Switchgear Evaluation Report

A review of standard switchgear systems used in village power applications throughout Alaska. This review is based on site visits and interviews with manufacturers.

Prepared for the Alaska Energy Authority
November 21, 2007

by

Marsh Creek LLC
2000 E. 88th Ave. Ste 100
Anchorage, AK 99507
Phone: (907) 258-0050

MARSHCREEK
ENERGY SYSTEMS

December 3, 2007

Mr. Kris Noonan
Alaska Energy Authority
813 West Northern Lights Blvd
Anchorage, Alaska 99503

Re: AEA-07-004-A
Evaluation of Rural Powerhouse Switchgear Equipment and Standards
Addendum

Dear Mr. Noonan,

Marsh Creek conducted follow-up discussions with the operators of each of the five sites visited (Elim, Golovin, Kasigluk, Stevens Village, and Tenakee) to review how the sites were doing and find out if any problems have come up since our site visits in Spring 2007.

Only Golovin reported any significant problems with their switchgear. As reported by Golovin's powerplant operator, Golovin's switchgear is operating in manual mode, rather than automatic. The engines and generators are still working, but the switchgear is no longer functioning properly. The powerplant operator indicated that the touchscreen and the computer aren't working. He's tried powering them down, first for a few seconds, then a few minutes, then for an entire 24 hour period. Initially, it would work for a brief period of time, then would fail again. Now it doesn't work at all. The problems are reported to have started approximately two (2) months ago. The individual GSS controllers are still working, which allows them to continue operating the facility in manual. If one of the generators goes off-line, the village will go dark, and he has to go down to the powerplant to bring another unit on-line.

Golovin's system was built by PowerCorp.

Please contact us if you have any additional questions.

Sincerely,

John Cameron

John Cameron
Vice President & General Manager

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MARSHCREEK, LLC, a certified ANC 8(a) Company

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PURPOSE OF REPORT

The purpose of this report is to evaluate competing versions of switchgear that have been installed in recent years throughout Alaska by the Alaska Energy Authority and the Alaska Village Electric Cooperative (AVEC). Each set of switchgear evaluated in this report was manufactured or assembled by a switchgear assembly firm that has either adapted the design provided by the Alaska Energy Authority, or has built the switchgear "on specification" - providing exactly what was required to be constructed.

This report will describe observed advantages and disadvantages of each system, and will provide information on the appropriateness of each system for the application. In all cases reviewed in this report, the applications consist of remote site generation facilities providing off-grid loads in small rural communities.

To provide a comparative analysis of the switchgear reviewed in this study, evaluation criteria were developed and agreed upon by the Alaska Energy Authority. Using these evaluation criteria for factors with the most importance, each system is ranked accordingly.

Finally, the report considers the present methodology used by the Alaska Energy Authority to specify switchgear when new installations are required.

METHODOLOGY

This report was prepared during the first half of 2007, and consisted of:

- Review of design used by AEA for new switchgear
- Review of manufacturer's literature, including O&M manuals
- Interviews with panel fabricators and site visits to their facilities
- Site visits to communities
- Interviews with local operators
- Hands-on review of systems, including ability of operator to change units or parameters, both locally and remotely.
- Interviews with AEA and Alaska Village Electric Cooperative (AVEC) personnel

INTERVIEWS

Interview reports are presented in the main body of the report.
The following manufacturers and key personnel were interviewed:

Applied Power & Control: Dennis Johnson, Dave Bechtel
12432 Highway 99, Unit 82
Everett, WA 98204

Main Phone: 425-710-9911
http://www.appliedpower-control.com/index.html

Controlled Power: Mike Dizard, Dennis Berkshire, James Dizard
17909 Bothell Everett Hwy S. E., Suite 102
Bothell, WA 98102
Main Phone: 425-485-1778
http://www.controlledpowerinc.com/index.html

PowerCorp: Alan Langworthy, Gavin Bates, Dale Letourneau, Russell Cahill, Erin McLarnon,
Export Drive
Darwin Business Park
Berrimah NT, Australia
0828
Main Phone: 61 (0)8 8947 0933
http://www.pcorp.com.au/index.php

Thomson Technology: Guy Anderson
9087A – 198th Street
Vancouver (Langley)
British Columbia V1M 3B1
Main Phone: (604) 888-0110
http://web.thomsontechnology.com/index.php

Alaska Village Electric Cooperative (AVEC): Mark Tietzel, Mark Bryan, Dave Williams, Bill Thompson
4831 Eagle Street
Anchorage, Alaska 99503
(907) 561-1818
http://www.avec.org

SITE VISITS

Site visits to the following communities were conducted during the preparation of this report:

Golovin
Date of visit: Friday, March 9, 2007
Switchgear provided by PowerCorp utilizing the Commander™ and GSS generator control units. Switchgear was assembled by Applied Power & Control.
Golovin is a community of approximately 150 people, located on the Seward Peninsula 70 miles east of Nome. Electric power is provided by Golovin Power Utilities. Golovin is assisted by AEA.

Elim
Date of visit: Friday, March 9, 2007
Switchgear provided by Kohler.
Elim is a community of approximately 300 people, located on the Seward Peninsula 96 miles east of Nome. Electric power is provided by Alaska Village Electric Cooperative.

Stevens Village
Date of visit: Friday, March 14, 2007
Switchgear provided by Controlled Power.
Stevens Village is a community of approximately 65 people, located on the north bank of the Yukon River, approximately 90 miles northwest of Fairbanks. Electric power is provided by Stevens Village Energy Systems. Stevens Village is assisted by AEA.

Tenakee Springs
Date of visit: Friday, April 11, 2007
Switchgear provided by Thomson Technology.
Tenakee Springs is a community of approximately 110 people, located on the east side of Chichagof Island, 45 miles southwest of Juneau. Electric power is provided by the City of Tenakee Springs. Tenakee Springs is assisted by AEA.

Kasigluk
Date of visit: Friday, May 8, 2007
Switchgear provided by Kohler.
Kasigluk is a community of approximately 550 people, located on the Johnson River, 26 miles northwest of Bethel. Electric power is provided by Alaska Village Electric Cooperative.

SWITCHGEAR, AND COMMON COMPONENTS

Switchgear used in rural Alaska villages follows a common theme that would be considered the industry standard. Typically, there are a minimum of two engine gensets that are connected to a common bus that is fed through feeders to the village loads.

Some of the most common terms and components used in switchgear systems are:

Synchronization allows multiple units to operate together, in sync, to provide power for loads larger than the capacity of a single generator.

Feeder breakers protect distribution lines to the community. In some power systems, these feeder breakers are bolted directly to the bus. In these systems, repair of a failed breaker will require a shutdown of power to the bus (and hence the entire village) to safely work on the equipment. In other power systems, feeder breakers can be removed from the bus without de-energizing the bus. These are draw-out breakers.

Generator breakers provide protection to the bus and to the generator, and are able to interrupt the connection between the generator and the bus in the event of a fault or if desired to isolate a generator. As with feeder breakers, these can be either bolted or rack mounted.

HMI is the Human-Machine Interface, and is often a touchscreen panel that is able to display information and provide control access for the generation system to the operator.

Relays are used in switchgear to provide protection against faults. The IEEE defines a "relay" as "an electric device that is designed to interpret input conditions in a prescribed manner and after specified conditions are met to respond to cause contact operation or similar abrupt change in associated electric control circuits" (IEEE 100-1992).

MANUFACTURER'S PRODUCTS AND INFORMATION

PowerCorp:

GSS is PowerCorp's Generator Supervisory System, which controls the operation of generators attached to the power system, typically in conjunction with the Commander™, which provides for overall control of a power system under automatic operation.

PowerCorp's GSS is manufactured under license by Woodward.

The following is a description of the Commander™ from the PowerCorp website:

> Automation and Control – "Commander"
>
> - The Commander system enables a power station to operate automatically without human intervention, except for monitoring, maintenance of plant and fuel supplies.

The controllers used in the Commander control system are:

- Commander Master Controller
- Generator Controller
- Feeder Controller

The Commander Master Controller automatically controls and monitors all diesel and/or gas generator sets, consumer feeders and fuel tanks in a power station. It provides alarm/event reporting, trending, remote access and external alarm notification.

Depending on system load conditions, the Commander Master Controller starts and stops generators to optimise station fuel efficiency. The Commander Master Controller maintains optimum loading and spinning reserve on all in-service generator sets. The Commander Master Controller power management continuously monitors the feeder load and matches the most economical configuration of the generator sets to the demand. By doing so it ensures that the following criteria are met:

- Maintaining the required spinning reserve
- Optimising the loading of generator sets
- Preventing low loading of generator sets

The Commander Master Controller is based on an open controller hardware architecture. Embedded industrial PC hardware is used with distributed I/O to achieve mission critical and highly reliable power station control. The Commander Master Controller is specifically designed for power station applications and can withstand temperatures between -40ºC and +50ºC.

Communications between the Commander Master Controller, the generator sets and the consumer feeder circuit breakers takes place via fieldbus using the CAN protocol. The Commander Master Controller enables fuel savings due to better loading of generator sets and fewer operation and maintenance costs due to much improved management of plant assets.

The Commander Master Controller is able to control and monitor:

- Up to 8 Generator Controllers.
- Up to 6 Feeder Controllers.
- An additional 1 Feeder Controller for use as a Local Light and Power Meter.
- Up to 12 Bulk Fuel Storage Tanks.
- Up to 3 Temperature Measurement Inputs.

Typical configurations and product specifications are included in the Appendix of this report. (source: http://www.pcorp.com.au/index, Products and Capabilities, 2007)

Woodward:

The GCP-30 Series (Generator Control Package) controls the operation of generators attached to the power system.

The following is a description of the GCP-32 from the Woodward website:

> The GCP-30 Series genset control is designed to provide total control for multiple, medium to large sized applications. A network of the compact, versatile GCP-30 controls is capable of controlling up to 14 gensets with automatic sequencing. Load management features include automatic base loading/peak shaving, import/export control and emergency power/back up power generation.
>
> The GCP-32 has logic for two circuit breakers including open/closed transition.
>
> View GCP-32 single genset application
> View GCP-32 multiple genset application
>
> Common Product Features:
>
> - Synchronization
> - Isolated single-unit operation
> - Stand-by operation
> - Peak load operation (auto start / stop)
> - Mains parallel operation
> - Start/stop logic for Diesel/gas engines
> - Operating hours / start / maintenance / kWh counter
> - Configuration via PC or front panel
> - Language Manager
> - Discrete raise/lower controller for n (speed) / f (frequency) / P (real power)
> - Discrete raise/lower controller for V (voltage) / Q (reactive power)
> - Mains import / export power control
> - Load-dependent start / stop
> - Load / var sharing for up to 14 generators
> - MPU input
> - 16 configurable discrete alarm inputs
> - 7 configurable relay outputs
> - CAN bus communication for control of unit and remote monitoring
> - CE marked
> - UL/cUL listed

- AMF operation
- Open transition (break-before-make)
- Closed transition (make-before-break)
- Softloading

Protection Functions:

- 3/4-wire measurement
- Mains/generator over/undervoltage (ANSI# 59/27)
- Mains/generator over/underfrequency (ANSI# 81O/U)
- Mains phase/vector shift (ANSI# 78)
- Generator overload (ANSI# 32)
- Generator reverse/reduced power (ANSI# 32R/F)
- Generator unbalanced load (ANSI# 46)
- Generator time-overcurrent (TOC) (ANSI# 50)

Special X-Package Features:

Models:
GCP-32/XPD
GCP-32/XPQ
GCP-32/XPQ+SB03
GCP-32/XPQ+SC10

- Real-time clock
- Event recorder (50 entries)
- Mains import / export power control via 20 mA
- Active power set point via 0/4 to 20 mA
- 7 configurable analog inputs
- 2 configurable analog outputs
- External operation mode selection via DI

Special Q-Package Features:

Models:
GCP-32/BPQ
GCP-32/XPQ
GCP-32/XPQ+SB03
GCP-32/XPQ+SC10

- Analog raise / lower controller for n (speed) / f (frequency) / P (real power)
- Analog raise / lower controller for V (voltage) / Q (reactive power)
- PWM raise / lower controller for n (speed) / f (frequency) / P (real power)

Option SB03 Features:

Models:
GCP-32/XPQ+SB03

- Serial communication with Caterpillar CCM (ECM & EMCP II)

Option SC10 Features:

Models:
GCP-32/XPQ+SC10

- CAN bus communication with IKD 1, ST 3 and engine ECU (SAE J1939, Volvo EMS2, Scania S6, Deutz EMR, MTU ADEC, MTU MDEC)

Certifications / registrations: UL/cUL, CE

Typical configurations and product specifications are included in the Appendix of this report. (source: http://www.woodward.com/power/gcp-32.cfm, 2007)

EVALUATION CRITERIA

Each system has advantages and disadvantages that were identified in the report. To provide a comparative analysis of the switchgear reviewed in this study, evaluation criteria were developed and agreed upon by the Alaska Energy Authority. These evaluation criteria are the considerations that any set of switchgear purchased or installed by AEA are evaluated against in order to provide functional and cost-effective generation controls. The most important factors that are considered by AEA when evaluating switchgear are:

- Cost to install (includes availability of local/regional technical support during installation)
- Standardization, compatibility, and availability of spare parts
- Operability/functionality (design provides functionality)/efficiency (cost to maintain)
- Cost of service, and whether upgrades are possible
- Redundancy capabilities

Additionally, the technical capabilities and track record of firms that submit bids to fabricate and install switchgear are also evaluated by the AEA. These include:

- Technical ability
- Company history
- Similar sites in Alaska

- Support for equipment: can AEA contact them during normal business hours?

As with many electric utility firms, the direction or philosophy used in the design and operation of switchgear determines the choices that are made for many years. This is necessary to provide standardization of operations, minimization of costs, and safety to personnel through the adoption of specific operating and maintenance procedures developed around specific equipment designs and components used in the switchgear.

