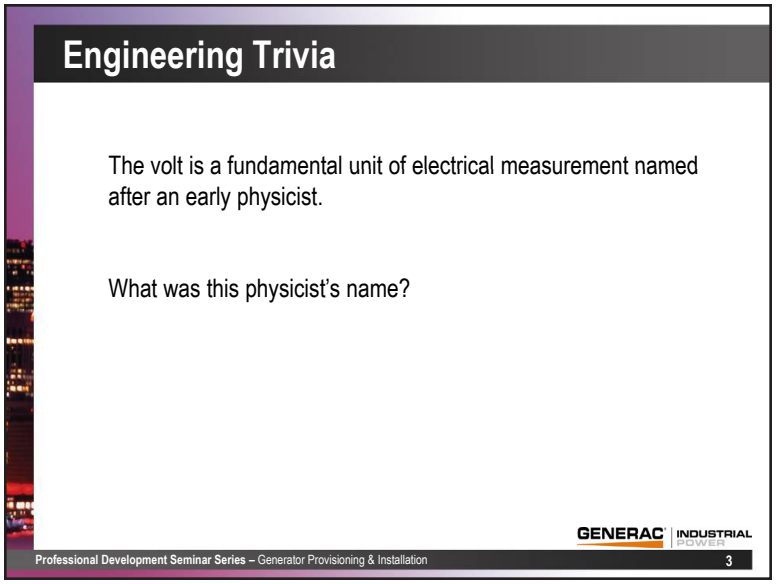
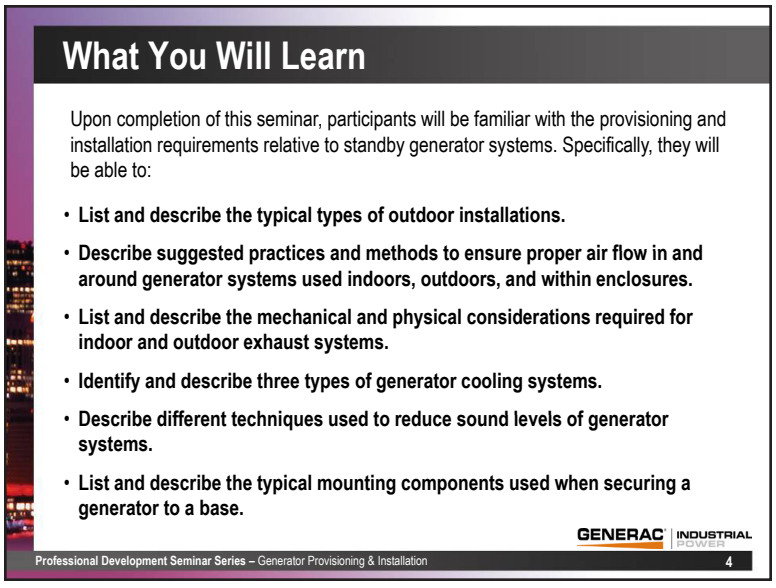
INTRODUCTION





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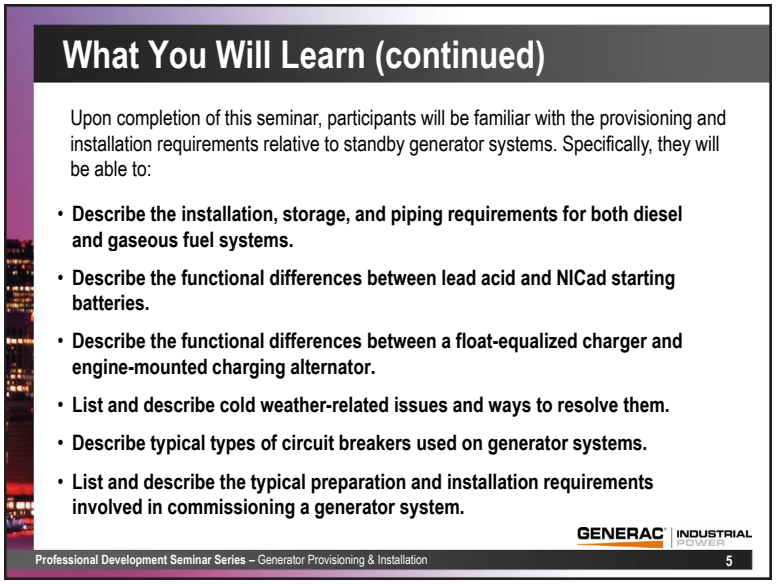
What You Will Learn (continued)
Upon completion of this seminar, participants will be familiar with the provisioning and installation requirements relative to standby generator systems. Specifically, they will be able to:
• Describe the installation, storage, and piping requirements for both diesel and gaseous fuel systems.
• Describe the functional differences between lead acid and NICad starting batteries.
• Describe the functional differences between a float-equalized charger and engine-mounted charging alternator.
• List and describe cold weather-related issues and ways to resolve them.
• Describe typical types of circuit breakers used on generator systems.
• List and describe the typical preparation and installation requirements involved in commissioning a generator system.
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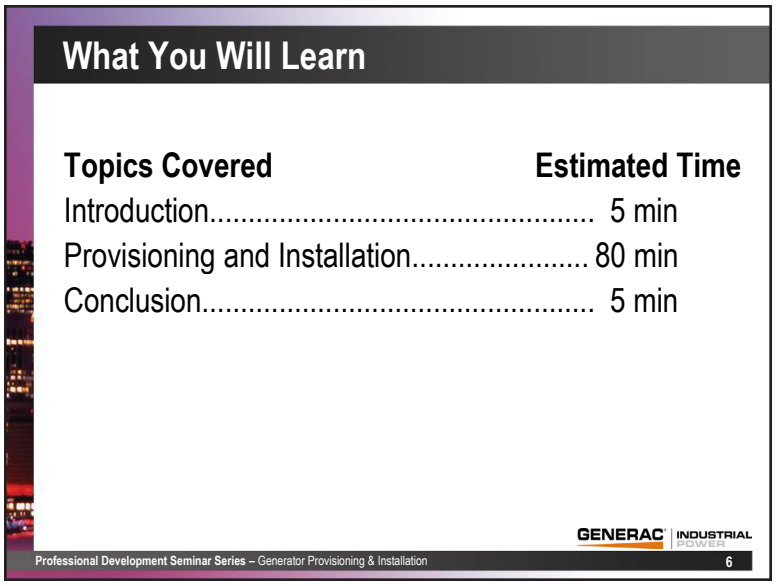
What You Will Learn
Topics Covered
Estimated Time
Introduction..... 5 min
Provisioning and Installation..... 80 min
Conclusion..... 5 min
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GENERATOR PROVISIONING & INSTALLATION

TIME: 80 minutes

OBJECTIVES:

Upon completion of this seminar, participants will be familiar with the provisioning and installation requirements relative to standby generator systems. Specifically, they will be able to:

- List and describe the typical types of outdoor installations.
- Describe suggested practices and methods to ensure proper air flow in and around generator systems used indoors, outdoors, and within enclosures.
- List and describe the mechanical and physical considerations related to indoor and outdoor exhaust systems.
- Identify and describe three types of generator cooling systems.
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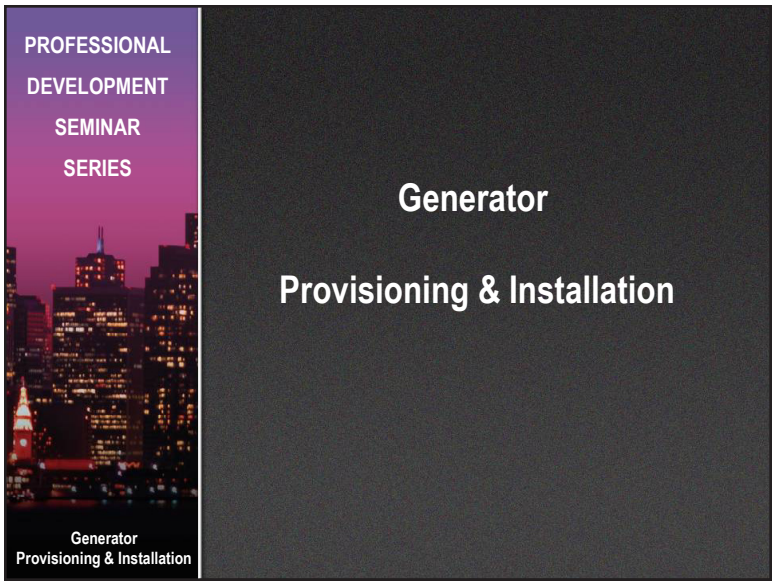

NOTES

Location – Outdoors

- Access and Egress
  - Exit and entrance points to the site
  - Five feet from combustible walls
  - Overhead interference points
- Electrical interconnect
- Fuel source location
- Exhaust discharge location
- Air flow
- Security and flooding
- Sound

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Location – Roof Top

- Structural support
- Vibration isolation
- Crane requirements
- Fuel supply

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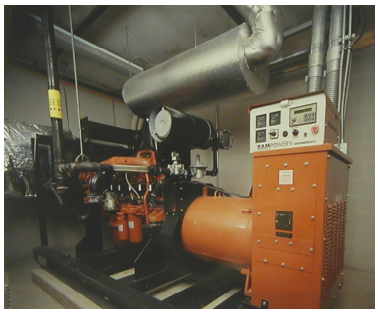
Location – Indoors

