Survey: Automatic Voltage Regulators

1 Synopsis

This survey is issued as part of a Request for Information (RFI) by the United States Coast Guard (USCG) as a means of market research for gaining knowledge of capabilities pertaining to Automatic Voltage Regulators (AVR) for shipboard generators that may meet Polar Ice Breaker's specific design and operational requirements.

2 Purpose

The purpose of this survey is to perform market research to identify the capability of currently manufactured automatic voltage regulators for shipboard generators that may meet Polar Ice Breaker's specific design and operational requirements as defined herein.

3 Requirements

The following design and operational requirements for automatic voltage regulators are sought:

1) Suitable for Marine (shipboard) installation;
2) Comply with ABS SVR, IEEE Std 45, and 46 CFR requirements;
3) Designed and tested to withstand externally excited vibration, Type I as specified in MIL-STD-167-1 or ANSI S2.26;
4) Operate with dynamic roll of as much as 45° and dynamic pitch as much as 10° (both single amplitude);
5) Capable of operating in ambient temperatures between 40 °F and 122 °F;
6) Capable of being used with 3-phase, 3-wire, 60 Hz, ungrounded generator sets producing 450VAC, 4160VAC, or 6600VAC power. Note that AVR does not have to be capable of accommodating all voltages listed at the same time, only one voltage per AVR is required;
7) Capable of being used with a rotary brushless exciter, PMG or PMA;
8) Voltage regulator using solid state and digital technology;
9) Capable of manual and automatic control of voltage of shipboard generator sets;
10) Maintain voltage within the parameters of MIL-STD-1399, Section 300 (450VAC) or Section 680 (4160VAC or 6600VAC), as appropriate;
11) Consist of modular components to allow removal and replacement of all components for service and repair;
12) Components capable of continuous operation in a drip-proof enclosure;
13) Mean Time Between Failures (MTBF) equal to or greater than 25,000 hours;
14) Mean Time to Repair (MTTR) not be more than 3 hours with no repair requiring more than 10 hours;
15) Operating or control modes capable of:
    a) Automatic Voltage Regulation (AVR) – Primary;
    b) Backup (Redundant AVR) – Secondary;
    c) Off;
    d) Manual or Field Current Regulation (FCR);
    e) Power Factor (PF);
    f) Reactive Power (VAR);
16) Include a front panel Human Machine Interface (HMI) display that includes pushbutton controls. Controls capable of: operating modes, set points, loop gains, metering, protection, limiters, system parameters and general settings;
17) Regulator capable of a separate adjustment of the generator voltage maintained by the voltage regulator. The adjusting means provided on the voltage regulator display. Voltage capable of being adjusted remotely;
18) Sensing circuit sensing the average of the three line-to-line voltages of the generator. The overvoltage limiting sensing individual line-to-line voltages. The sensing circuit using true RMS sensing;
19) Withstand without damage sustained operation at any frequency from rated to zero. Protective devices may not be used to meet this requirement. The regulator providing under-frequency compensation or a V/Hz Ratio Limiter. This parameter being adjustable;

20) Withstand without damage sustained operation at frequencies between rated and 125 percent rated. The regulator need not maintain the required steady-state voltage regulation during overspeed operation above 105 percent of rated speed;
21) Provide overvoltage limiting feature to limit the voltage in the event of a failure in the regulator. The voltage limiting feature being functional in both the "Automatic" and "Backup" modes of operation;
22) Utilize a microprocessor-based design. A means capable of communicating between a Personal Computer (PC) and regulator. Setup of regulator parameters provided via Windows-based software;
23) Provide user customizable stability programming setpoints, step changes and ranges to facilitate proper stability;
24) Capable of Over-Excitation Limiting (OEL) in all modes of operation and Under-Excitation Limiting (UEL) in all modes other than FCR mode of operation;
25) Capable of stator current limiting;
26) Capable of Volts per Hertz ratio limiter and capable to adjust the limiter parameters;
27) Capable of soft start for an orderly buildup of terminal voltage from residual to the voltage setpoint in the desired time with minimal overshoot. A user selectable soft start level from at least 0-90% in 1% increments with a time delay range of at least 1-1000 seconds in 1 second increments provided;
28) Capable of utilizing negative field forcing;
29) With all reactive compensation circuits inoperative, the voltage regulator system capable of maintaining the average voltage on the generator with which it is intended to operate within a steady-state voltage regulation band of 1 percent of rated voltage (±0.5 percent of the rated voltage) at any frequency between 95 to 105 percent of rated frequency. The generator capable of operating anywhere from no load to rated kilowatt (kW) load at any PF between 0.5 lagging and 0.8 leading.
30) With the regulator-exciter system in the "Automatic" mode, the sudden application of a balanced 2.0 per unit current with a power factor of 0 to 0.4 lagging, resulting in a voltage dip at the switchboard no greater than 14.0 percent of rated voltage;
31) The voltage adjusting means furnished for the "Automatic" and "Backup" modes capable of changing the voltage from 3.0 percent below to 7.0 percent above the rated voltage in steps of not more than 1.0 percent of rated voltage at any load from no load to full load at rated PF. Capable of meeting this requirement with the reactive droop compensation circuit, if provided, inoperative;
32) Reactive droop compensation and reactive differential compensation modes for paralleling provided. Capability to switch between reactive droop compensation and reactive differential compensation;
33) Capable of providing an adjustment for the reactive droop compensation circuit. The range of adjustment capability is from zero to at least 10 percent of rated voltage in steps not to exceed 0.2 percent of rated voltage;
34) At rated generator kW load with 0.8 leading PF, the regulator capable of maintaining generator terminal voltage within the steady-state voltage regulation band;
35) An overvoltage limiting circuit incorporated in the voltage regulator. This circuit capable of automatically limit generator overvoltage to a value not exceeding the set value between 105 and 130 percent, in steps not exceeding 2.0 percent of rated voltage. The normal setting for overvoltage limiting will be 110 percent of rated voltage.

4 Response Instructions

Please provide Product Guides/Data Sheets for each automatic voltage regulator that meets the design and operational requirements listed above. Additionally, please complete the questions on Attachment (1). If the automatic voltage regulator does not meet an individual requirement stated above, please indicate the maximum capability for that requirement.

Attachment (1) – Automatic Voltage Regulator Questions

Please provide the following data for each proposed AVR. Note that separate information should be provided for AVRs to be used with generator sets producing 450VAC, 4160VAC, and 6600VAC power if necessary. Equipment to be used with generator sets producing voltages other than those specified above may be provided as well for informational purposes.

1. Manufacturer and Model Number
2. Physical and technical characteristics of the AVR
3. Rough Order of Magnitude (ROM) Cost
4. Range of voltage capable of being regulated. (Ex: 100-600V)
5. Excitation Power Source capability (type, voltage, phase, etc.)
6. Field Forcing Voltage and Current Options
7. Voltage Sensing Type (Ex: True Three-Phase RMS)
8. Regulator Response Time (Ex: <10 milliseconds)
9. Pre-position Setpoint Capability
10. Enclosure IP Rating
11. Non-operating (Storage) Temperature Rating
12. Network Interface Type (PROFIBUS, MODBUS, CONTROLNET, etc.)
13. Description of Each Operating/Control Mode
14. Regulator Accuracy in all Operating Modes
15. Regulatory Compliance certificates of approval.