The switchgear installed in the five communities visited during this study are ranked in accordance with these criteria.

RANKING THE SYSTEMS BASED ON EVALUATION CRITERIA

A point weighting system was developed based on the evaluation criteria presented by the AEA. The values used to weight the criteria are shown in the ranking matrix. Based on discussions with the AEA, the most important criteria are: cost to install, standardization of equipment and components, functionality and operability, cost of maintenance, and redundancy capabilities. Additional criteria were used to evaluate the firms: technical ability, company history, operating history in Alaska, and technical support for equipment.

ADDITIONAL FACTORS FOR CONSIDERATION

In addition to the evaluation criteria used, other factors that merit consideration in the selection of switchgear include:

1. Kohler shares their source code with AVEC, would they share this with someone else? Once key individuals leave AVEC, are there others available who know how to program the gear?

2. The Kohler gear started out as standby gear, and was subsequently modified to be used for prime power. Is this modified design available to others besides AVEC?

3. The PowerCorp gear allows the user to modify the graphics used to display information, though the gear at Golovin appears to have some editing problems. However, for purposes of functionality and stability, the essential power control functions of the PowerCorp software are not available for modification by the end user.

4. Controlled Power, Applied Power & Control, and Thomson Technology all build gear to specification. Each of these firms are competent, well established firms, with a strong track record of successfully installed systems. Each system they build is shop tested, and will do exactly what it is designed to do. Each of these

firms is able to work with the client or a local genset distributor to resolve any difficulties that might arise from the design, installation, or use of their switchgear.

5. There is a greater learning curve with an HMI to diagnose problems when communication with a village is lost. Use of indicator lights provides a specific benefit when dealing with operators who are not fluent in computer usage and might have difficulty navigating through a touch screen. Though they may not be able to identify the sequence of events that led to trouble, they are able to identify specific problems that need to be resolved in order to bring a generator back on-line.

6. Many village power plant operators have stronger experience with the mechanical operation of the plant, but are less experienced with newer technologies used in fully automated switchgear. Many power plant operators have been serving in that role for many years, and are familiar with manually operated switchgear for power production, as well as the required maintenance to keep engines running.

7. Switchgear that can accommodate both automatic and manual controls offers the best value for present applications.

8. Increased bandwidth in communication channels has allowed the use of cameras inside the powerhouse, in both the switchgear room and the generator room. This provides an increased level of safety, since the condition of the powerhouse can be visually monitored prior to the commencement of any remote control operations.

Switchgear Evaluation Summary

	Max. % of Score	Elim	Points	Golovin	Points	Kasigluk	Points	Stevens Village	Points	Tenakee Springs	Points
Switchgear Mfr.		Kohler / AVEC		PowerCorp **		Kohler / AVEC		Controlled Power		Thomson Technology	
Owner		AVEC		AEA		AVEC		AEA		AEA	
Installed gensets		3		4		3		4		3	
Cost to Install *		$187,650		$200,000		$187,039		$150,000		$133,000	
Cost to Install Per Section	25%	$62,550	8%	$50,000	17%	$62,346	8%	$37,500	25%	$44,333	20%
Standardization of Control Systems With Other Installations in Alaska	10%	Established Standard	10%	One System Only, Not Yet Widely Adopted in Alaska; but Numerous Installations Worldwide.	7%	Established Standard	10%	Established Standard	10%	Established Standard	10%
Operability / Functionality	20%	High	20%	High	20%	High	20%	High	20%	High	20%
Cost of Maintenance	5%	Low	5%	Low	5%	Low	5%	Low	5%	Low	5%
Redundancy of Controls	10%	High	10%	High	10%	High	10%	High	10%	High	10%
Redundancy of Master Processors	10%	Single	5%	Single	5%	Single	5%	Main & Backup	10%	Main & Backup	10%
Alternative Energy Applications:		Built to Spec; Can Adapt to Alternative Energy Sources		Can Adapt to Alternative Energy Sources		Built to Spec; Connected to Wind Generators		Built to Spec; Minimal Wind Systems Applications		Built to Spec; Minimal Wind Systems Applications	
Firm's Technical Ability	10%	Excellent	10%	Excellent	10%	Excellent	10%	Excellent	10%	Excellent	10%
Company History	5%	AVEC Founded 1968	5%	Founded 1988	5%	AVEC Founded 1968	5%	Founded 1979	5%	Founded 1973	5%
Design Acceptance		Design is Used in Multiple Locations		Design is Used in One Location Only		Design is Used in Multiple Locations		Design is Used in Multiple Locations		Design is Used in Multiple Locations	
Technical Support During Normal Working Hours	5%	Wisconsin / Anchorage	5%	Australia / Anchorage	3%	Wisconsin / Anchorage	5%	Seattle	4%	Seattle	4%
Total	100%		78%		82%		78%		99%		94%
Rank		**4**		**3**		**4**		**1**		**2**	

OBSERVED ADVANTAGES / DISADVANTAGES WITH EACH SYSTEM

PowerCorp:

Advantages:

- Fully-functioning generator and switchgear controllers.
- Established design, used extensively throughout Australia.
- Redundant design, allows for continued power production even if specific elements are in fault.
- Full service capabilities, including engineers and technicians.

Disadvantages:

- Only one system in Alaska. At present, no economies of scale with respect to adoption of their equipment as a standard.
- Australia based company with minimal presence in the U.S.; technical staff is located in Australia.
- Programming code for the Commander™ device is proprietary information. Users can make changes to screen display, but functional changes are controlled by PowerCorp.
- Golovin switchgear has one master processor, the Commander. In the event of a failure of this device, the functionality provided by the Commander would not be available.

Kohler:

Advantages:

- Switchgear is part of integrated power plant system.
- AVEC has revised design of switchgear, and has adopted revised design as its standard.
- Switchgear has draw-out breakers, which eliminates the possibility of shutdowns to repair or replace generator or feeder breakers.
- Redundant design, allows for continued power production even if specific elements are in fault.
- Full service capabilities, including engineers and technicians.
- AVEC personnel are now very familiar with Kohler switchgear, including programming requirements.

Disadvantages:

- System was originally intended for standby power use, but has been modified to prime power use.
- System works well with Kohler equipment, but has required modification to enable communication with non-Kohler engine gensets.

Controlled Power:

Advantages:
- Switchgear is built to specification, and can accomplish any technical performance requirements as designed.
- Full service capabilities, including engineers and technicians.

Disadvantages:
- Dependent upon the design.

Applied Power & Control:

Advantages:
- Switchgear is built to specification, and can accomplish any technical performance requirements as designed.
- Full service capabilities, including engineers and technicians.

Disadvantages:
- Dependent upon the design.

Thomson Technology:

Advantages:
- Switchgear is built to specification, and can accomplish any technical performance requirements as designed.
- Full service capabilities, including engineers and technicians.

Disadvantages:
- Dependent upon the design.

STANDARDIZATION OF SWITCHGEAR DESIGN

As part of its mission to reduce the cost of energy in Alaska, AEA provides competent and qualified electric power generation and distribution repair and installation services, and develops specifications and designs for Alaska communities that do not have the expertise to design, build, or in some cases, fully maintain, a modern diesel-fired electric powerplant and its associated switchgear. This is due, in part, to the growing complexity of modern power plants that are beyond the technical capabilities of small village-based electric utilities.

To carry out its mission, AEA has developed, over the course of many years of experience in rural Alaska, a standardized design specification for switchgear. The standardized specification adopted by the AEA contains an essential set of controls necessary for remote diesel-fired generation applications. AEA can, and has, revised their switchgear specifications when circumstances warrant changes. This includes the introduction into their design of new technologies and improved devices that offer improved functionality, lower cost, or longer life. AEA has also taken steps to identify and field test new systems, as evidenced by their installation of the PowerCorp switchgear system in Golovin.

Switchgear units in use in AVEC's system have greater diversity of applications, and the specifications developed by AVEC have more features and capabilities than the systems designed by the AEA. As a consequence, the switchgear evaluated for this study for villages served by the AEA tended to have a lower purchase price than switchgear units developed for AVEC.

AVEC has adopted a standard switchgear configuration based on equipment built by Kohler, with features that are required for their installations across Alaska. These features have been developed by AVEC's engineering and operations staff, and provide switchgear that could be installed in many of their power plants.

For instance, AVEC chooses to purchase gear that has an initial higher cost because it is less expensive for them in the long run to have equipment that is compatible throughout their system. AVEC operates in 51 villages throughout Alaska, and as they indicated in their interview, once they have adopted a switchgear standard, a newer design must be significantly less expensive or significantly better for them to change their adopted standard.

The adoption of a standardized design may result in a slightly higher installed cost, since the features and equipment designed to cover all possible contingencies may be more than is required for a given location; but standardization reduces costs to the utility for expenses such as spare parts inventory, the training of operations and maintenance technicians, and the ability of engineers and technicians to troubleshoot systems when problems develop. Further, by adopting a standard design, equipment programming, failures, limits, input/output requirements become known factors that do not require re-learning when working from village to village. At many electric utility firms, the direction or philosophy used in the design and operation of switchgear determines the choices that are made for many years.

APPROPRIATENESS OF EACH SYSTEM FOR THE APPLICATION

Determining the appropriateness of switchgear that is used in a specific application is dependent upon a variety of factors that are decided by each organization. In the case of AVEC, there is a significant economic benefit to be gained from the adoption and use of a standardized design throughout all of the facilities they operate. AEA standardizes, but with fewer options – the AEA switchgear is tailored for use in remote, small villages. However, as with AVEC, once the AEA has adopted a standard, their technicians, engineers, and parts suppliers all know the gear, and have learned how to keep it running. It is, therefore, still economically beneficial for the AEA to adopt and retain a standard switchgear design.

AEA provides assistance to individual communities, and is usually required to provide the least expensive switchgear equipment that can meet the required minimum specifications. For example, although it is helpful, there is no requirement that switchgear provided for the City of Tenakee Springs match the equipment provided for Stevens Village Energy Systems, or for any other individual community's power plant. However, there is an advantage to AEA to adopt a standardized design, as AVEC has, because it reduces the cost of maintaining systems in the future.

Switchgear purchased by AVEC for a given village may have features that they do not intend to use in that village, but it is part of a common switchgear package that has a known look and feel. AVEC is willing to pay more for their switchgear because it is less expensive, in terms of operations and maintenance expenses, over the long run.

This is also true for PowerCorp, whose switchgear system is in use in a number of locations around the world, most predominantly in Australia. As they indicated in their interview, they provide a switchgear package that has a standard set of features. In the case of Golovin, they did not provide the wind power module because they were specifically directed not to include it. However, the wind power module, and others, would normally be included in the switchgear package. If upgrades or alternative energy generation sources were later added, the base package would already contain the programming needed to make the system work properly.

PowerCorp has adopted a standard that, while more expensive up front, reduces costs for their customers over the long run. With their standardized solution, their engineers, technicians and parts people all know the gear, know how to keep it running, and know how to fix it quickly if a problem should develop. Additionally, in the case of

PowerCorp, they also manufacture the controllers used in the switchgear, and they therefore have an interest in continuing to use these devices in new switchgear installations.

An individual community may have specific requirements that require modification of the basic switchgear design that AEA has developed. It is appropriate for AEA to continue to use their present design approach.

INTERVIEWS

Interviews were conducted with AVEC personnel, as well as the following switchgear manufacturers: Thomson Technology, Applied Power & Control, Controlled Power, and PowerCorp.

Of particular note were the comments by AVEC that once they had adopted a design, it would require a significant improvement in technology for them to modify their design. In their view, having adopted a standardized design, with known and tested components, provided an economic benefit to their utility that was substantially greater than the value of changing designs as new components become available. This was because their technical personnel, once they were trained on the adopted switchgear, were able to rapidly troubleshoot problems and were more likely to either limit the duration of outages, or eliminate them completely. Additionally, the adoption of a standardized design minimizes warehouse stocking requirements, and therefore minimizes the cost of maintaining equipment in the field.

The issue of wind generation was discussed with each manufacturer. The switchgear at Kasigluk currently integrates wind power. PowerCorp has other non-Alaska sites where wind power is integrated, but this was not available for inspection.

The recent cycle of investment in new switchgear equipment has provided an opportunity to incrementally update switchgear designs to adopt new technology. This includes the use of Ethernet, PLC's, PC's, and fully automated operations. As this cycle continues and the reliability of newer technologies is more firmly established, earlier technologies will likely continue to be phased out of use. This includes the use of synchronizer lights and manually operated synchronizing switches, and the use of indicator lights on the front panels. However, because of the remoteness of these villages from a technician who would be able to provide full-service repair capabilities, each manufacturer specifically designed into their equipment several levels of redundancy, just in case a particular system or component failed. The overriding mission is to keep the power on.

OPERATIONS AND REMOTE ACCESS

The powerplant control systems were accessed both from Anchorage and at the operating station computer located inside the power plant. Genset control, including start, stop, and the switching of units, was demonstrated at each of the plants (except Kasigluk). Due to the critical nature of power plant operations, all remote operations were conducted by qualified utility personnel.

Each of the community's remote monitoring and control systems provide the basic functionality required to remotely operate the system. There are differences between the screen layouts, and some of the systems are more easily navigated than others. Typically, display screens are constructed using software tools available with the program used to program the main PLC or PC. The effectiveness and ease of use of display screens reflects two principal considerations: first, the quality of the tools available for rendering and populating a display, and second, and perhaps most importantly, the knowledge and experience of the programmer who has built the display screens.

There is frequently a trade-off between the ability of a processor to collect, process and control data, and the display of that data. The decision to divert more processing resources to displaying information on a more user friendly screen has to be weighed against the requirement that the processor have sufficient speed and capacity to perform the required mission critical tasks. Additionally, the software tools that are provided to build and display the user interface may require significant amounts of processor capacity.