- Air flow
- Exhaust
- Heat
- Fuel
- Fire
- Sound
- Secured area
- Access & egress



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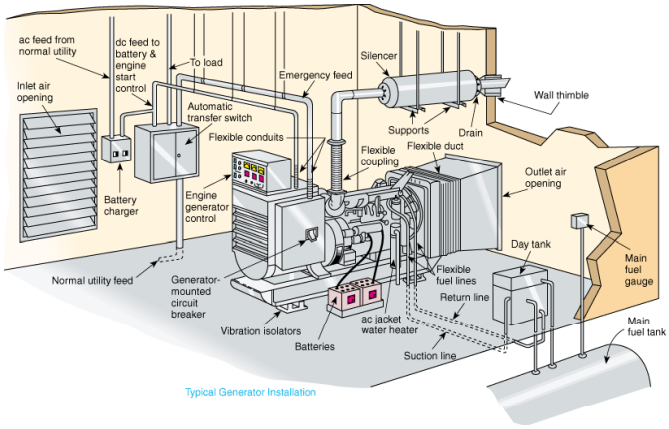
Indoor Location



Typical Generator Installation

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NOTES

Indoor Location – System Design

- **Separate room (level 1)**
- **Room with two-hour fire rating**
- **Fire protection system**
- **Fire risk evaluation**
- **Battery-powered emergency lighting**
- **Minimum access spacing 36" (NFPA 37)**
  - NEC working space requirements may require 48"

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Airflow – Outdoor Locations

- Unrestricted air flow
  - Discharging up versus out
    - Recirculation
    - Prevailing winds
  - Clean, clear area

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NOTES

Airflow – Enclosures

- **Weather**
  - UL2200 tested with unit
  - Materials
    - Steel (typical)
    - Aluminum (optional)
    - Stainless Steel (rare special)

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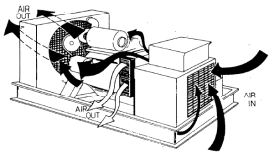
Airflow – Indoor Locations

- Air inlet
  - Opening 1.5 to 2 times radiator area (attached radiator)
  - Size for room temperature rise (remote radiator)
    - CFM ≅ (BTU/Hr rejected) / desired Δ Temp + combustion air

- Air outlet
  - Match radiator flange or larger
    - Compensate for louver or screens
    - Minimal duct work (straight & short)
    - Watch for recirculation



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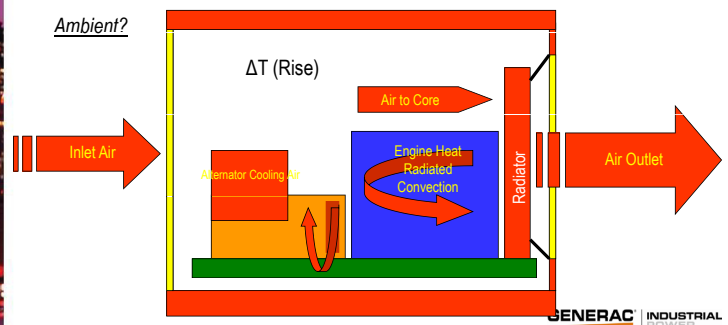
NOTES

Airflow – Indoor Locations

What is ambient temperature?

Is it measured inside or outside the room?



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Exhaust – System Design

- **Flex connection**
- **Condensate traps**
- **Thermal expansion**
- **Exhaust blankets**
- **Thimble**
- **Acceptable back pressure**
- **Silencer**
  - Industrial, Critical, Hospital, etc.
  - Key is to specify desired sound level for the system

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Exhaust – Discharge

- Exhaust direction
- Air handler intake

Exhaust stacks when necessary

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Exhaust – Location in Enclosures

- **On top**
  - Aesthetics & rust from muffler
- **In discharge hoods**
  - Limited to 400 kW
- **Inside enclosure**
  - Must be thermally wrapped

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NOTES

Cooling System – Block Heaters

- **Block heater (100ºF min)**
  - Convection & circulating types used
  - Wattage based on engine size
  - Required on diesels

- **Spark-ignited engines**
  - Crank speed determines start-ability
    - Battery heater
    - Synthetic oil
  - Block heater may not be the best choice for small (< 100 kW) spark-ignited engines
    - Operation cost
    - Maintenance cost

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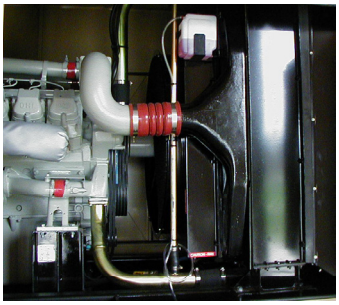
Cooling System – Radiators

- **Engine-mounted**
  - Most common and reliable
  - Usually designed for 50° C
- **City-water cooling**
  - Limited acceptance
- **Remote radiator**
  - Heat exchangers
  - Circulating pumps
  - Electric-driven fans
  - Complexity and reliability concerns



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NOTES

Cooling System – Remote-Radiator Considerations

- **Basic design considerations**
  - Engine constraints
    - Pressure and flow restriction on engine water pump
    - Pressure constraints on engine seals
  - Piping layout
    - Isolation valves (monitoring)
    - Burping the system
    - Air entrainment
  - Powering fans and circulation pumps
    - Powered by generator (emergency distribution panel)
    - Breakers (monitoring)
    - Direct connection (no motor starters)

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Cooling System – Remote-Radiator Considerations

- **Other design considerations**
  - Charge Air Cooling (CAC)
    - Air-to-air
    - Separate water jacket
    - Temperature requirements
    - EPA emission characteristics
  - Other cooling
    - Fuel coolers
    - Oil coolers

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NOTES

Sound – Levels

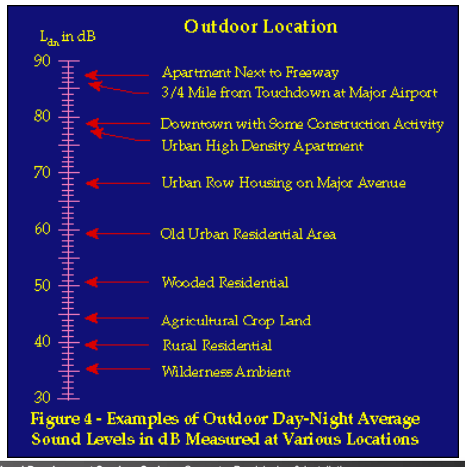

Figure 4 - Examples of Outdoor Day-Night Average Sound Levels in dB Measured at Various Locations

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Sound – Enclosures

- **Sound Attenuated**
  - Weather housing (-5 dBa)
  - Standard sound housing (-15 dBa)
  - Level 2 sound housing (-20 dBa)
  - Custom enclosure designs (-25 dBa)

- **Custom enclosures**
  - Expensive and not factory supported (testing)

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NOTES

Sound – Design Concepts

- **Enclosure options**
  - Become costly at low dBa levels
- **Distance**
  - Double distance is a 6 dBa reduction
- **Walls**
  - Direct sound up
  - Provides other benefits
    - Enhanced security
    - Added wind protection

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Mounting – Concrete Slab

- Concrete slab
  - Required to secure and support
  - Extend beyond profile of generator (18" minimum)
  - Designed to support wet weight
  - Wire or re-bar reinforced as required
  - Double check stub-up location

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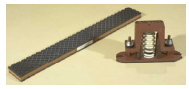
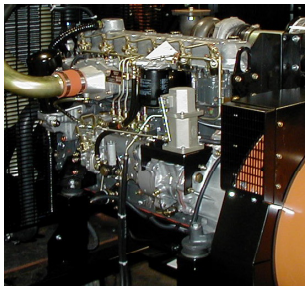
NOTES

Mounting – Isolators

- **External Isolators**
  - Pad or Spring
  - Most generators ≥ 500 kW use spring isolators
  - Most generators ≤ 400 kW internally isolated
  - Avoid spring on ≤ 400 kW (typically not required)





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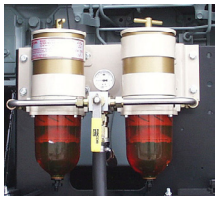
Diesel Fuel – Engine Options

- **Typical Options**
  - Secondary filter/water separator
  - Secondary filter with heater
  - Fuel data from engine ECM (EPA tier 3 engines)

- **Non typical options**
  - Duplex secondary filters
  - Mechanical fuel pressure gauges



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Diesel Fuel – Tanks

- **Typical tanks**
  - Secondary containment sub-base tanks (8-hour, 12-hour, 24-hour)
  - Main Storage tanks (24 hours and up)
  - Day Tank (2-hour, 4-hour)
- **Special requirement tanks**
  - Sub-base day tank (8 hours with transfer pumps)
  - UL2085 fire rated (code-required in select markets)