For example, in the case of Golovin, the remote access screens required re-sizing each time a new screen was selected, and although the screen size was expanded, the information on the screen did not change its size proportionally. However, as the manufacturer discussed in their interview, the first and most important element of their program was the operation of the power plant, and the graphics software was not mission critical.

However, having an effective user interface is important when dealing with plant operators who may not be computer literate. As discussed in the section on ranking systems based on the evaluation criteria, the use of indicator lights provides a specific benefit when dealing with operators who are not fluent in computer usage and might have difficulty navigating through a touch screen. This is the driving factor behind the requirement to continue using indicator lights, even though more information is available on the computer screen.

Both AEA and AVEC require village based operators to visit the power plant several times each day to fill the day tank and make sure there are no problems. This requirement stems from prior experiences where the power plant day tank overflowed or the facility suffered some other problem.

Having an operator visit the facility several times each day serves to identify problems at an early stage. One of the results of this policy is that the switchgear has indicator lights on the front of the panel to allow the operator to quickly identify equipment problems, though the indicator lights do not reveal the sequence in which problems occurred.

Village powerplant operators become familiar with the engines, generators, associated equipment, and switchgear as a result of their experience and training.

COMMUNITIES VISITED

<u>Stevens Village</u>

Uses Woodward GCP-30 for generator control.
HMI: Allen-Bradley Panelview Plus 700.
Indicator lights give ready indication of both engine and electrical problems.

Manufacturer: Controlled Power
Date of visit: March 14, 2007

GCP-30 used in Stevens Village switchgear.
Note the similarity in layout and design to the GSS offered by PowerCorp.

Allen-Bradley Panelview Plus 700 used in Stevens Village.

Kasigluk

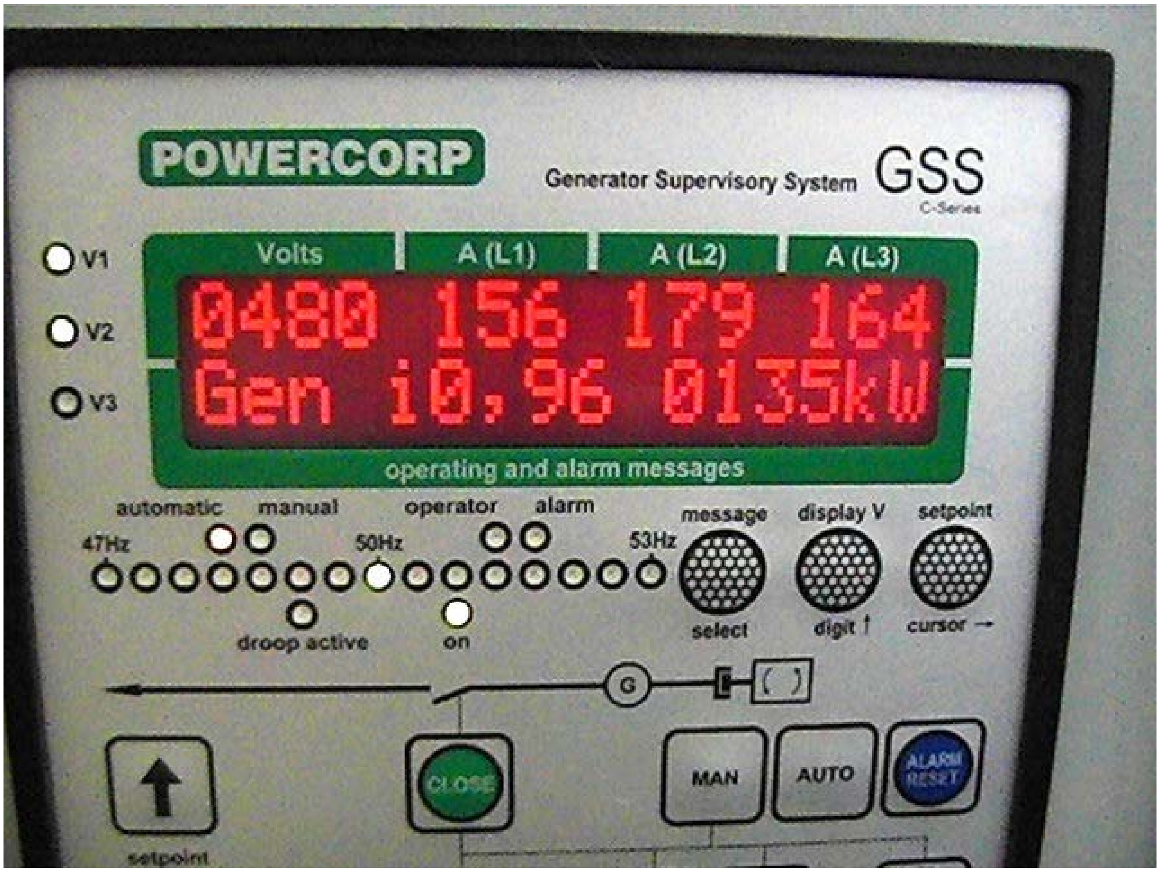
AVEC powerplant, showing touchscreen and bus power meter underneath. All plant generation systems, including wind, can be controlled through this screen.

Manufacturer: Kohler Power Systems
Date of visit: May 8, 2007

Golovin

Switchgear assembled by Applied Power & Control.
Uses PowerCorp GSS and Commander for generator control.

Manufacturer: PowerCorp
Date of visit: February 9, 2007



PowerCorp GSS, in service at Golovin.
According to the interview with PowerCorp, the faceplate for newer units has been updated to reflect the 60Hz standard used in the U. S. This unit is calibrated for 60 Hz. Changing the faceplate would require removing the unit and replacing it with a new unit with the updated faceplate.

Elim

Manufacturer: Kohler Power Systems
Date of visit: February 9, 2007

Tenakee Springs

Uses Woodward GCP-30 generator controllers.
HMI is Allen-Bradley Panelview.
Indicator lights give ready indication of both engine and electrical problems.

Manufacturer: Thompson Technology
Date of visit: April 12, 2007

Tenakee Springs switchgear, April 2007

INTERVIEWS WITH LOCAL OPERATORS

At each site visited, the local operator was interviewed. In each case, the local operator reported no problems operating the equipment at their site. Instead, they typically had specific problems with an engine that required parts and technicians to bring their facility back up to full readiness.

In villages where the panels were fitted with a wide array of indicating lights, the operators indicated they found the lights helpful. The operators generally liked the facilities (all were newer facilities, with the oldest not more than five years old).

RECOMMENDATIONS FOR STANDARDS

AEA provides assistance to individual communities, and is usually required to provide the least expensive switchgear equipment that can meet the required minimum specifications. There is an advantage to AEA to adopt a standardized design because it reduces the cost of maintaining these systems in the future. AEA has done this with their standardized design, as has AVEC and PowerCorp.

AEA provides a specified product, and can revise their specifications when circumstances warrant change. The existing specification was reviewed and was found to be appropriate for the general conditions encountered in the remote power plants that AEA is tasked to assist.

Through the adoption of a standardized design, equipment programming, failures, limits, input/output requirements become known factors that do not require re-learning when working from village to village.

This report therefore recommends that AEA continue its process of evaluating new technology as it becomes available; and incorporate that new technology, where beneficial, into the existing switchgear specifications that are presently used as the basis for proposal requests.

SUMMARY

This report evaluated competing versions of switchgear that have been installed in recent years throughout Alaska by the Alaska Energy Authority and AVEC. The basic design and layout of the switchgear evaluated in this report follows a design provided by the Alaska Energy Authority and which is well suited to serving a remote power generation application.

SWITCHGEAR EVALUATION CRITERIA

Each system has advantages and disadvantages that were identified in the report. To provide a comparative analysis of the switchgear reviewed in this study, evaluation criteria were developed and agreed upon by the Alaska Energy Authority. These evaluation criteria are the considerations that any set of switchgear purchased or installed by AEA are evaluated against in order to provide functional and cost-effective generation controls. The most important factors that are considered by AEA when evaluating switchgear are:

- Cost to install (includes availability of local/regional technical support during installation)
- Standardization, compatibility, and availability of spare parts
- Operability/functionality (design provides functionality)/efficiency (cost to maintain)
- Cost of service, and whether upgrades are possible
- Redundancy capabilities

Additionally, the technical capabilities and track record of firms that submit bids to fabricate and install switchgear are also evaluated by the AEA. These include:

- Technical ability
- Company history
- Similar sites in Alaska
- Support for equipment: can AEA contact them during normal business hours?

The evaluation summary for the switchgear reviewed in this study is shown in Table 1.

KEY ISSUES

Interviews were conducted with the switchgear manufacturers and with powerplant operations and maintenance personnel. Each facility was visited to inspect the switchgear in operation and to gain familiarity with its operating characteristics.

Table 1: Switchgear Evaluation Summary

	Max. % of Score	Elim	Points	Golovin	Points	Kasigluk	Points	Stevens Village	Points	Tenakee Springs	Points
Switchgear Mfr.		Kohler / AVEC		PowerCorp **		Kohler / AVEC		Controlled Power		Thomson Technology	
Owner		AVEC		AEA		AVEC		AEA		AEA	
Installed gensets		3		4		3		4		3	
Cost to Install *		$187,650		$200,000		$187,039		$150,000		$133,000	
Cost to Install Per Section	25%	$62,550	8%	$50,000	17%	$62,346	8%	$37,500	25%	$44,333	20%
Standardization of Control Systems With Other Installations in Alaska	10%	Established Standard	10%	One System Only, Not Yet Widely Adopted in Alaska; but Numerous Installations Worldwide.	7%	Established Standard	10%	Established Standard	10%	Established Standard	10%
Operability / Functionality	20%	High	20%	High	20%	High	20%	High	20%	High	20%
Cost of Maintenance	5%	Low	5%	Low	5%	Low	5%	Low	5%	Low	5%
Redundancy of Controls	10%	High	10%	High	10%	High	10%	High	10%	High	10%
Redundancy of Master Processors	10%	Single	5%	Single	5%	Single	5%	Main & Backup	10%	Main & Backup	10%
Alternative Energy Applications:		Built to Spec; Can Adapt to Alternative Energy Sources		Can Adapt to Alternative Energy Sources		Built to Spec; Connected to Wind Generators		Built to Spec; Minimal Wind Systems Applications		Built to Spec; Minimal Wind Systems Applications	
Firm's Technical Ability	10%	Excellent	10%	Excellent	10%	Excellent	10%	Excellent	10%	Excellent	10%
Company History	5%	AVEC Founded 1968	5%	Founded 1988	5%	AVEC Founded 1968	5%	Founded 1979	5%	Founded 1973	5%
Design Acceptance		Design is Used in Multiple Locations		Design is Used in One Location Only		Design is Used in Multiple Locations		Design is Used in Multiple Locations		Design is Used in Multiple Locations	
Technical Support During Normal Working Hours	5%	Wisconsin / Anchorage	5%	Australia / Anchorage	3%	Wisconsin / Anchorage	5%	Seattle	4%	Seattle	4%
Total	100%		78%		82%		78%		99%		94%
Rank		**4**		**3**		**4**		**1**		**2**	

From the interviews with manufacturers and utility personnel, the following key points emerged:

- Utility operators place a premium on the standardization of design in switchgear, since their experience has shown this to be the most cost effective way to achieve economies of scale, and reduce the time required to identify and correct any problems.
- High-speed, reliable communications are considered vital to efforts to modernize switchgear and reduce operating costs.
- Switchgear manufacturers are able to build equipment to meet customer specifications.

SWITCHGEAR DESIGN

Standardization. As part of its mission to reduce the cost of energy in Alaska, AEA provides competent and qualified electric power generation and distribution repair and installation services, and develops specifications and designs for Alaska communities that do not have the expertise to design, build, or in some cases, fully maintain, a modern diesel-fired electric powerplant and its associated switchgear. This is due, in part, to the growing complexity of modern power plants that are beyond the technical capabilities of small village-based electric utilities.

To carry out its mission, AEA has developed, over the course of many years of experience in rural Alaska, a standardized design specification for switchgear. AEA can, and has, revised their switchgear specifications when circumstances warrant changes. This includes the introduction into their design of new technologies and improved devices that offer improved functionality, lower cost, or longer life. AEA has also taken steps to identify and field test new systems, as evidenced by their installation of the PowerCorp switchgear system in Golovin.

The standardized specification adopted by the AEA contains an essential set of controls necessary for remote diesel-fired generation applications. Switchgear units in use in AVEC's system have greater diversity of applications, and the specifications developed by AVEC have more features and capabilities than the systems designed by the AEA. As a consequence, the switchgear evaluated for this study for villages served by the AEA tended to have a lower purchase price than switchgear units developed for AVEC.

AVEC has adopted a standard switchgear configuration based on equipment built by Kohler, with features that are required for their installations across Alaska. These features have been developed by AVEC's engineering and operations staff, and provide switchgear that could be installed in many of their power plants.

For instance, AVEC chooses to purchase gear that has an initial higher cost because it is less expensive for them in the long run to have equipment that is compatible throughout their system. AVEC operates in 51 villages throughout Alaska, and as they indicated in their interview, once they have adopted a switchgear standard, a newer design must be significantly less expensive or significantly better for them to change their adopted standard.

The adoption of a standardized design may result in a slightly higher installed cost, since the features and equipment designed to cover all possible contingencies may be more than is required for a given location; but standardization reduces costs to the utility for expenses such as spare parts inventory, the training of operations and maintenance technicians, and the ability of engineers and technicians to troubleshoot systems when problems develop. Further, by adopting a standard design, equipment programming, failures, limits, input/output requirements become known factors that do not require re-learning when working from village to village. At many electric utility firms, the direction or philosophy used in the design and operation of switchgear determines the choices that are made for many years.