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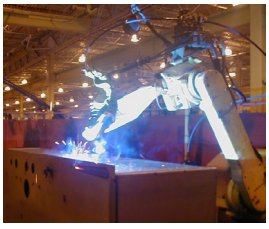
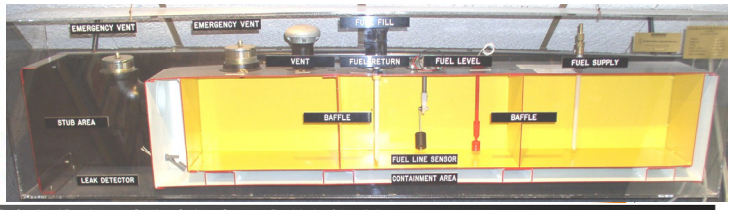
Diesel Fuel – Standard Tanks

- Sub-base configuration (very common)
- Secondary containment (double wall)
- Various heights and capacities
- UL 142 listed
- Stub-up at rear of the tank
- Various connections





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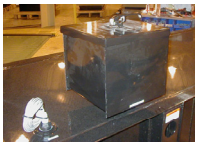
NOTES

Diesel Fuel – Special Tanks

- **Local code special requirements**
  - Fill–spill box
  - High level contact
  - Remote fill-alarm panel
  - Special fill connection
  - Auto fill shutoff
  - Normal vent elevation
  - Tank elevation



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Diesel Fuel – System Design

- Is the system fail-safe?
  - Return lines or pumps (day tanks)
  - Isolation valves and solenoids
  - Piping is protected
  - Safe filling system
  - Vents installed
- Is the fuel source reliable?
  - Other users
  - Fuel maintenance program

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NOTES

Diesel Fuel – System Design

- **Day tank with main storage tank**
  - Main tank lower elevation
    - Day-tank pump
    - Gravity return
    - Engine return to main tank
  - Main tank higher elevation
    - Isolation solenoid (bypass capability, NFPA110 5.6.3.2.1)
    - Return pump (sized larger than inlet flow)
    - Fuel cooler may be needed

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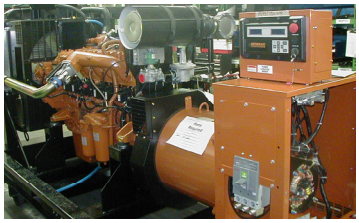
Gaseous Fuel Systems

- Natural Gas
- LP Vapor
- LP Liquid
- Dual Fuel (LP or Natural Gas)
- Bi-Fuel™ (Diesel and Natural Gas)



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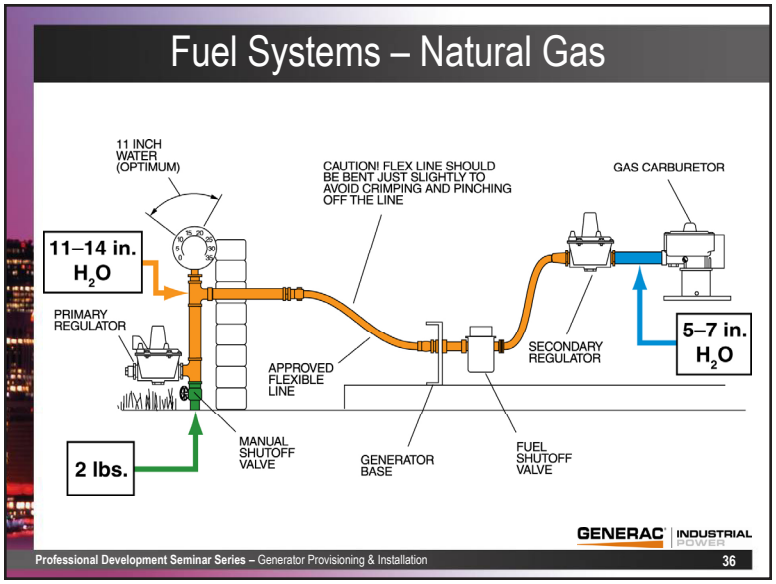
Fuel Systems – Natural Gas
11 INCH WATER (OPTIMUM)
CAUTION! FLEX LINE SHOULD BE BENT JUST SLIGHTLY TO AVOID CRIMPING AND PINCHING OFF THE LINE
GAS CARBURETOR
11–14 in. H2O
PRIMARY REGULATOR
APPROVED FLEXIBLE LINE
SECONDARY REGULATOR
5–7 in. H2O
2 lbs.
MANUAL SHUTOFF VALVE
GENERATOR BASE
FUEL SHUTOFF VALVE
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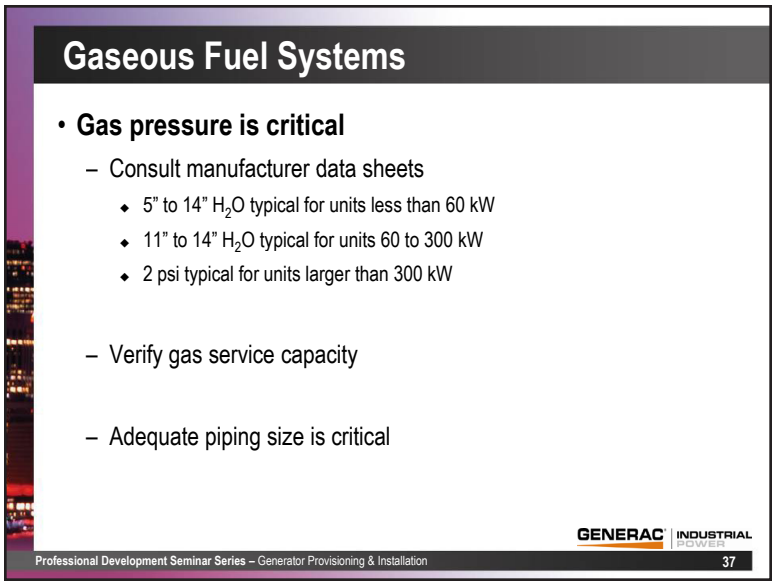
Gaseous Fuel Systems
• Gas pressure is critical
– Consult manufacturer data sheets
◆ 5" to 14" H2O typical for units less than 60 kW
◆ 11" to 14" H2O typical for units 60 to 300 kW
◆ 2 psi typical for units larger than 300 kW
– Verify gas service capacity
– Adequate piping size is critical
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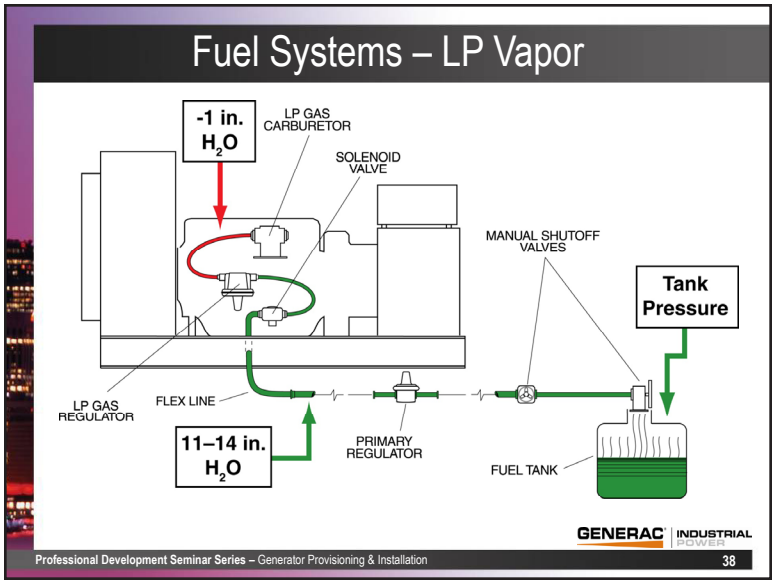
Fuel Systems – LP Vapor
-1 in. H_2O
LP GAS CARBURETOR
SOLENOID VALVE
MANUAL SHUTOFF VALVES
Tank Pressure
LP GAS REGULATOR
FLEX LINE
11–14 in. H_2O
PRIMARY REGULATOR
FUEL TANK
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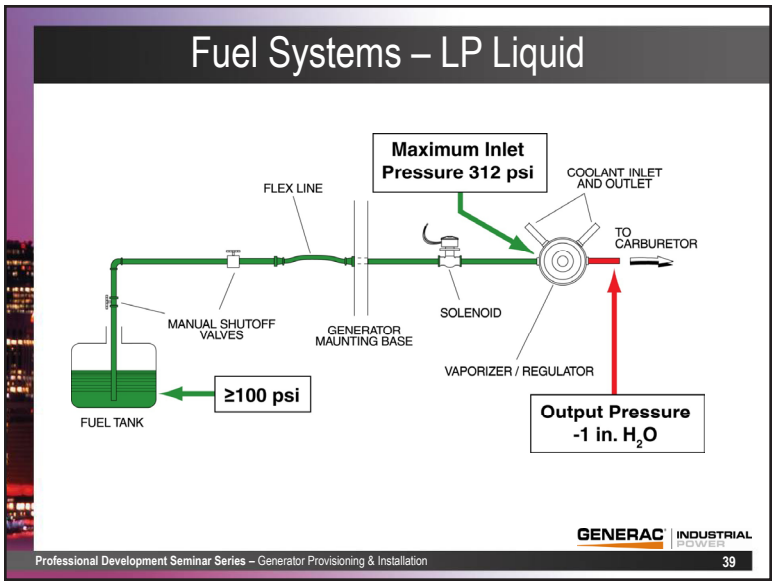
Fuel Systems – LP Liquid
Maximum Inlet Pressure 312 psi
COOLANT INLET AND OUTLET
FLEX LINE
TO CARBURETOR
MANUAL SHUTOFF VALVES
GENERATOR MAUNTING BASE
SOLENOID
VAPORIZER / REGULATOR
≥100 psi
Output Pressure -1 in. H_2O
FUEL TANK
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Gaseous Fuel Systems