Appropriateness. Determining the appropriateness of switchgear that is used in a specific application is dependent upon a variety of factors that are decided by each organization. In the case of AVEC, there is a significant economic benefit to be gained from the adoption and use of a standardized design throughout all of the facilities they operate. AEA standardizes, but with fewer options – the AEA switchgear is tailored for use in remote, small villages. However, as with AVEC, once the AEA has adopted a standard, their technicians, engineers, and parts suppliers all know the gear, and have learned how to keep it running. It is, therefore, still economically beneficial for the AEA to adopt and retain a standard switchgear design.

The existing specification was reviewed and was found to be appropriate for the general conditions encountered in the remote power plants that AEA is tasked to assist.

RECOMMENDATIONS

AEA provides assistance to individual communities, and is usually required to provide the least expensive switchgear equipment that can meet the required minimum specifications. There is an advantage to AEA and to AVEC to adopt a standardized design because it reduces the cost of maintaining these systems in the future. AEA has done this with their standardized design, as has AVEC.

AEA provides a specified product, and can revise their specifications when circumstances warrant change. The existing specification was reviewed and was found to be appropriate for the general conditions encountered in the remote power plants that AEA is tasked to assist.

This report therefore recommends that both AEA and AVEC continue their process of evaluating new technology as it becomes available; and incorporate that new technology, where beneficial, into the existing switchgear specifications that are presently used as the basis for their proposal requests.

Applied Power
Tuesday, March 27, 2007
Everett, WA
9:30 AM

Dennis Johnson, Applied Power
Dave Bechtel, Applied Power

John Cameron began the interview by reading the intent of the contract.

Q:
Describe the main features and benefits of the switchgear you manufacture:

A:
What people have found is that since Applied Power is small and long established, we are able to pay a lot of attention to a particular job – we're not a high volume shop. We design, test, and make sure everything works here. Can't chase it to the job site, we want to make sure it works before it leaves the shop. We feel our switchgear is better designed and better tested than others. Highly customized to the individual site.

Q:
How did you get selected to build the switchgear for Golovin?

A:
We met with one of PowerCorp engineers, went over the control scheme, reviewed specification, went through our configuration, and came up with proposal to put the switchgear together. PowerCorp furnished them with drawings, and converted to US standards, they reviewed. Put together drawings so that anyone who looks at it would be looking at a conventional drawing (not European or Australian standard).

Q:
Where have you installed this switchgear, or similar switchgear?

A:
In the Northwest, we've done a number of hospitals in eastern Washington and Boise, ID. We've been working with one customer in California that does a lot of work with the US Navy. Marine vessels obviously go wherever. We have a significant marine presence, and our work is about 50/50 marine work. Nikkels Bros, Dakota creek, and shipyards. Marine market is vigorous down here. WTA (31 boat high speed catamaran project). Nikkels has the first four boats, and Applied Power is doing the work for them. Applied power also provides gear for tugs as well.

With marine applications, there is no need for remote monitoring (engineer is on board). However, the control scheme for paralleling, etc., is common. Some similarity for hospitals. In marine applications they want to monitor from bridge, and have remote control of switchgear for bow-thrusters from bridge; including CANBUS connections.

Configuration software is really good. They use the European equivalent of Woodward gear. Tied to ECU over CANBUS. They do a lot of work with ComAp generator controls and equipment. ComAp is a Czech firm that has been building generator control systems since 1991.

Q:
How many locations in Alaska have you built equipment for?

A:
Most has been through Precision, or Cummins NW. Kenai Hospital, BP (slope) through Cummins and PDD, ConocoPhillips.

Q:
Are there any lessons learned on constructing equipment for the Alaska market?

A:
For operational aspects, using breakers instead of fuses. Better chance of keeping things on line if you use breakers. Have to use fuses on high voltage side for rejection of overages. Considering the requirement for over-current protection, what is the best fit?

Can't have enough remote monitoring. Data from end user often misses the cause of the problem. Better shot at getting to the source of the problem if you have more monitoring. Alarm log, time date stamping; ComAp provides a time based stamp of events. Really help with troubleshooting.

For remote locations: the switchgear has to be right before it leaves the shop. Go to extended lengths where they test extensively (burn-in the gear for a week and let things work and see if they're going to fail).

Q:
What electrical standards is your equipment built to?

A:
UL 1558, 891, 508. 1558 is switchgear.

Q:
Is your software built on an open architecture platform?

A:
Depending on the controller specified, the customer would want the software and ladder files after transfer at completion of job. Same thing for SCADA. They'll get the run time packages. Applied Power does not do proprietary gear or software, they just pass through whatever they're using. They can either do their own programming, or install the customer's desired program.

Q:
Availability of replacement parts?

A:
Give them recommended spares, basic list includes consumables (lamps, fuses, etc.). Depending on how extensive they want, they can do more. Applied Power does not maintain a stock of spare parts for switchgear they build.

Q:
Support for obsolete technology?

A:
Gets calls for help, and is able to work projects from years past. The major vendors (PLC) they have their own upgrade paths. The major vendors will often recommend to customers that the parts are obsolete, and it is time to upgrade. This gives customers the option to upgrade. No proprietary code (C or C++). Value added is the engineering and the wiring to make they work correctly.

Q:
Regional support? How do you service the equipment you sell?

A:
They do their own startup. They are there at commissioning to make sure that everything is connected correctly. One of the value added items is a training session (line item that is paid for). During training, they'll go through scenarios. In the marine field, they do a lot of work with customers making sure the gear works properly, and afterward if any problems arise; they are available to help fix them.

A lot of shops have their own service departments (CAT, Cummins, etc.) and are able to work on all of the equipment. Get calls from OEM technicians that are servicing the components. They do a lot of work for Stuart and Stevenson, which did a lot of

Waukesha work all over the US. Applied Power is still supporting all of the Stuart & Stevenson gear.

Still answering questions and helping with terminals at Spokane airport (9 years ago).

Q:
As you consider future technological developments, what technology do you see will offer the greatest benefit in switchgear?

A:
Capability of remote monitoring, getting ourselves there. As connection gets better, can fully diagnose the problem. Can guarantee uptime, aside from mechanical problems, if we have connections to get remote data. The stuff is out there, it's not proprietary. All of the gear out there (GE, Siemens, ABB) has good reliability, just difference in features. Some customers have personal preferences.

Fuel efficiency is going to be really important. If you can shave off 1% fuel consumption, over a 30-year lifetime, it can add up. Comes down to control technology. which parallels the arc of Ethernet. A lot of the software is now free. For the price of a PC and Ethernet connection, they can look at their gear from anywhere in the world.

Q:
Do you know of any problems that arose during the installation of your equipment in Golovin, and how were any problem(s) resolved?

A:
There was one question that came up on the operation of alarms and breakers. Had to point out the operation from the manuals. True bell alarm (occurs on overcurrent). GE does it that way, but ABB doesn't. ABB gives bell alarm on shunt trip, remote external trip. To Dave, bell alarm is an overcurrent alarm.

PowerCorp was on site. PowerCorp did their FAT here. Heart of the system is their GSS, Commander. AP got the hardware taken care of as specified by AEA. Everything was functional. PowerCorp arrived, did the witness FAT at the shop. They had to ring out their programs.

Q:
Do you know of any problems that arose during the construction of your equipment in Golovin, and how were any problem(s) resolved?

A:
Since installation, all of the questions go to PowerCorp. AP's function was to put the switchgear together, following AEA's specs. PowerCorp gave direction on how to build their gear. It was their product.

Business:

Year founded: 1994.
Owners: Appliedpower.com has a good bio.
Legal ownership structure: Corporation.
Business units: no other ownership (Dennis/Dave).

Evaluation criteria:

Q:
Describe features that simplify use of the switchgear:

A:
Depends on whose gear it is compared to. If compared to a larger system, Applied Power is more open, and their drawings are easily understood and interpreted. Larger shops (Kohler, etc.) have more proprietary systems that are often times not shared with service people. AP is using off the shelf controllers, components that make it easier for people to work on. AP isn't designing or selling a proprietary system.

Applied Power switchgear is easier to troubleshoot. Other manufacturers, such as Kohler and CAT, are at the "plug" level. They don't have a laid out terminal strip that can be easily accessed. Hard to troubleshoot a potted din-rail switch. Install cost is a big part of the cost of the job. Another example is how wire bends get into the enclosure. Takes more money up front, but it can save several days worth of install time.

Applied Power is using Rittal enclosures with side plates, and they put on drip cover for marine applications. Gasket between sections for NEMA 12 rating. Rittal is a German design, with their plant in Ohio.

Q:
Describe any features that simplify maintenance requirements:

A:

Applied Power provides the customer with all of the documentation and manuals to make it understandable in the future. Their switchgear is not cramped, have enough space to make it work. Running buswork to back so they have a set of lugs to connect to. No curve, just a straight shot for wire runs into cabinet.

Q:

Do you keep records of your gear?

A:

Electronic. They keep the records. Heavier reliance of CD-ROM instead of 12 copies of manuals. PDF files of all documents. Easier to read.

Q:

What kind of display is available? Are there options for display of stored or real-time data?

A:

Spec gear. They can make whatever the customer wants.

Q:

How many indicator lights can a user add to your switchgear?

A:

Spec gear, can build whatever is wanted. The industry trend is to go with PLC's and PC, but many end users still haven't gone with computers. In the water business, there has been a transition to PLC's, but not as much in the power generation business. Problem isn't just in Alaska, but across the industry.

Perhaps part of the question is on the robustness of PLC gear. Can an operator shutdown the system if the play with it? Unfortunately, dumbing down the system doesn't give information back. Relay board can't be monitored, unless install camera with sound.

Q:

How many DI or AI can be connected to your switchgear?

A:

Will build to suit. No proprietary gear.

Q:
How many DO or AO can be operated by your switchgear?

A:
Spec gear, can build to suit. No proprietary gear.

Q:
Do customers have the ability to modify program?

A:
Yes. Customer gets a copy of the program at turnover.

Q:
Can your equipment be expanded?

A:
Spec gear.

Q:
What training or maintenance support is available?

A:
On-site commissioning can also include training. They prefer to not be bothered during the startup. At the end of commissioning, then they do the training session. If they have time, will go through the drawings and make sure that the customer know how the system works. Informal training comes with the job. Videotaping is part of the spec for training sessions at the hospitals.

Q:
Is your switchgear compatible with other non-diesel generation systems (e.g.: wind, hydro, solar, other internal combustion drivers)?

A:
Akutan was a Hydro-diesel system. Most of their switchgear is used with reciprocating engines; one turbine.   Value of alternative fuels doesn't allow them to pay for the systems themselves. For example, with wind generation in rural Alaska, the towers probably cost a huge amount of money.

Q:
What is the expected service life?

A:
Most people shoot for a 20-year life. Maybe less in Alaska. Limits are breaker cycles.

Q:
What components or systems are expected to require replacement in 10 years? 20 years?

A:
Breaker cycles. Depending on maintenance, you might get more life. If the customer has a 3 or 4 genset arrangement, and they're cycling on and off for paralleling, they will have more cycles with the breakers, resulting in a shorter lifespan for the breaker.

On older gear, they have found that customers want to be able to look at the gear remotely.

Q:
Describe any warranties offered:

A:
Standard is 1 year from startup, or 18 months from shipment. Hospitals are different, they have 5 year warranties. If a customer gets into an extended switchgear application, they may ask for separate breakout price on extended warranty.

Q:
Is there additional efficiency that is achieved by using your switchgear?

A:
1% fuel efficiency adds up over 30 year lifetime. Comes down to the controls. The integrated control systems have load profiling and load leveling-out that is built in, and reduces spinning reserve. This results in greater fuel efficiency.

Design capabilities:

Applied Power can handle its own projects. Take each project from start to finish. Prepare bid, do autocad drawings, purchasing, layout, etc.

Q:
Quality controls (ISO 9000-2000 certified).

No.

Q:
Annual sales:

A:
$1 to $1.2 million per year. Accommodate the ups and downs. Keeps staff for the long-term. Can bring in others to help during busy times.

Q:
Service support over phone?

A:
Shop and mobile numbers are published on the website. No one seems to be intimidated by the clock.

Q:
Where is manufacturing?

A:
Everett, WA.

Q:
Location of spare parts?

A:
N/A

Q:
How much fabrication is done in-house?

A:
Most all of the work. 95+%. Some panel work is shipped out, metal plating.

Q:
Do you build all of your switchgear to specification?

A:
Yes, all.

Q:
Do you have a way to measure customer satisfaction with your switchgear?

A:
Yes. We got calls back from customers who were especially pleased with the Rittal gear. And we don't have any lawsuits.

AVEC (Alaska Village Electric Cooperative, Inc.)
Thursday, March 29, 2007
Anchorage, Alaska

Mark Teitzel, PE, VP & Manager, Engineering
Dick Walker, PE, Sr. Electrical Engineer

Mark Bryan (MB), Manager, Operations & Maintenance (Interview after the initial interview)

John Cameron began the interview by reading the intent of the contract.

Q:
Describe the main features and benefits of the switchgear that you have constructed for AVEC (what are the key elements that must be in the switchgear you buy/design):

A:
One of the main things is open access software so that it can be worked on. Want vendors to provide software code. Bill Thompson isn't able to attend this interview session, and we would recommend you also talk with him about switchgear and software.

We require 2 voltage regulators for every switchgear. How they work together is an opportunity.

After acquired gear from Kohler, we've bought Kohler generators. They're designed to work together and so the compatibility is good.

The display of engine parameters on the Kohler monitor has been achieved. DESC 100 is now the standard voltage regulator.

Kohler is easier to deal with, and we get more function from them. They have a better understanding of what AVEC wants, although there's been some confusion with factory on latest set. They seem to be able to bid less expensively than other manufacturers. Advantage is that they've built so many of them.

Standardization, right or wrong, good or bad, stay with it. We know what the gear looks like, how it works, how it fits, and we get it to work better each time.