- **Adequate service or tank size**
  - Consider other gas loads
  - Consider ambient temperatures
- **Adequate pipe sizing**
- **Primary pressure regulator at unit**
- **Isolation valves (secured)**
- **Flexible fuel lines (approved)**

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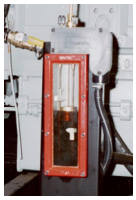
Oil Lubrication System

- **Typical Options**
  - Oil heaters
  - Oil make-up systems (consult manufacturer recommendations on tier 3 engines)
  - Oil temperature indication and alarms (may be standard on tier 3 engines)
- **Non-typical requirements**
  - Pre-lube systems
  - Oil-level indication and alarms



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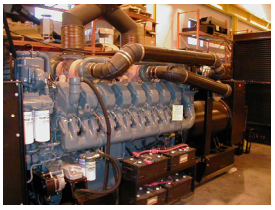
NOTES

Starting System – Battery

- **Lead acid (generally maintainable)**
  - Cost effective and excellent cranking amps
  - Highly reliable when on maintenance cycle
  - Familiar to end-users
    - Fast replacements
    - Jumping and boost charging
- **NiCad**
  - Expensive (initial cost & disposal)
  - More sensitive charging requirements
  - Poor end-user awareness
- **Typical options**
  - Oversized batteries
  - Dry batteries (storage applications)



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Professional Development Seminar Series – Generator Provisioning & Installation 42

Starting System – Charging

- **Float-equalized charger**
  - Maintains battery charge
  - Equalizes cells for maximum cranking amps
  - Usually 10 amps

- **Engine-charging alternator**
  - Fast battery recovery after cranking
  - Adds reliability to system (failed charger)

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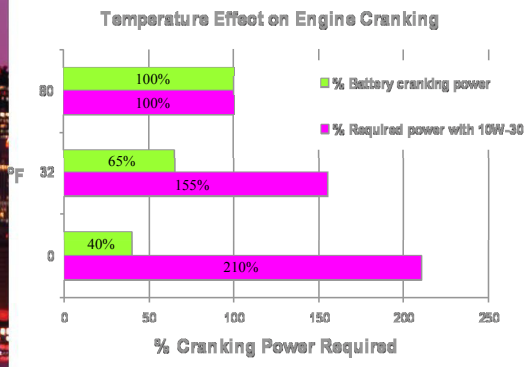
NOTES

Starting System – Battery Heater

- Battery blanket option



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Speed Control – Governor System

- **Electronic (industry norm)**
  - Isochronous (maintains 60 hertz operation)
  - Typically integrated into generator or engine controller
  - Older designs may use an external controller
  - +/- 0.25% frequency regulation
- **Mechanical**
  - Droop (speed decreases when load increases)
  - Historically common in small diesels
  - +/- 5% frequency regulation

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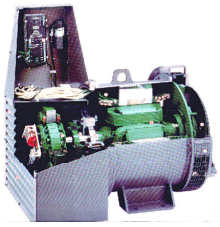
NOTES

Alternator Accessories

- **Strip heaters**
  - Extends life by minimizing moisture
- **Tropical coating**
  - Epoxy "green" over-coating
  - Additional moisture barrier
- **PMG (permanent magnetic generator)**
  - Standard in larger kW units
  - Supports breaker coordination



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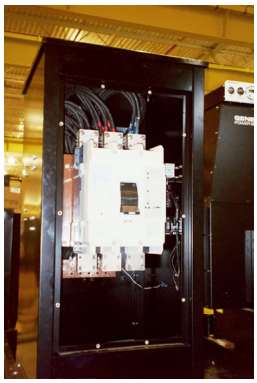
Circuit Breakers

- **Standard**
  - Thermal magnetic
  - Single breaker
- **Options**
  - Multiple breakers
  - Shunt trip
  - Auxiliary contacts
  - Electronic trip
  - Ground fault



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NOTES

Coordination

- Has the genset arrival at the site been scheduled?
- Does the transport company have a contact?
- Has rigging been arranged?
- Identify location of loose parts
- Larger units require exhaust mounting

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Checking for Shipping Damage

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NOTES

Installation Safety

- **Keep system disabled prior to startup**
  - Batteries disconnected
  - Generator in OFF position
  - Breaker open
  - ATS in manual

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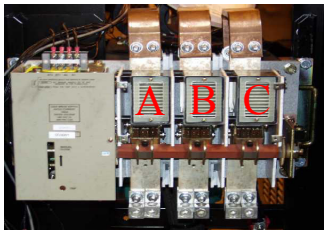
Power Wiring – Phase Rotation

- **Phase rotation**
  - Confirm generator and facility rotation at ATS (startup check)
  - Connections should include enough cable to change rotation



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NOTES

Power Wiring – Terminations

- **Conduits**
  - Cluster conduits under breaker
  - Keep ABC and N conductors grouped together
  - Plan for regrouping phases in conduit layout
- **Terminations**
  - Cable termination determined by ATS and breaker lugs
  - 75-degree cable requirements (don't use 90-degree cable)
  - Support lugs when tightening (broken ATS and breakers)

Note: Alternator leads are 150-degree wire

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Power Wiring – Load Bank Provisions

- **Is load bank testing required (ref NFPA 110)?**
- **Periodic load bank testing is recommended**
- **Wiring provisions???**

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Professional Development Seminar Series – Generator Provisioning & Installation 53

NOTES

Power Wiring – Grounding and Bonding

- Neutral should be bonded for grounded systems
- Three-pole ATS, the neutral is bonded at the service
- Four-pole ATS, the neutral is bonded at the generator
- Generator requires a grounding conductor
- Grounding electrode (rod) does not replace grounding conductor

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Auxiliary Power Wiring

- **Battery charger and block heater**
  - 120/240 VAC
  - May want on separate circuits
    - Spark-ignited generators in summer ($ savings)
    - Block heater failures – maintain battery charger

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NOTES

Auxiliary Power Wiring

- **Other 120/240 accessories to be powered (options)**
  - Battery blanket heaters
  - Alternator strip heater
  - Motor-operated louvers
  - Load centers
  - Convenience outlets
  - Typically OEM wired

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Controllers

- Usually standard component with options
  - Digital controller meeting NFPA 110, level 1
  - Governor and regulator integration
  - Paralleling capability

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Professional Development Seminar Series – Generator Provisioning & Installation 57

NOTES

Control Accessories

- Annunciator
- Alarm horns
- Communication capability (modem, Ethernet, etc.)
- Additional I/O capability
- Custom logic/functionality

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Professional Development Seminar Series – Generator Provisioning & Installation 58

Control Wiring

- General
  - Control wiring in separate conduit
  - Pull spare control wires
  - Wiring requirements vary with control type
  - Consult wiring diagrams and owner manuals
- Typical control wiring
  - 2-wire start (2 wires, ATS to generator)
  - ATS position indication (3 wires, ATS to generator)
  - Communications (2 wire shielded, various)
  - Remote annunciator (4 wire shielded from generator)

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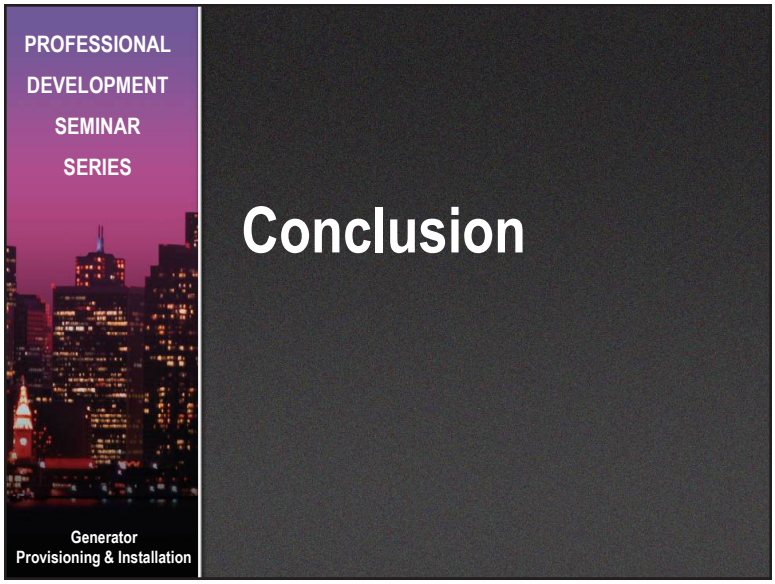
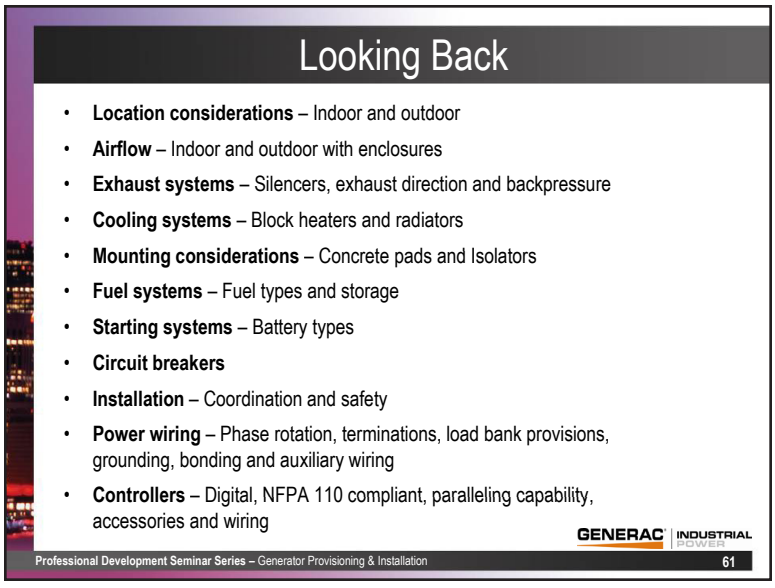
Professional Development Seminar Series – Generator Provisioning & Installation 59