For cases where we have new gear in an existing village: when we see a potential new installation, we know how the Kohler gear works and interfaces, which is better than starting all over again. Where there is already Kohler gear on site, reusing the Kohler gear has advantages and savings. Either way, we do what is practical at the site. In the case of Chevak, we installed a complete new powerhouse. Others, we put in a Butler building; the solution depends on what works for the site. Familiarity is with the engineers, operations and maintenance personnel, and installers. Local operators still have to be trained.

Training and operations is Bill Thompson's world. Talk to him about that.

For training, we bring in an operator and walk them through it. All 47 have HMI's.

Isolation and pseudo-redundancy that is different from AEA.

AVEC has more bells and whistles. Haven't seen AEA's gear, but in terms of the control philosophy, not nearly as PLC controllable. Represent different levels of comfort with the control features (in-house). Are we controlling too much? How many people understand it? Some changes to switchgear programming are not shared with manufacturer.

What is the advantage of PLC controllers: capability to respond. At a load range, we want to switch engines. This results in the more efficient production of power. If there is a fault in the village, signal and control the feeder breakers. Ability to adapt to changing conditions in the village, all with the goal of keeping power on in the villages. SCADA system not the most important thing in the world.

If the system fails, with good monitoring, we can find the problem and fix it quickly. However, it is better to keep the units running and not have to rely on programming. Minimize the knowledge base that the operators have (to have) and not have to keep an operator there 24/7.

Q:
Please tell us about the wind generation systems you have in place:

A:
Wind generators, sometimes the frequency dips and causes grief. It's a fairly complex system (Kasigluk).

We are satisfied with the system in Kasigluk. Still working some bugs out of it, but it'll be a very good system. Major change from Kasigluk, old: Woodward EGCP-2, new is just a PLC. Problems with the old EGCP-2. Wind generator has its own controller. All run by the Kohler switchgear. Kohler switchgear does the dispatching. Secondary load controller through boiler, heat up water. Northwind 100, manufactured by Northern Power, have own controller. They bid on the SCADA system. They supplied the SCADA system, communicates with the Kohler switchgear. Kohler switchgear dictates what can go on-line. Dump load to maintain wind penetration (235 kW boiler). Another load to allow for more wind generation. Hot water will eventually go to a washeteria, and possibly residential service. Water plant not hooked up, and the community center is being served with the heat recovery system. Hydronic heat provides heat off the plant. Node that goes through boiler, then back to heat exchanger, then through community center.

At 3am, it's hard to decipher programming. Kohler worked with Bill Thompson to get the software all worked out, and it doesn't take much when it gets here.

Q:
Please compare today's switchgear with older gear. Do you need all the capability that today's switchgear provides?

A:
We find it more economical to run one engine at a time, which is foreign to switchgear manufacturers, who expect to be running multiple units, running them in parallel. Wanted that capability (paralleling) without adding too much custom stuff, but only under emergency conditions. Run un-manned power plants. Our philosophy is "KISS": not wearing out two engines, not worried about oil leaks, fuel leaks, coolant leaks. One engine running at a time. Most switchgear is built on the idea of running multiple units on-line. Not ours. That philosophy was a surprise to some of the suppliers. In the event of the failure of the largest unit, we want the capability to parallel smaller units to maintain service.

Biggest plus is the ability to optimize fuel usage. Koyuk is an example of where a good operator was able to use less fuel because the operator would know whether a load would increase or not, and efficiently decide between units, instead of letting the automatic gear make the switch.

Our fuel efficiency is approximately 14 kwh/gal for our gensets, running one at a time, Better by just running one unit only.

In case the switchgear goes down, on the Kohler units with the Kohler Decision Maker, we can at least get the engine started.

Total automatic, manual from switchgear, and manual from engine controller. May have to do some magic to make the system work at lowest level with the switchgear, but we haven't had to do it. We have separate engine modules, so if one fails, we can still produce power. For example, we can still do a manual start from the switchgear if there was a fire in #2. If we need to turn off the automatic functions, can still use synchronoscope and do it manually. Even if switchgear loses, and down to one engine and cold, can manually close breaker and bring power back up. If burn up bus, can disconnect at terminal box at engine, and run temporary feed to feeder breaker and run it that way.

Charge batteries off a portable genset to charge the batteries to start the engines.

Space limitations, some switchgear manufacturers want 42 or 48" deep gear; Kohler was willing to go with 36" gear. No draw-out breakers, we're using bolt-in power breaker. Phasing away from the use of older style breakers, to new breakers.

Expanded sectionalizing to drop off distinct feeder breakers. Now we use at least 4. New gear has at least 6 feeders. With new wind locations, putting in boilers, also have a separate feeder breaker for the boiler (200 – 300 kW boilers). Heat is used in the Laundromat. However, no distribution to homes.

4 combined villages: Wales, Selawik, Tooksook Bay, and Kasigluk. Wind turbine is the NorthWind 100, manufactured by Northern Power.

In looking for a switchgear manufacturer, we were concerned with the size of the company and wanted engineering support. Some history of manufactured gear, knew what they were doing. Standardized on Square D breakers.

Are the operators totally comfortable with the new gear? It's a learning process.

Start a genset late in the night, how do we answer the calls for help?

Kohler was the low bidder initially. Now we don't have to do additional engineering each time. We have dimensions, layout, cable entry, and connection diagrams. Field people are more familiar with it. Theoretically the design and installation goes quicker, which results in us saving money.

We know the components that have failed. For purchasing and replacement, quicker to acquire and easier to acquire.

Our switchgear is able to do automatic dispatch, black start, drop feeders according to load. Remote monitoring (not yet developed in Elim, but in Tooksook and Kasigluk). Economic dispatch gives better fuel economy. Black start: can bring itself right back on line.

Q:
Where have you installed this switchgear, or similar switchgear?

A:
We have 11 installations, and have purchased 15 total lineups. Generator modules across the yard; Elim, Gambell, Kaltag, Kasigluk, Koyuk, Kalskag, St Marys, Savoonga (not in service yet), Selawik, Tooksok Bay, 2 additional lineups on order for Hooper Bay and Chevak.

Q:
How satisfied is AVEC with the gear?

A:
Fairly satisfied. The switchgear can be adapted to wind generation. Readily adaptable to Kohler engines; CAT and Cummins engines are a little more difficult. Fairly reliable, though the ability to display data from Cummins and CAT engines is more difficult. Now, we have more technicians that are familiar with the gear, can troubleshoot the gear. Respond to the operators. Seen a lot of engine starts and shutdowns. So far, the switchgear has been reliable for large number of starts/stops. Fair number of breaker operations.

MB: For AVEC, it's a giant leap forward. Have circa 60's, 70's, 80's gear out there. Having the automation and automatic dispatch is a big improvement on our older gear. The new gear handles black starts. Have a few bugs to work out, but it's great. Technicians like it, and our operators are getting over being intimidated by it.

MB: Some of the operators are not yet comfortable with the Square D breakers. Most of the older guys haven't played with them a lot, and there are different levels of comfort among the operators. Melangarine (square D). Some problems with the LA breakers, with hybrid motor operator, getting rid of them. PG's seem to work better, electronic trip units, can adapt more quickly.

Q:
Any wear/tear problems with the switchgear?

A:
Better question for ops/purchasing. So far, 3 breaker trip units have failed, but they're easy to replace.

MB: no. Seems very high quality.

Q:
Are there any lessons learned on constructing equipment for the Alaska market?

A:
Using different kind of power cable: DLO (diesel locomotive).

MB: one leap was to eliminate the EGCP-2 and move to a PLC.

MB: Use locomotive cable, fine strand stuff that is easier to use.

MB: Biggest advantage, still have the operator for meter reads and fueling. Another advantage is economic dispatch. Price of fuel near $3/gal, and any way you can squeeze more efficiency out of the fuel is beneficial. We have small, medium, and large gensets. This means we have a winter unit, swing unit, and a summer unit.

MB: master PLC has failed once or twice.

Putting additional checklists on the gear to make sure it is working properly before turning it over to the operators.

Q:
What electrical standards are your equipment built to?

A:
Since we're a certificated utility, we don't have to worry about standards (not within power plants under direct control of AVEC personnel only). Most have a UL sticker. Even VFD's have a UL 508 label. The Power Commands are listed.

Q:
Any problems with the availability of replacement parts:

No. We have replacement parts and spare parts lists. When we commission a new site, the manufacturer will give us a kit with spare parts.

Q:
Do you have any special requirements for support for obsolete technology?

A:
We've replaced old feeder breakers. However, we're leaving the old motor operators. Not replacing anything unless it is a failure point. As upgrades are available, we go to a newer version.

Q:
Do you rely on regional support from equipment manufacturers?

A:
Varied. Sometimes they've hired Cummins or CAT technicians to service equipment. So far, they haven't needed to have someone from Kohler to service switchgear.

Q:
As you consider future technological developments, what technology do you see will offer the greatest benefit in switchgear?

A:
Remote monitoring is weak on Kohler gear. Been impressed with the SmartView touted by Northern Power, web based, can access at any location. Overall value is questionable. Is the cost justified?

Technology, better training: Any questions on how to operate, comes up on the screen and tells them how to do it. Can't get the fault to clear, it would be useful to not have to dig through manuals and explain what's going on.

How these units are programmed and how many revisions, and what level it's displayed. Basic programming, how the safeties are set and what they are. Checking the safeties would be a big advantage. Safeties: O/C, oil pressure, temps, when shift over, temps of fuel oil, voltages, etc. More I/O points than we're using. How we get data back. Not taking up so much space would be better.

A way to check the accuracy of the displayed meters. Are the CT's correct?

Satellite system is a little uncertain. Want a more reasonable system to bring data back. No fiber to most of the communities, though there is a project to run fiber to Old Harbor.

MB: remote communications. Somewhat blind right now. Everything is over the phone, or via written paper. Want to be able to download plant alarms, fault notification. Wireless Internet Service Provider (schools had wireless, available). It's out there, but still difficult. Have been going to Star-band satellite, and the cost has gone down.

Q:
Do you know of any problems that arose during the installation of your equipment in Elim and how were any problem(s) resolved?

A:
On the feeder switches we had shallow cabinets, so getting all the feeder cables out was a problem.

Original programming, setting of safeties, display of information.

It was one of the first installations, so there were numerous problems. We just keep plugging away. Elim had a high number of power outages. Spurious engine faults, difficulty resetting, and we had voltage regulator difficulties. Almost 4 years ago. Things get better after time passes. Reliability has improved. Fuel efficiency is not where they want to be yet. They're running a larger unit to make sure there aren't any shutdowns. Engine efficiency isn't as high as they want. Running 13 kwh/gal range, versus 12 kwh/gal range for AEA.

Gambell is our most recent installation. Problems there include high circulating currents; inability to load share; and an inability to sync. Gambell had a legacy engine (old EGCP, woodward controlled 1150) Cummins. Bill Thompson is working on those problems. Direct switchover problems. Mismatched stator windings. Checked generator for matching pitch, compatability. Tackle each problem and keep going. Power is staying on, in spite of problems. Now, all the problems appear to be resolved.

Q:
Do you know of any problems that arose during the construction of your equipment in Elim, and how were any problem(s) resolved?

A:
No problems with the construction, installation. No real problems in startup either.

Business:

Number of years in business: 39
Year founded: 1968
Members, 7,500 approx.
Legal ownership structure: Cooperative

Q:
What technology improvements are you presently pursuing?

A:
New switchgear has comm/modbus for better communications to the switchgear. More capability to get information back and forth to breakers.

MB: communications.

MB: Biggest problem with wind turbines is foundation. Getting them to stand up in the tundra is a problem. Selawik has lattice towers, and we can winch down the turbine. Easier foundation requirements as well.

Northwind has a tubular tower. Big guys are designed for winching down the tube. On the little ones, not designed similarly. At Tooksok Bay the generator failed, and destroyed itself. Northern Power warrantied it.

Q:
What is the mean time to overhaul?

A:
MB: Good question. For the gearboxes and generator, we don't really know. Probably tied to the B-life of the bearings.

Q:
What about failures of blades, if the crane is gone, how do you swap out a blade?

A:
MB: Had issues with unit so high up in the air. Designing a crane/boom attachment that would go to the top of the tower, but there were some problems with foundation, vibrations. We have a warranty period with them, so they'll have to provide the crane.

Conflicts coming up on adaptation to wind. Challenging on properly signaling of boilers and wind turbines. Wind turbines not all shutting down instantaneously, when the load is 300 kW in Tooksok Bay. Challenge to sort through the vendor claims.

Q:
How readily adaptable to the inclusion of wind power is the switchgear?

A:
MB: very good. With 400,000 kwh generated, only had to shed 22,000 kwh. Increased overall generating efficiency to 17 kwh/gal for half of the year. Forecast for 2007 is higher. 480,000 kwh per unit.

MB: Ease of adaptability due to Bill Thompson's choice for selecting that component in the gear. Bill Thompson takes over after they give the wind turbine to us.

MB: We have full open architecture; the PLC gives all the tools needed to meet power production requirements for the gensets, except Cummins. Cummins has the more fuel efficient engines, if all 3 were Cummins they could buy the switchgear that can talk to the engines.

Q:
Describe any features that simplify use of your switchgear.

A:
We have a master screen that can go in and get all the information that's needed. Have an additional HMI to look at the wind. Bill Thompson is incorporating some of that into the master screen.

Biggest thing: not a lot of troubleshooting. If something doesn't work, we swap it out.

Q:
Describe any features that simplify maintenance of your switchgear.

A:
Troubleshooting is easier: we swap out components. With SCADA system, Bill Thompson can do amazing things over the Internet. In the development stage, we can jump on line and see what's going on. Can pretty much see anything he wants to see. 2-router system, and between that router and the next router, they can get on to the Internet.

Q:
Discuss the ease of operator interface.

A:
We've had some HMI failures, but overall the operator interface is straightforward and easy to use.

Q:
How many indicator lights can a user add to your switchgear?

A:
Big fan of indicator lights. Have a few, not as many as the old days (every year, less and less).

Q:
Do customers have the ability to modify program?

A:
Yes. They can adapt their gear.

Q:
What is the expected service life of your switchgear?

A:
The service life of our old gear was 30 years. 30 years is realistic. On average, we have16 power plant shutdowns per year out of 47 plants.

MB: bus, etc.: 20 to 30 years. HMI's have a shorter lifespan. Same is true for breakers.

Q:
What components or systems are expected to require replacement in 10 years? 20 years?

A:
Trip units on breakers are the main failure spot (electronic). Next would be HMI's.

Q:
Describe the ability of your switchgear to interface with electronic engines.

A:
MB: good success with that. Bill Thompson can give more details. Those units can run independently, and can run off the control panel from the switchgear, and fully automated using master PLC. Our switchgear has a lot of redundancy.

Q:
Are there additional questions you would ask if you were talking with switchgear manufacturers about their gear?

A:
Does their equipment have the same level of redundancy? Can it be operated fully manual, partial manually, and fully auto? Further, we have individual modules (separate containers) that can produce electricity on their own.

AVEC (Alaska Village Electric Cooperative, Inc.)
Thursday, April 19, 2007
Anchorage, Alaska

Interview with Bill Thompson.

John Cameron began the interview by reading the intent of the contract.

Q:
Describe the main features and benefits of the switchgear that you have constructed for AVEC (what are the key elements that must be in the switchgear you buy/design):

A:
One of the main things is open access software so that it can be worked on. Want vendors to provide software code.

Kasigluk is the cutting edge. Total PLC control, rather than the Woodward EGCP2, which have been less than acceptable.

Don't consider the development work done, for example, we have a teleconference to review some of the issues that are still pending, such as things they need to improve, flexibility they need to add. More complex configurations, more flexibility of dispatch. Right now it's too hard-coded. Need to generate O&M manuals. Tie into SCADA, provide forensics. Took a lot of risk with new technology in the field without SCADA. Not too bad yet, switchgear has reduced the length of time of an outage, not necessarily fewer outages. Operator now doesn't have to get out of bed or come in from fish camp.

Q:
How well has the integration of wind power gone? Powercorp claims they have the answer to the technical issues of integrating wind power with diesel, under medium or high penetration.

A:
It's not difficult if you pay attention to the details. No doubt that Powercorp knows what they're doing. We find the biggest problem is trusting the wind towers. On the touchscreen they can calculate output. But we don't trust that two of three will cut out. They cut out at a certain wind speed. As a result, our confidence factor is down at 30%. In our case, our switchgear is designed to change when confidence level increases.

Q:
You're using a heat recovery system – hot water for storage, for the wind generation system?

A:
High penetration is important. Wales has high penetration. Otherwise, we have to crank up a boiler to avoid motoring up a diesel. At first, only Tooksok Bay was hooked up and we needed the boiler. Now with the two villages, don't have that problem. Probably don't need the boiler. If wind generation becomes a reasonable benefit, no reason why we won't add more wind.

The longer we wait, the better the technology for inverter technology. The goal is to have a system that segues into a "diesel-off" system in the future. In most cases it's not necessary or practical at this time. He's not being pushed into it, but he's looking at it.

Q:
Has your switchgear manufacturer, Kohler, been accommodating in your development efforts?

A:
Can't say enough good things about them. Worked together for 6 or 7 years. They made a proposal, it was for standby, and it wasn't okay, it needed to have cold and remote considerations. They were very receptive; thought it was a challenge, and managed to adapt their pre-existing engineering designs. One of the key requirements was that there had to be full disclosure. AVEC has the code on all the PLC's and configurations they use on the switchgear. Otherwise, we have to worry about the future of a particular company and whether they will be around to support their software.

An engineer from Australia or Wisconsin can't fine tune these as well as we can. AVEC has not abused the disclosures. Can talk to them more intelligently, can tell them exactly what is working and what isn't.

Q:
Kohler is the standard package?

A:
If someone else wants to bid, they have to meet stringent requirements. There can be no single point of failure. Can't use a single PT, etc. Anyplace where there is a common issue that doesn't allow you to get at least one or two gensets back on line. They're looking now at prime power after working on the AVEC projects. We're not married to them, but we have only a minimal amount of disapproval. Any competitor that can fit the bill would be considered.

Q:
Is your vendor price competitive?

A:
Don't know about prices. For many years they didn't change their prices, only adders if we had asked for new items.

For Kasigluk, ECP2's had serious functionality issues. They took P100 switchgear technology and integrated it in to the gear they're selling to AVEC. At their cost. Didn't have to give up on reliability issues, just got rid of an unreliable component.

Q:
What do you consider the most important criteria for the switchgear?

A:
We want reliable switchgear that is flexible. Always fighting complexity, want to keep things as simple as possible. Minimize the complexity of the switchgear. PLC has a good size program, constantly throwing more stuff at it: wind, boiler recovery, forensic capabilities, etc. Went through the design carefully years ago about what could keep the lights off.

In the 3 generator cells in Kasigluk, there are no interconnections. If Gen 1 goes down, we can still run generators numbers 2 and 3 reliability. No ludicrous problems (e.g.: Gen 1 thinks it is carrying load when it isn't). There are only some communication lines between the cells. No crosscurrent compensation, since the wiring for one could affect the others. All the power supplies are individual transformers, fuses, if something goes wrong with a feeder breaker; it only affects one power supply.

Can pull fuse on master PLC and not suffer even a momentary outage. That was the first thing he did when he was testing the new switchgear. They have succeeded.

Design of the switchgear is built up in layers to run the generator safety and reliably. In a pinch, the switchgear can be treated as a breaker and close it by hand to get the lights on.

Next level up is to have the gear load share.

Top level is dispatch level, where generators are taken on and off-line.

Q:
When you make changes, do you share it with the manufacturer?

A:
BT: 90% of changes are software. Yes, we send code back to them fairly frequently.

Q:
Describe any problems or issues you've had with the integration of wind turbines with the diesel engine control systems?

A:
Atlantic Orient: Induction generators with smaller ratio than size of the powerplant (65 kW), when they went on and off-line, no bump on the system. At Selawik, did install electric boiler for dispatch. Didn't want to relinquish control to the wind system for keeping the lights on. They had to get used to that. Exchange a couple of signals: cannot generate above a certain level; they provide a signal to tell AVEC how much kW the wind turbine is generating at every point in time.

Once the paradigm was developed, we used it at the next facility. It's up to him to decide what their reliable capacity is.

Bottom line is, we keep the lights on. Everything else is fluff.

We don't consider the wind tower reliability up to it's full potential. If they tell him it's a 100kW running, then needs to know if it is one, two, or three units. If 100kW from one unit, then less confident in the reliability. If two or three units, he can be more confident.

Selawik: induction gear well known, 30 yrs experience. Northern Power units are DC link inverter based. The behavior of those wind towers is totally dependent on the firmware installed in the inverters. Northern Power is a black box in the sense that they can do anything they're programmed to do. They thought they could do power control and frequency. That hasn't been part of the package yet, though. VAR contribution is programmed into the inverter. If they want to go to diesel-off, or low diesel peaking, then will have to re-program the black box.

Northern Power, installed in Toksook Bay, had to go fix the wind towers with stable output on a small system. In one instance, he was standing watching the wind turbines turn, and diesel gensets were having to hunt. One per cycle issues, but these got fixed.

Kasigluk went much more smoothly. Now believes he has all of the development challenges behind.

Wales also has wind. The diesel-off mode village. Battery bank and motor generator to allow diesel-off generation. The amount of time of diesel-off hasn't been good. 99% of the time they still have diesels running. Still has a way to go.

Q:
Do you consider your system to have open architecture software?

A:
Yes. The EGCP2 experience drove him nuts. It was black box, and it took a long time to find the incompetencies, and they were very dissatisfied with it. Now, they have to have full disclosure. Still have to run these plants in 20 years. We don't want to have to develop this system again from scratch.

Q:
Describe the availability of replacement parts:

A:
Our design is such that there be no single piece of equipment failure that causes an outage. There are some instances of getting equipment up, but it hasn't caused an outage; the gear is able to run manually. Doesn't think there has been a single one that is due to a switchgear fault.

If we had to replace parts, we are designed to completely de-energize the generator cell, even though the other generator cells are still producing. Wanted the electrician to be able to work on the equipment

No drawout breaker, due to space considerations. Breakers they use have been very reliability. Have had to replace a shunt trip, but the new Square D breaker is very good. If one of them fails, it will be a pain in the butt. Took the gamble, and couldn't go with the extra depth.

Q:
Do you know of any problems that arose during the installation of your equipment in Elim, and how were any problem(s) resolved?

A:
One of his complaints is about new electronic engines. Engines are too complex for their people to work on. Cummins QSX engines are an example because Onan has made them so complex, and without a significant benefit for the added complexibility.

Switchgear contract gave them an engineer for one week. Mike Pincus came out on the first couple, and made sure it was working properly. Overall, no problems.

Q:
Do you know of any problems that arose during the construction of your equipment in Elim, and how were any problem(s) resolved?

A:
No problems with the construction or installation. No real problems in startup either.

Q:
Describe any features that simplify use.

A:
We have minimal controls that the operator has to use to run the plant. Two switches: 1) breaker to manual or auto; 2) engine control switch – run in manual or let the PLC run dispatch; and finally, open or close the breaker.

Bottom up: wiring prevents switchgear from starting the engine. Can switch the engine on at the engine. Can run and generate. The operator can throw the breaker into manual, and can use the sync scope to closed manually; then adjust speed up and down. Normally don't do it with the operators. Auto system looks after them better than the local operator. We don't make judgments on what could fail.

Next level: Leave breaker in automatic. Starts up automatically.

We require our operators do an oil change on the engines, and fill the day tanks each day (3 times per day). The operator hits button on day tank controller, and fill day tank. Takes readings.

Q:
Describe any features that simplify maintenance.

A:
Has a real problem with electronic gear, namely, geeks are designing infrastructure. In light of CIP requirements (Critical Infrastructure Protection, 2001 White House directive). Have to be careful about protecting critical infrastructure. This changes our approach.

Remote control of plants in bush Alaska, CIP requirements are brought into play. Their switchgear is designed to work without someone having to push a button.

Q:
Describe the ability of your switchgear to interface with electronic engines.

A:
Biggest problem is Cummins – PowerCommand is a devil to use. Designed by geeks, rather than power generation people. The display (keypad display on the gensets), have 3 buttons on each side of the display. Don't have a common return to root button (monkey syndrome), have to watch the display to find out what the switch does on each display. One certain button can turn off the auto-synchronizer button. Makes the engine inoperable.

Q:
Are there additional questions you would ask if you were talking with switchgear manufacturers about their gear?

A:
How do I keep the power plant running 20 years from now? With all the new technology, with elaborate schemes for things that have been done for 100 years, they're just trying to keep the lights on.

Q:
Anything else?

A:
Touchscreen displays drive him nuts, generally. Complicated, big investment of time involved in getting the screen set up. Can't just put in a new screen; have to bring in the tag lists, buttons, etc., to make a different manufacturer's screen work. Know it will be obsolete in 3 years, and it drives him nuts about future maintainability issue.

Once spent 3 days programming in a new display for wind generators and boilers. Revamps the software, then gets an error message: "CE license does not match". When dumped new program into the screen, had to put a new key in because he wasn't authorized to load the new program. Had to go back to the earlier version of the software programming code to make it work. Anytime there is a touchscreen operator terminal, it should raise a red flag. Anything that reduced the complexity is a plus. Just don't trust them. Using CE Microsoft. Might be working okay, but too many things to go wrong in the future in terms of maintainability.

Controlled Power
Tuesday, March 27, 2007
Bothell, WA
1:30 PM

Mike Dizard, Controlled Power
Dennis Berkshire, Controlled Power
James Dizard, Controlled Power
Dave Wilder, Controlled Power

John Cameron began the interview by reading the intent of the contract.

Q:
Describe the main features and benefits of the switchgear you manufacture:

A:
Compactness. Took from angle iron frame, worked with GE, came up with mini tower (80”) and does everything that AEA wanted.

Remote access. Able to do about anything from the gear from anywhere in the world. Change genset controller set-points. Remote access to all gear that has software.

Standardized on components. No matter who builds it, looking at the same stuff.

Flexibility to make changes. Can be serviced by anybody. Everything we use could be bought from somebody else off the shelf.

Use all draw-out circuit breakers. Get away from contactors. Draw out CB’s make it easier to service. A technician has to take the bus down to take a contactor out. Any of the small jobs, all stationary, have to kill the whole village.

400A sensor in an 800A frame, then can upgrade if needed later. Can go .5* rating plug.

Communications. Everything is Ethernet compatible now.

There is better equipment out there. When they find it, it can be used in the switchgear.

Stevens Village is a Controlled Power site. They’re working on a panel for Elfin Cove. Buckland is GE gear. Stevens is 3 to 4 years old.

Controllers: GCP is outstanding. Works great, easy to program. Woodward GCP 31.

Woodward is coming out with an Ethernet gateway that will talk to the controller. Expect to stay with PLC structure. No black box.

Q:
Where have you installed this switchgear, or similar switchgear?

A:
All over the north slope. Every North Slope Borough village has controlled power switchgear. Point Hope, Point Lay. One in a church, BP has their equipment. Native hospital in Fairbanks. Wells Fargo bank on Raspberry (Anchorage). NOAA site in Fairbanks. Loran site. Kodiak Hospital. Most of these are the second set of switchgear. Deadhorse: all up and down the main drag in Deadhorse (Baker/Atlas). AVEC, Training school in Seward, Alaska Power & Telephone. Most of the villages are their own utilities. Replaced Alaska Power Systems modules. Nushagak upgrade (15kV switchgear). Hospital in Kotzebue. St. George Island.

Q:
How many locations in Alaska have you built equipment for?

A:
Probably over 100 sites. Almost 30 years in Alaska.

Q:
Are there any lessons learned on constructing equipment for the Alaska market?

A:
Build the switchgear to last.