NOTES

CONCLUSION





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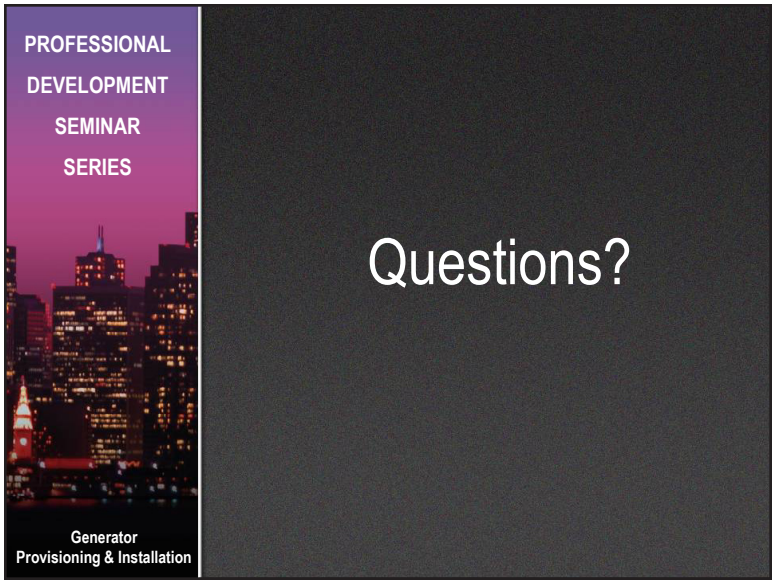
CONCLUSION



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NOTES

Online Final Assessment

Final assessments are available for each PDSS session. These assessments are Web-based and can be accessed using Generac's online learning system *"The Learning Center"* (http:// learning.generac.com). PDSS participants are required to obtain a score of at least 80% to pass an assessment. Each online assessment also contains a training survey. The survey provides each participant an opportunity to rate various components of the learning experience along with information relative to business development. Instructions for how to register and log in to this system, take the final assessment and print a certificate, are described in the Registering in *"The Learning Center"* section below.

Continuing Education

Upon successful completion of a seminar, participants will be awarded 2.0 PDHs (Professional Development Hours) and 0.2 CEUs (Continuing Education Units). Successful completion of a seminar requires that the participant have:

- Attended the complete seminar
- Received a minimum score of 80% on the Final Assessment

Certificate of Accomplishment

Participants who successfully complete the seminar and receive a passing score on the online final assessment are entitled to a "Certificate of Accomplishment." Certificates are available for printing directly from the participant's account screen on Generac's online training system *"The Learning Center".* Instructions for how to register and log in to this system, take the final assessment and print a certificate, are described beginning in the following section.

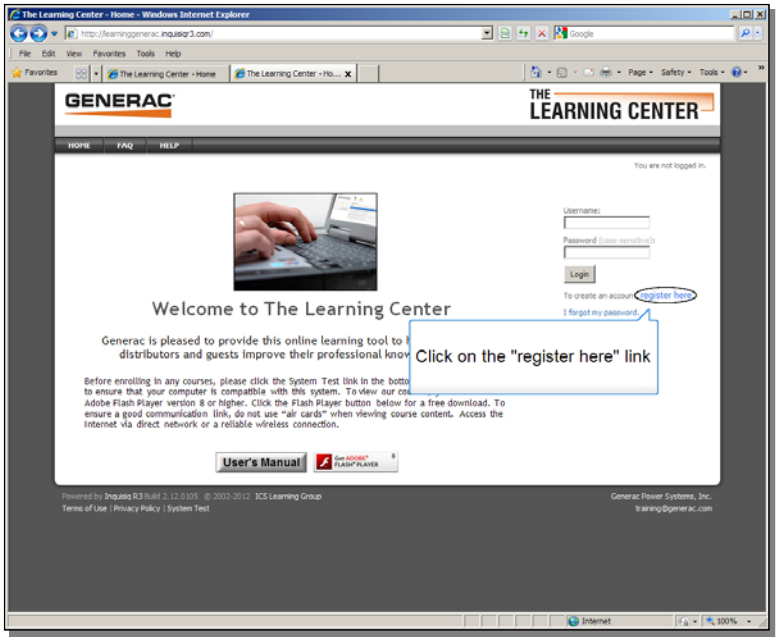
Registering in *"The Learning Center"*

To gain access to *"The Learning Center*", you are required to register and set up a user account. During your account setup you will create a *Username* and *Password*. Your username and password can then be used to log in on subsequent visits.

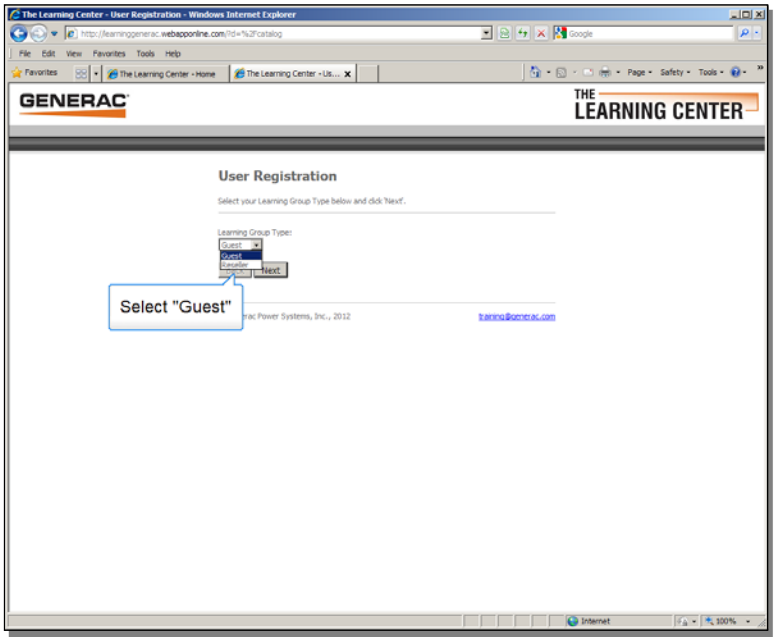
The following pages will aid you in the registration process along with the Final Assessment, Survey and Certificate procedures.

To begin the registration process, open your computer's browser and enter http:// learning.generac.com. This should take you to *"The Learning Center"* home page. This page is displayed at the top of the next page. From this point you can follow illustrated steps.

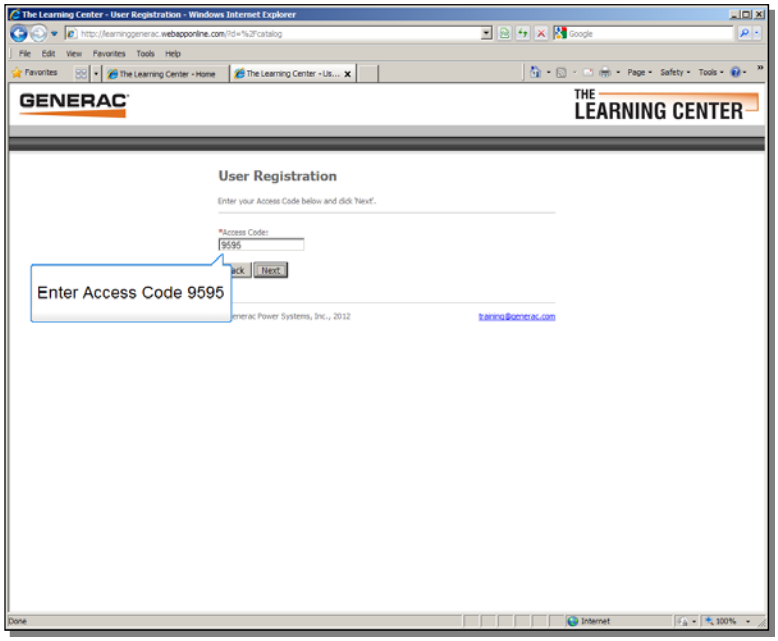
Begin by entering http://learning.generac.com in your computer's browser. The screen below will be displayed. Click on the "register here" link to begin the registration process.