Technology has changed. Best thing is remote access. Designing with remote access is the key for troubleshooting, any kind or problems or programming change. Be able to work on it from anywhere.

Most of the small villages don't have anybody on staff to fix things. People forget how to work on the equipment. Need more training, and train more often. Take more out of their hands, makes their life easier. What should take two days actually takes three (3) days. Still save money when the village has more training.

Not to use motor operated breakers.

Always be aware of the shipping factor. Weather plays a big role. There can be less time than was planned due to shipping delays.

Q:
What electrical standards is your equipment built to? NEC.

A:
Is your equipment third party listed? UL and ETL. 508, 891, 1558, and medium voltage. 1558 they have to come in.

Q:
Is your software built on an open architecture platform?

A:
Everything is open. The Woodward program is open. The Allen-Bradley RSView logic software for PLC is open.

Q:
Describe the availability of replacement parts:

A:
Within 24 hours, can procure anything. A lot of stuff available from NorthCoast Electric, in Anchorage. When they ship panels, they also ship a replacement parts list, and spares.

Q:
Do you provide support for obsolete technology?

A:
We've upgraded a lot of obsolete equipment in recent years. BP in Anchorage was an upgrade 2 years ago. Replaced circuit breakers, replaced all the components, added a PLC. For the North Slope Borough, we disassembled the complete gear, redid the doors, panels, everything. Re-installed. Most of the stuff they've installed over the years, they can still get the components.   Leave the bus and breakers, upgrade everything else.

Q:
How do you service the equipment you sell?

A:
They've got people they can send up for troubleshooting and repair. Controlled Power has five engineers that can do field service. A lot of it has been done through genset suppliers.

Q:
Do you offer warranty terms?

A:
Usually 12 months, parts and labor. 18 months from startup.

Q:
As you consider future technological developments, what technology do you see will offer the greatest benefit in switchgear?

A:
Remote control, remote access. All digital. No potentiometers to adjust, etc.

Q:
Do you know of any problems that arose during the installation of your equipment in Stevens Village, and how were any problem(s) resolved?

A:
Worked with AEA's startup tech on the startup. There are always little setup things, but in Stevens Village, no major issues. Nothing that was bad enough that couldn't be fixed over the phone.

Q:
Do you know of any problems that arose during the construction of your equipment in Stevens Village, and how were any problem(s) resolved?

A:
None.

Business:

Number of years in business. 28
Year founded: 1979.
Legal ownership structure: Corporation
Annual sales: $3 to $4 million per year.

Q:
What technology improvements are you presently pursuing?

A:
Mostly staying current with technology, especially PLC's. We've been doing more with newer tech PLC's, tag-based PLC's. Instead of I/O address, everything is tag based. Do a lot of distributed I/O. AEA jobs are based on device net. Distributed I/O is the name of the game.

Most customers are willing to go with a more streamlined communication approach. Power monitoring using Ethernet. In the future, no serial ports. Talk to everything, including engine ECM's.

Can build to specification.

Q:
Describe any key alliance or partnerships you have with equipment/component manufacturers.

A:
We work closely with GE, Allen-Bradley (OEM gear), Siemens, and Woodward.

Q:
Describe any features that simplify use of the switchgear:

A:
Open architecture: using programming software that most people in the industry know. Ladder logic is very straightforward to program. AEA has the capabilities to do their own programming of the interface. Stevens Village was programmed by James Dizard, though AEA usually does their own programming. The program is very flexible, and they decided they wanted to do it themselves.

Q:
Describe any features that simplify maintenance requirements:

A:
Spend a lot of time with layout to make it easy to maintain. CT's are the hardest thing to get to (have to take the bus apart) for servicing. We make sure that the wires have good labeling. Otherwise, it's just typical switchgear maintenance. Everything is accessible.

Q:
What kind of display is available? Are there options for display of stored or real-time data?

A:
We can provide anything. Panels are built to specification.

AEA specifies the display they want in the gear. Before there was a spec, but now they've settled on what they want. Felt limited with the Allen-Bradley Powerview software. Web enabled functionality is important, and Allen-Bradley hasn't moved as quickly as others. Alley-Bradley will be there, but they're not there yet. AEA does their own screens. They do their own data-logging, etc.

Q:
How many indicator lights can a user add to your switchgear?

A:
As many as desired. Panels are built to specification.

Q:
How many DI or AI, or DO or AO, can be connected to your switchgear?

A:
As many as desired. Panels are built to specification.

Q:
Do you expect to increase this number in future versions of your switchgear?

A:
It's all device-net, and they're not anywhere near the capacity of the equipment.

Q:
Do customers have the ability to modify program?

A:
Yes. All the panels are built to specification.

Q:
Can your equipment be expanded?

A:
Yes.

Q:
What training or maintenance support is available?

A:
Training is on-site, a lot of times it is in detailed in the specification. They've allotted time, based on the spec, for training. Can be done here, or on the job site, or both. Controlled Power writes the manuals: O&M manuals are on CD as pdf files. Today, most job sites don't have drawings or manuals, like them on pdf instead.

Q:
Describe your competent service organization:

A:
We're not in the field service industry. However, they have a staff of 5 engineers that can go out and do service work, or training. Engineers usually take care of the equipment they designed.

Q:
Is your switchgear compatible with other non-diesel generation systems (e.g.: wind, hydro, solar, other internal combustion drivers)?

A:
They've built systems with wind power and diesel hooked together. Rotating reactor, induction generators. Have done turbines, water, and wind.

They have extensive experience in non-power generation applications, such as control systems for conveyor belts and freezer controls for fish processing plants. They've also done runway lighting panels for airports in Alaska. Another area they've done extensive work is in pile driver controls.

Have to have other gensets on line with wind turbines, and have to keep adequate loads in order to better utilize wind generation systems.

Q:
Are there any features that your switchgear has which simplify installation?

A:
One of the first things they do when planning a job is to sit down with the client and decide how big the gear is going to be - front/back access, and an interconnect list for wiring up gensets. This includes determining the physical location of lug connections (back, side or top access). UL and ETL are getting more stringent on where things are located. The standard is a "finger safe installation".

Q:
What is the expected service life of your switchgear?

A:
25 years.

Q:
What components or systems are expected to require replacement in 10 years? 20 years?

A:
Circuit breakers and PLC's usually require replacement or upgrade the soonest in switchgear. The life of circuit breakers will depend on how many operations the breaker performs. Newer CB's are good for 100,000 mechanical operations (not electrical operations).

Another goal is to design the switchgear so that lights are off most of the time, reducing the frequency of bulb replacement. Also, they no longer rely on batteries in the PLC itself for program memory. Memory is now flash memory.

Q:
Describe your Utility data management options or requirements:

A:
Panels are built to specification. Typically, data management is done on a computer, and not within the PLC. This usually means having a server. An advantage of today's equipment is that most of the equipment can be talked to directly.

Q:
What communication channels are available to access your switchgear equipment?

A:
Anything, but Ethernet is preferred.

Q:
Is Controlled Power ISO 9000-2000 certified, or do you have other quality control systems that are used?

A:
Controlled Power is not ISO-9000. However, they do have a thorough quality control program. Project engineer, shop guys have a list of things that have to be done to the panel before it ships (e.g.: drawings, etc.).

Q:
Do you provide service support over phone?

A:
Most of them give out their cell phone numbers. Everyone carries cell phone. All of their customers know how to get hold of them. And customers know how to get hold of the genset guys, who know how to get hold of them.

Q:
Where are their manufacturing facilities?

A:
All is done at Factory in Bothell. They own their own building.

Q:
Do you keep spare parts, and where are your spare parts kept?

A:
All spare parts are kept at their factory in Bothell. Estimate they have $20m in spare parts. They also work at teaching distributors to keep the right mix of spare parts to better serve customers.

Q:
How much fabrication work is done in-house?

A:
95% of the work is done in-house. Controlled Power doesn't do painting. Often, if they are sending a cabinet out for painting, then they will also get openings punched in at the same time.

A lot of engine manufacturers have their own panel manufacturing facilities. As a result, Controlled Power has had to look elsewhere for work. They've worked new areas such as pile drivers and airport runway lighting. This has broadened their sales base, but has also allowed them to learn a lot from these other applications. These other jobs have taught them a lot for the genset power market.

All the big guys want the parallel switchgear jobs. On big projects, the guy that can do ATS, switchboards, etc., do it all (turnkey) has the advantage in winning the project.

Work with AEA a lot, and provide them lots of extra hours. Their goal is to improve the gear and make it work better. They give AEA a lot of extra effort, and it makes the projects better.

PowerCorp (teleconference)
Thursday, March 27, 2007
4pm; and

Friday, March 30, 2007
4:10 pm

Alan Langworthy – Managing Director, Powercorp Pty. Ltd.
Gavin Bates – Electrical Engineer, Powercorp Pty. Ltd.
Russell Cahill – Service/Product Support Manager, Powercorp Pty. Ltd.
Dale Letourneau – Registered AK P.E., Powercorp Alaska
Erin McLarnon – Operations, Powercorp Alaska

John Cameron began the interview by reading the intent of the contract.

Q:
Describe the main features and benefits of the switchgear you manufacture:

A:
Gavin Bates:

The basis of this switchgear is that it full automates a power station, meaning the power station can be run unmanned. The switchgear can even take care of generator failures without an operator.

It can also conduct automatic scheduling for fuel savings, as well as provide remote access where depending on the users level of access they can dial in (via traditional phone line or Ethernet) to do maintenance, review data and other tasks, including manual control. The units can be run over a standard telephone network interface.

The system is layered in controls, such that each of the generators, although they can load-share with each other, they're independent. A failure of one will not affect the others. If there is a failure of the automatic overriding control system, the units can still be run in manual mode, they still synchronize automatically, and still load share automatically; it's just that the operator has to switch units manually. Quite a few levels of redundancy, looked at the whole system, and determined that the most important thing on this system is that the lights in the community stay on. The system can also have multiple failures, but can still keep a reliable, consistent power supply to the village.

Alan Langworthy:

The power station controller is the system's primary role, and the visualization aspects were added later.

The controller can handle:

- multiple generation sources
- multiple feeders
- demand side management

The power control system came first then the visualization. The system was designed for power station control that uses an industrial PC. The program uses standard C++ programming. A PLC can't do the detailed sequencing.

Q:
Can have multiple failures and still get power to the community?

A:
We began the process 18 years ago, designing a specific program, C++, programming language to let them handle complexity of fast-changing engine situation. Can handle multiple engines/feeders that have to be handled safely and quickly and logically, and incredibly reliably. It's easy to produce visualization that is pretty and easy to manipulate, their interface system doesn't have elaborate graphics, rather practical graphics. Control of the machine, and communicate that information to operator in timely manner is the main focus of Powercorp equipment.

To illustrate the differences between their system and packages that are delivered by others. There is a system called "Sytec", it's an advanced SCADA package, primarily for industrial applications. Have worked with that package in previous years. In one application they worked on, when the plant went into a failure mode, it wasn't able to handle them in a timely manner. Recorded alarms in a jumbled manner (time-stamped). Made it difficult to evaluate. A package designed for an industrial application, with overhead used for graphics, was unable to meet a fundamental requirement of power plant operations. That's what can go wrong when an industrial SCADA program is used for power generation control function. Our software is designed as a power control system, so that all of the events and alarms that happen in a very rapid time window, are put in the correct order, so it makes it very easy for an operator to fault find.

Have to use an industrial PC to run their software, cannot run it on a PLC. A PLC cannot manage the dataflow that is required to do the power generation control function. C++ used for their software.

Russell Cahill:

If you lose one generator controller you still have full control of the other gensets. If you lose the industrial PC, which is a rare occurrence, there will be no blackouts. Engines default back to manual mode and the local operator is still able to start/stop, run isochronous/droop, using push buttons on controllers. Automatic sequencing (economic dispatch) of machines would be lost. Each generator is responsible for its own automatic synchronizing and load sharing.

Alan Langworthy:

It's worthwhile noting that we introduced AEA to that Woodward product. We worked with Leonhard- Reglerbau system before Woodward purchased that company in Germany. But with the Woodward purchase of the company in Germany, we continued our close connection with Woodward. The engineers in the Woodward company in Germany have worked very closely with our engineers. We modified that product of Woodward's to do prime power, and to do the functionality that has just been described. Woodward had never heard of that before and therefore incorporated it into the GPC 30. The GPC 30 product that is used in the AEA system because Powercorp told them about it.

The Powercorp GSS is Woodward's GPC 30 with additional functions developed by Powercorp and therefore why Woodward places the Powercorp faceplate on that piece of equipment. The GSS was developed by Powercorp with Leonhard, which no longer exists because they were purchased by Woodward. Leonhard was a relatively small engine generator controller that we worked with in the early days before they were purchased by Woodward. We have historical documents showing the entire development of the GSS.

Powercorp is quite disappointed that AEA claims they discovered the function of the GPC 30.

The GSS is mainly a prime power application that is able to incorporate renewables and the GPC is mainly for UPS applications.

Q:
What agreements do you have in place with Woodward that will allow the GSS to still be produced, or as you upgrade it, to have those incorporated into the GSS?

A:
Alan Langworthy:

Woodward manufactures a number of products for a number of clients around the world. They brand them differently – you'll see similar looking products with a different front face, on a number of different manufacturers of turbines and things like that. We have an agreement with Woodward to put our front panel on the device. The reason we do that is because there are some features in the GSS that are unique to the GSS. The GCP-30 has some limitations that are not in our system. Our product has some software features that the GCP-30 doesn't have.

The GCP-30/31 was originally developed for UPS (uninterruptible power supply) applications, where the main power supply fails. We focus on prime power and generation, and it's those are the features that we work into the GSS with Woodward. Woodward recognized that the software that is run in the GSS justifies it having a separate screen on the front and having it as a unique product. It is able to run with renewable plants, and that's one of the features that is in their product.