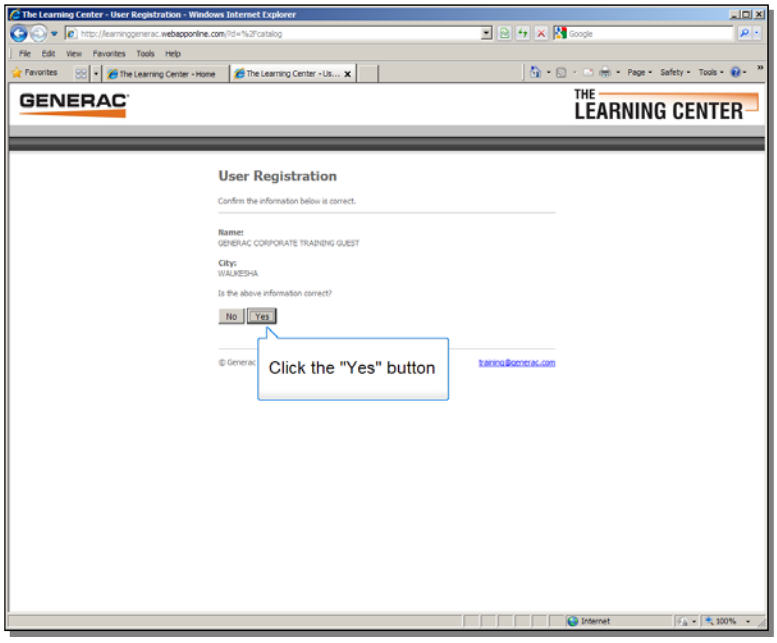
On this screen you will select "Guest" from the drop down box and click the "Next" button.



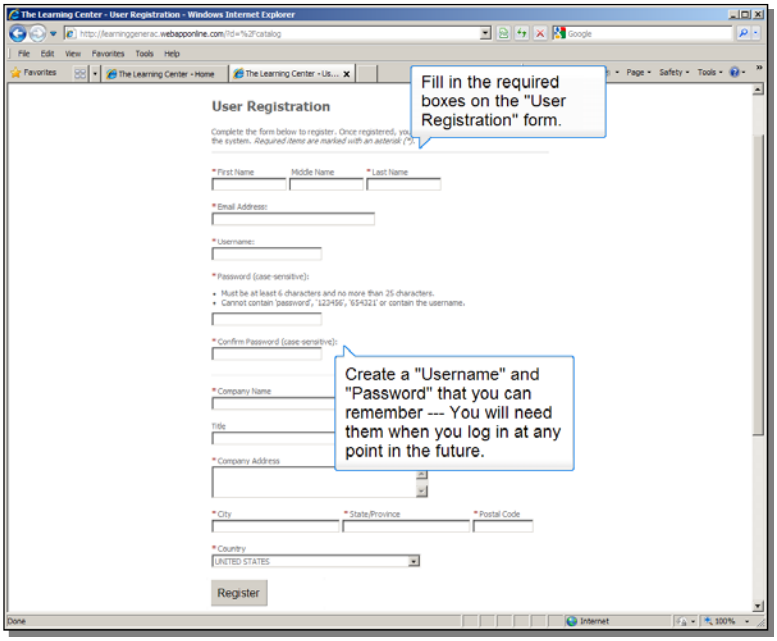
In this next screen enter **Access Code 9595** and click the “Next” button. Please keep this code private.



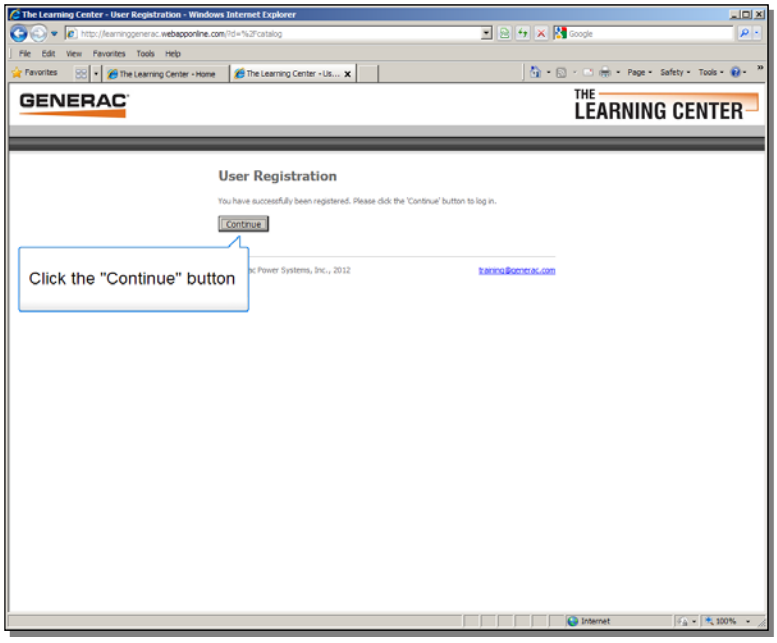
This screen confirms the correct access code entry. Click the “Yes” button to proceed.



The next screen contains the “User Registration” form. Fill in the required boxes, and then click the “Register” button.

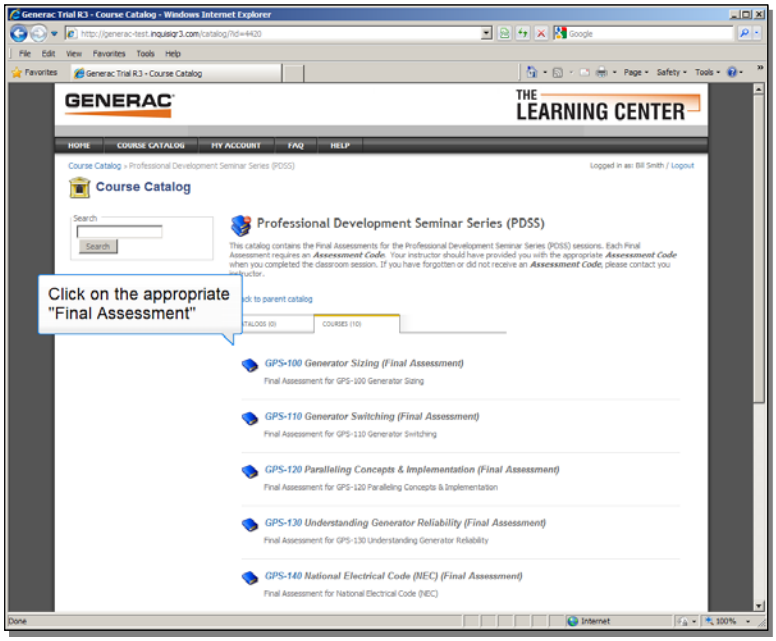


The next screen confirms your registration. Click the “Continue” button to proceed.

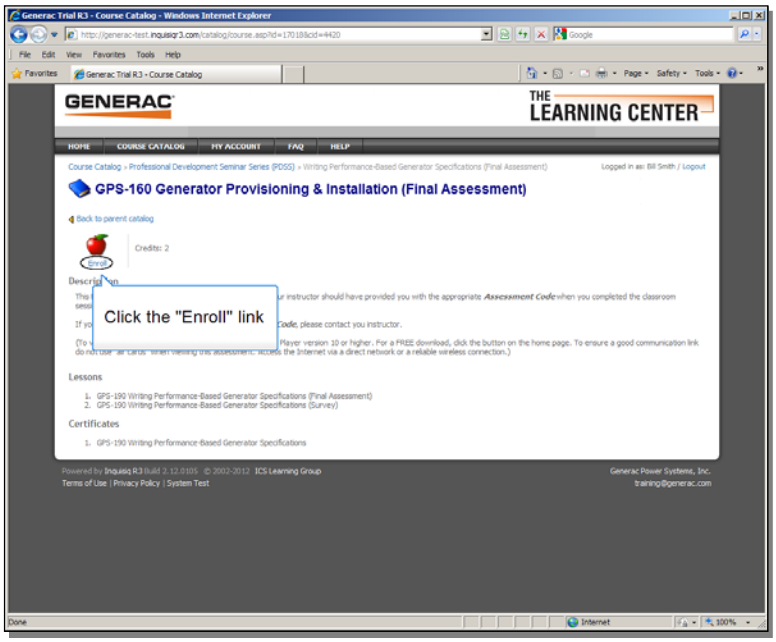


The next screen displays the “Course Catalog.” Click on the “Professional Development Seminar Series” link.

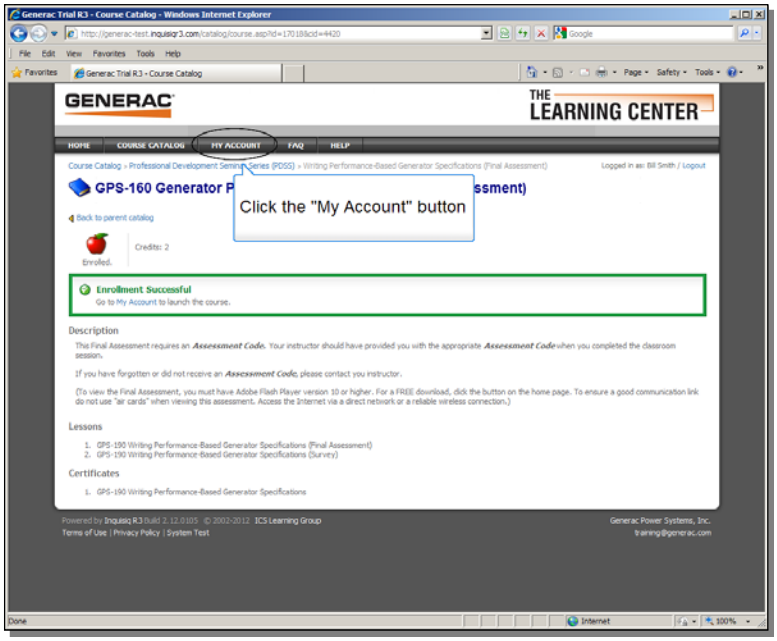
This next screen lists all currently available Final Assessments. Click on the Final Assessment that is tied to the course name and number you completed.



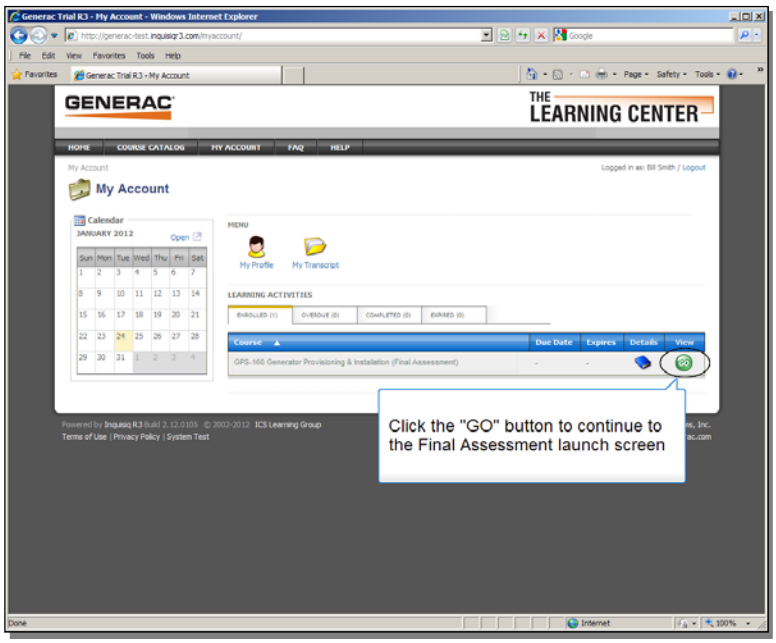
The next screen is the “Enrollment” screen for the Final Assessment that you selected. Click the “Enroll” link to proceed.



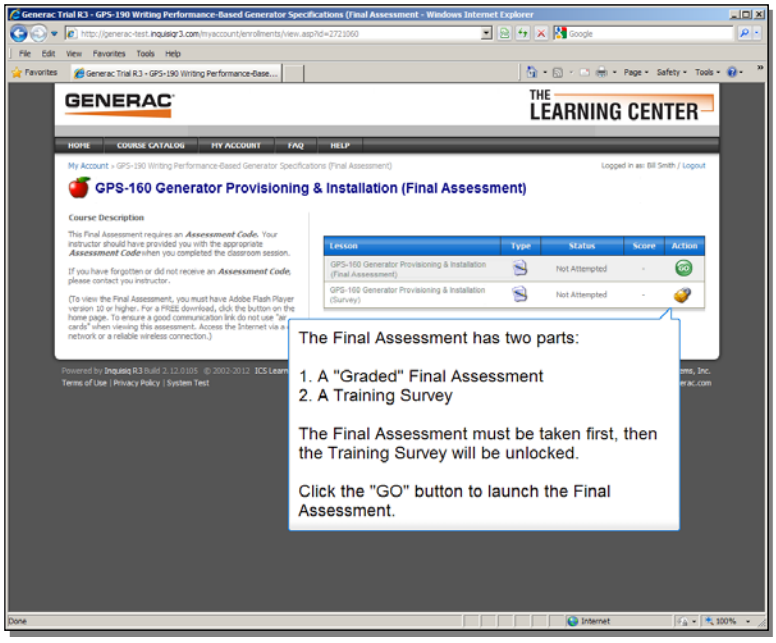
This screen confirms your enrollment. Click the “My Account” button to proceed.



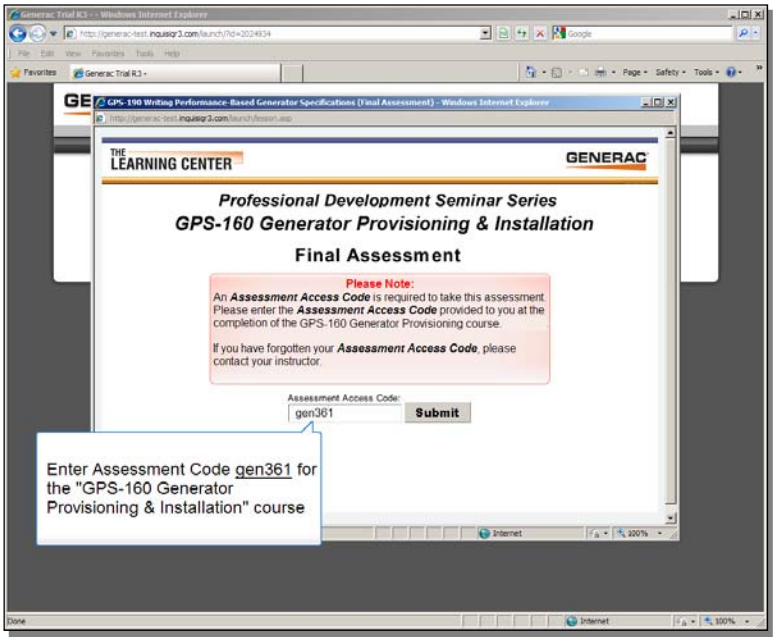
This is your “My Account” screen. Note that the Final Assessment you selected is displayed under the “Enrollment” tab. Click the “GO” button to proceed.



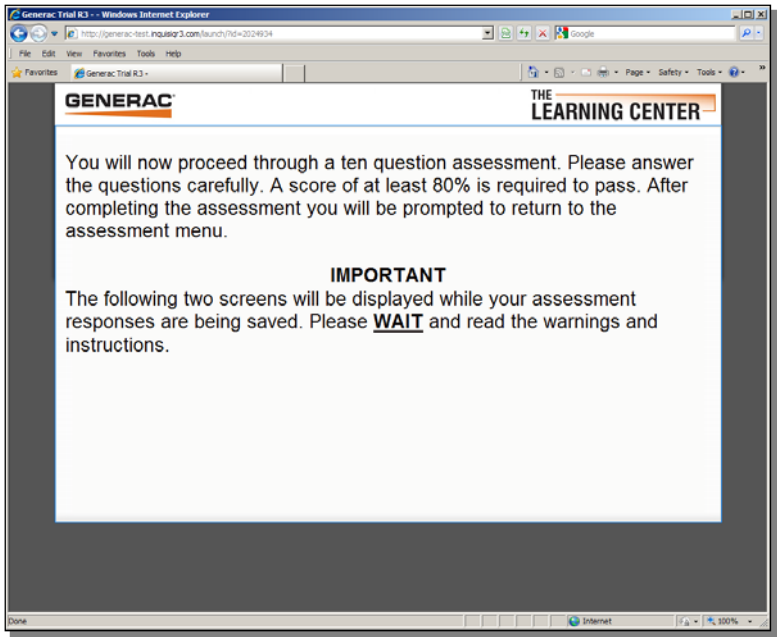
This screen lists the two parts to the Final Assessment. You must take the “Graded” Assessment first, then the Training Survey.



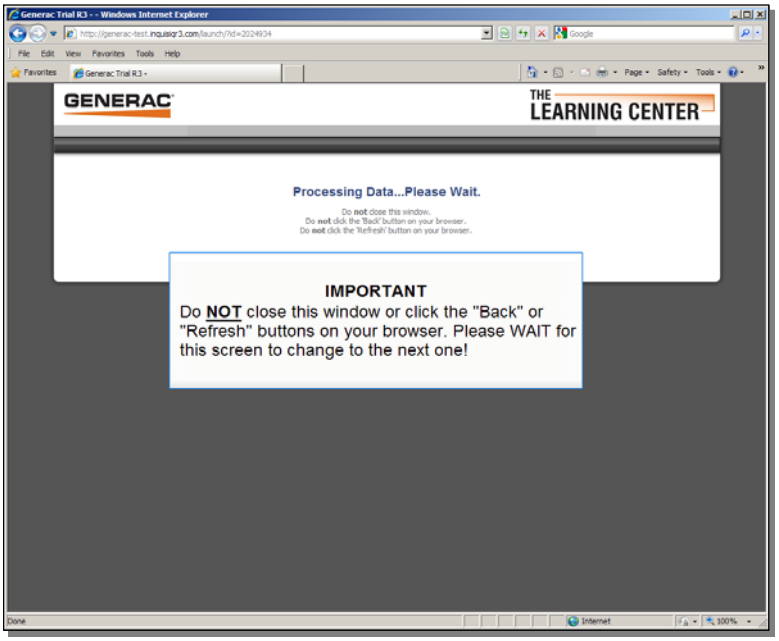
In the next screen an “Assessment Code” is required before you can continue. The code for GPS-160 Generator Provisioning and Installation is **gen361**. Enter the code in the box and click the “Submit” button to continue.



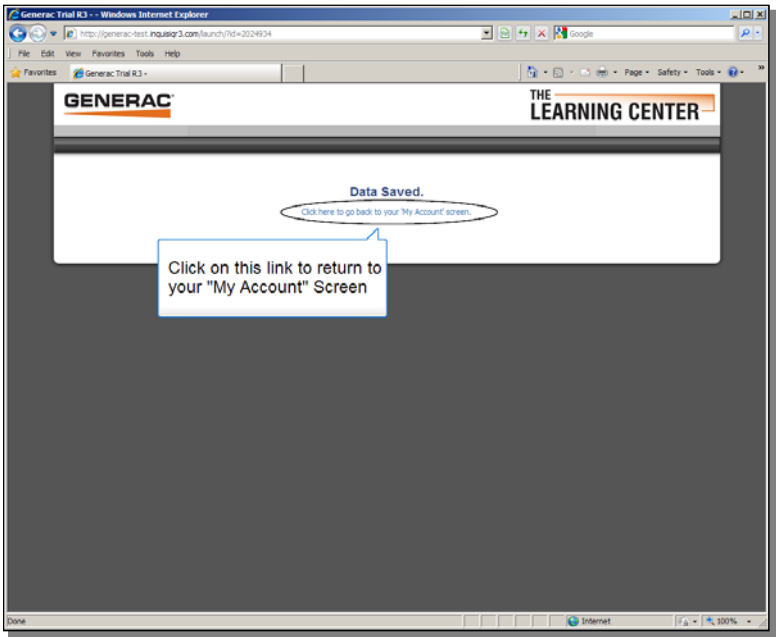
You will now proceed through a ten question assessment. Please read the warnings below.



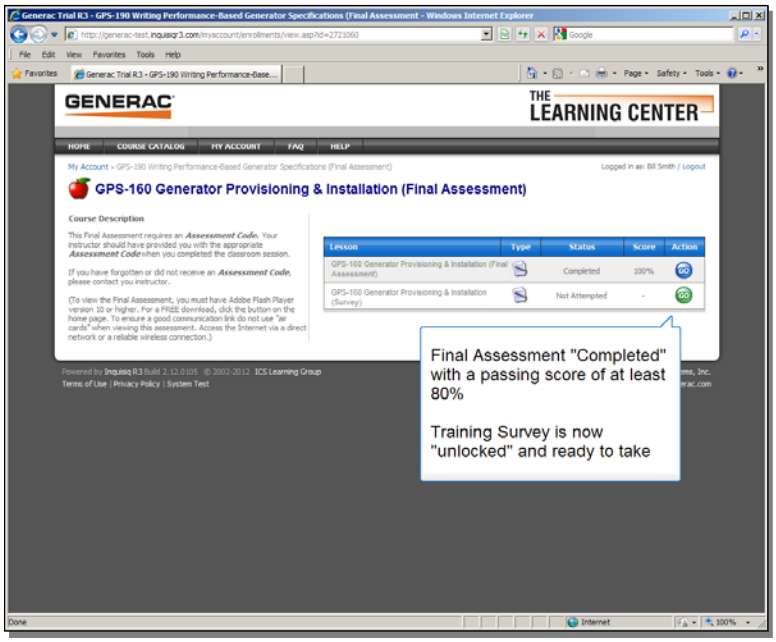
Please follow the instructions on this screen. You must wait for your assessment data to be saved. Do not close this window or click the 'Back' of 'Refresh' buttons on your browser.



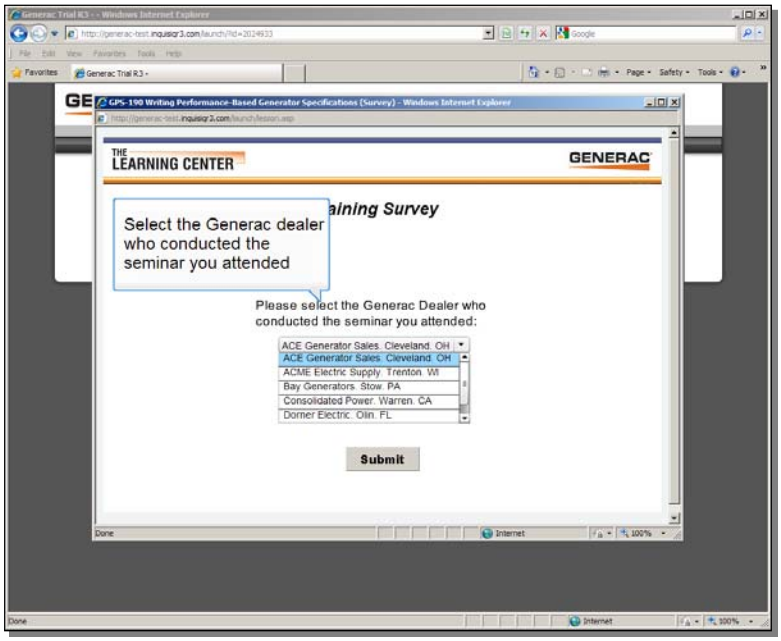
This screen confirms that your data was saved. Click on the link shown here to proceed.



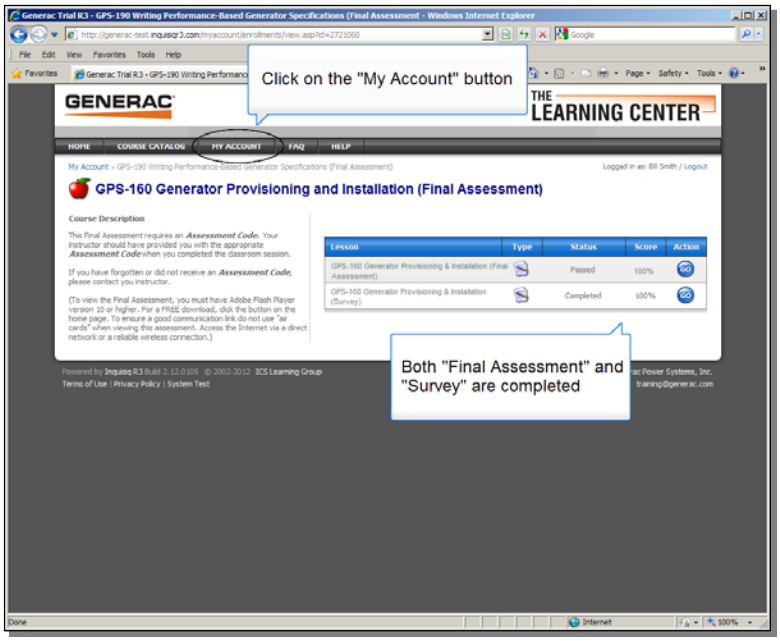
This screen will be displayed after your assessment data is saved. Note that in this example the assessment was passed with a score of 100% and the Survey is unlocked and ready to launch.



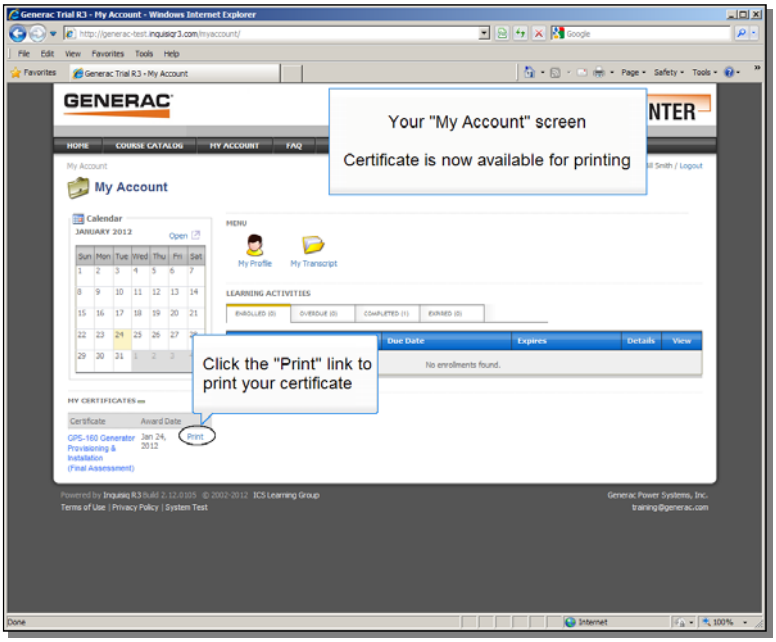
Upon launching the Survey, this screen will be displayed. Select the Generac dealer who conducted the seminar you attended.



After completing the survey you will be prompted to return to the assessment menu. Your response data will be saved as before, and you will see the screen below. Click the "My Account" button to continue.



Your "My Account" screen will look similar to the one shown here. Click the "Print" link to print your certificate.



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