In addition to that, they have a close relationship with the engineers in Stuttgart, where Leonhard was based and where Woodward now has a facility.

We have hundreds and hundreds of the GSS controllers out there. Any product ages, and when the product ages to the stage where it requires replacement, advance notice is given by the manufacturer, and plenty of notice is given stock up on spare parts. Plenty of time is given to migrate that technology across to something else. In the example of Golovin, in 15 year's time, we may decide to migrate that engine controller to somewhere else. But in the meantime, the parts and pieces are readily available. It is not a unique device in that sense.

Same goes for the PLC. We work with a particular industrial PC, but it is not unique, it can run on all sorts of industrial PC's. Hardware in any PC gets migrated (updated) all the time as electronics change. One of the things we find frustrating is that the electronics industry is improving things all the time, and with improvements, means change. We have all the technicians available to migrate those individual elements of the computer as we move forward.

Q:
Do you anticipate any difficulty in obtaining the GSS in the future?

A:
Alan Langworthy:

No.

Q:
Please discuss any features and benefits of the software used in the system.

A:
Alan Langworthy:

There is a very advanced trending system which is part of our SCADA system that is part of the visualization graphics. It is designed for fault assessment and fault analysis, all written by Powercorp.

The situation that can occur if a supplier is not in control of the software, is that the software company can change their software, or go out of business. This can disrupt the future of the software program. Using software that is written fundamentally by someone else can be an Achilles heel to the security of the system. Because we've written all of the software ourselves, including the visualization and trending, we do not have that problem. The alternative criticism can be made "that your software is unique, it is particular to your company. You go out of business, you go somewhere, the longevity and security of the system is vulnerable.

The software is not unique, we can go out of business and longevity is vulnerable.

What we do in those circumstances, and what we have offered to AEA, is to place a copy of the software in escrow. Place a copy of the source code in some reservoir based in Alaska; that legally, if Powercorp goes into bankruptcy, that would justify AEA having access to the source code. That is absolute security. The software, written in C++, is perfectly normal, ordinary programming language that is easy for others to understand. We have offered this to AEA. Powercorp does not believe that there is any of the packaged software products ever able to be done in that mode. We can make this offer because it is our software, specifically derived for power generation and control.

Recognize nervousness of a utility depending on software, but we'd like to point out that there are different aspects to that vulnerability. The ultimate security is for the utility to have access to the source code, and to know that the source code is documented, and written in a normal language that can be accessed by other programmers. Powercorp runs over 70 power stations in the Northern Terrorities for the local power and water authority in Australia, and they've never required the source code to be placed in escrow. The local water authority is completely comfortable with the reliability of the software and the strength of the company to not require that. But it was an offering we made for them, as we did for AEA.

You asked about access to parts for the GSS, but the far more important issue is access to the software. One of the typical criticisms levied is to say "well, this is a common package that is used by many people. But if that package is not under the full control of the utility, then that independent third-party software provider, be it a PLC programmer, be it a SCADA package, any of those can be left high and dry, because a third-party decides to change their mind and no longer support that particular piece of software. Doesn't believe that a firm such as Allen-Bradley would ever put their source code into escrow for a utility.

We're willing to do that because we're focused on utility automation, and we understand where the utility is coming from. We know that utilities are absolutely trustworthy organizations, but we do place it in escrow to secure that intellectual property fair and reasonably.

Q:
What if someone wanted to change your program written in C++?

A:
Alan Langworthy:

We have a GUI layer as well. We have something like 700 parameters; the GUI layer is absolutely easy to operate for any operator. Don't want operator on the station to make changes to key parameters. Another layer for authorized person, engineer or other person, to make changes. The program allows maximum flexibility. Can drive program in any direction they want. This refers to the fundamental software underneath, not the screen display (the GUI).

Gavin Bates:

One of the points that will come up is the ability to change the fundamental insides of the software. This often seems to comes from the "mad scientist" inside all electrical engineers. Any EE can pick up a PLC and change the program. PLC allows those to be changed. Approached, in the past in the Northern Territory, their water authority had a group of engineers that sat down and built up the program to run the plant (pumps and gensets). Although they could design the programs, they don't have a strong background in programming. This resulted in fairly fragile programs, where one change can create an unintended change somewhere else. Powercorp has qualified software engineers that focus on software. Their software engineers have sat down and planned out the software, how the modules interact, and have built it and programmed it. The software at Golovin is similar to every other facility they've got. The wind control module is an extra module that is attached to the program.

Extensive real-world testing, because it's running in these other 40 to 50 other stations. Where a customer has a new requirement, we're always happy to enter into an engineering development contract with them and write a new module or modify the ones we have, and make the changes to provide the extra functionality they desire.

Alan Langworthy:

Engineers who do PLC programming in these utilities, are very reluctant to do the boring documentation. As a software company, Powercorp keeps records of all their software.

This is necessary to provide, as an example, evidence for insurance claims. Lack of documentation comes to the fore when the engineer leaves the company. Larger picture of the responsibility of the utility to its customers that extends beyond today. Security over changes to the software. Can make changes to GUI layers, but there are levels of security that can prevent customer from making changes to certain parameters that would be dangerous. This is not necessarily the case with one-off PLC program written by another programmer using an off-the-shelf program. It is possible to have a loophole or a problem wthin there that is buried, which could create a dangerous situation. One of the benefits of having the same uniform software running in dozens and dozens of power stations is that one hopes all of the dangerous loopholes have been eliminated.

Q:
Would you characterize your software as an open architecture, or a closed architecture? Or would that be applicable in your case?

A:
Open architecture. Very open with all of their communication channels. Open with that protocol, we provide that protocol freely, so that we encourage others to be able to connect up devices that will be able to meet that protocol. Represent other devices, use open architecture.

The latest version of their visualization software allows them to add and subtract icons to create their own power station picture.

Q:
What protocols does your software support?

A:
Protocols: the basic, CANOPEN. Specs are freely for that are available. The secondary protocol is Modbus over Ethernet or Modbus over Serial Comm; Data extraction, FALL protocol, which is plain text protocols. Open an Ethernet channel to the box, type in "?tag-name", and gives the result. CANOPEN based on CANBUS hardware specification (Controller Area Network), high speed high reliability communications bus .

Gavin Bates:

A lot of these companies tend to say, why turn over control of station to a company with a black box without access to the program. An interesting parallel is: AEA used to use PLC's to control their generators, they physically went away from PLC's to control their generators, to Woodward GCP-31. Woodward has plenty of development staff and weight, so it's a relatively easy decision to say they don't want to put up with the hassle of keep modifying PLC programs, and redoing all the software all the time; we can just buy this product from Woodward, select the parameters in exactly like we do all the power station master controllers, and it all just works. The argument that we want control over everything seems to just come down to a matter of convenience and reliability. And that's where we're coming from as well. Our software is very convenient, it has all the parameters to worry about, developed over many years, installed in many stations, very well proven. Certainly a low investment in terms of hours to figure out if something has gone wrong.

Alan Langworthy:

Utilities have moved away from having control over everything by moving away from PLC for the generators to the Woodward black box. They recognize that the Woodward black box is excellent, because the core programming behind it is absolutely well proven and they trust it. They just adjust the parameters to have it do what they want it to do. Exactly the same analogy with the station controller. The station controller has a core program that is well-proven and tried, exactly the same as the GCP-30, and it has a set of parameters that they can change to achieve the goal. Everybody uses boxes that have a core program that they know works, and you do your own design and parameter setting on top.

Programming in Woodward is C programming, parameter based, same as the Powercorp GSS. As with the station controller, you have to set it up as Powercorp has done to have reliable, high speed control over the machine.

Russell Cahill:

Download section on website, brochures that talk about other features that didn't get discussed today.

Q:
Where have you installed this switchgear, or similar switchgear?

A:
Everywhere, Northern Territories; Indonesia; Mawson, Antarctica; Alasksa, but mainly Australia.

Q:
You have one system in Golovin, have you got any other systems in Alaska?

A:
Alan Langworthy:

No, we have been very much frustrated by AEA, and we have failed to be able to achieve what we consider to be a fair bidding process to achieve any more sales.

Q:
Are there any lessons learned on constructing equipment for the Alaska market?

A:
Gavin Bates:

Believe they made right choice by having an office in Alaska.

Option of where to build (Australia or elsewhere) and decided to build in the U.S., which saved a lot of hassle. Guys up there know all of the conditions. NT and Alaska are very similar, except temperature. Russell went up during the install and commissioning to work with AEA and their technicians.

Whole installation, learned a lot of things there. In the powerhouse, the generator is identical to here. There were some issues with delivery of gensets that were out of AEA's hands. Short turnaround, they have confidence in their installation crews.

If the software is not suitable for the application, can add modules to the system. AEA took them up on this offer and had the system talk to the heat recovery system. Obviously haven't needed to do this in the Northern Territories, but that was an example of extra functionality that was added into the system at the request of AEA.

Q:
Have you tried marketing your gear to other entities besides AEA?

A:
Alan Langworthy:

Yes. Have been to KEA in Kotzebue, TDX, AVEC and others.

Business:

Number of years in business: 19
Year founded: 1988.
Ownership: Private Limited Liability Company owned by Alan Langworthy.
Business units: Powercorp Group: Powercorp Holdings, Powercorp Proprietary Ltd, Powercorp Operations, Powercorp R&D, and Powercorp Alaska.

Q:
With respect to switchgear, what technology improvements are you presently pursuing?

A:
Power industry is in a great state of change, throughout the world. A high level of de-regulation in Australia. Along with the demand for renewable energy, high price of diesel fuel. All of these issues are bearing down on the power industry. Focus of the company is on remote power, remote communities, improving the lifestyles of communities.

From the power perspective, that centralizes on taking their dependence on diesel fuels away and providing alternatives. Also working on desalination to produce water. Very good adjunct to helping communities.

Expanding capabilities in renewable energy, core controller has capability of integrating other plants, to secure themselves against a threatening world.

Q:
What electrical standard is the switchgear built to?

A:
Gavin Bates:

They are built to Australian standards here in Australia; that's why we contracted with Applied Power & Control in Washington to build the switchgear for America.

Dale Letourneau:

The switchgear was built to AEA specifications of Steven's Village. It was a draft specification for their upgrades they had been doing.

Many of the items asked for in the AEA specification were older technology and didn't apply when they used the Powercorp controller.

Alan Langworthy:

The engine controller (Woodward) is U.S. manufactured and meets all U.S. standards, although it is manufactured in Europe. All certified for the U.S.

Dale Letourneau:
The panels are UL 891.

Q:
What is the availability of replacement parts?

A:
Alan Langworthy:

We stock all relevant Powercorp parts in Anchorage, such as spare Commanders, GSS' and FMS'. They've also got spare parts back in Australia. The PC & GSS are both production items from Woodward. Woodward, as a professional and public company, would give forward notice if they decided to discontinue production of the GSS.

Over time technology does improve, so we concentrate on the interface between items as another piece of equipment becomes available – we will integrate so it can be simply plugged in.

C++ program can run on various platforms, so if the industrial PC they're presently using isn't available the program can be put on a new and better PC. The software isn't unique to "those" black boxes. It could be migrated to an updated genset controller.

Dale Letourneau:

Most of the parts used are specified by AEA such as circuit breakers, indicating lights, etc. Most of these items are standard catalog parts that you are at the mercy of the manufacturer for their availability.

Gavin Bates:

As an example of supporting obsolete equipment, SMA, the original generation controller manufacturer quit making the original controller and therefore most parts are not available. However, after 6 years of not manufacturing this piece of equipment or making supplies they still take and repair parts.

Q:
As technology ages are you letting customers know about these changes?

A:
Alan Langworthy:

Yes, that's part of our customer service. How the notification takes place would depend on what part it is. Specialist parts, such as the PC, they would notify the customer. Otherwise, the majority of components we use are not unique and are in normal production because we understand technology changes.

Q:
Regional support and how is service supported?

A:
Alan Langworthy:

The entire system is designed for unattended, automatic operation, as a fundamental. The equipment is designed with redundancy and reliability levels that are expecting that they are going to work in a hostile environment and work reliably for many, many years. We've only just taken out the last of our 20-year old switchgear, and so I can say that we have had experience of our single automatic switchgear technology lasting 20-years, which is exceptional in the world of automation.

We've also built into our switchgear a basic operator level capability, so that a very unskilled person on site in the community can readily take control; start and stop engines. That is absolutely essential to guarantee reliability in some sort of catastrophic situation. They must be able to, in a very simple way, to start an engine, put it on-line, and get power back on to the community.

We have different layers of servicing. First of all, reliability. Second, local operators being able to manually manage the system in the simplest possible way. If you examine our man-machine interface, we try to reduce the number of buttons. We hate lots of lights and buttons, and bells and whistles. It only confuses the poor old operator on-site.

1) Anchorage
    - Employee Alaskans to do local work. Right now we have reduced our workforce in Anchorage due to no foothold. The employment of Dale, Dennis, Erin and the like, is a genuine commitment to employing Alaskans. Our very next task is to employ technical staff, based in Anchorage, to do the local work. We have limitations to the number of equipment we've got, makes it very difficult to justify that staff.
2) Remote Access from Darwin
    - We operate complex equipment, in the Azores, in Antarctica, and throughout Australia. Some of the equipment we operate in Australia is 2,500 km from their offices. We're able to interface with that technology, we're able to diagnose, we're able to download, we're able to take control, we're able to do all of the things that a technician would be able to do from a service center. We can provide remote access via dial up/Ethernet; however we've had limitations in Golovin. AEA removed access to station, so we're not allowed to communicate with it.
3) Darwin
    - A trained service technician is available 24/day, 7 days a week, 365 days a year by phone.

- Technicians can travel to site for a fee.

We have found that most problems end up being mechanical.

The primary service (change oil, etc.) is the utilities responsibility. In the case of Golovin, the primary service function would lie with AEA. The normal procedure is that AEA and/or operator would be notified by computer, phone, etc, of a problem. If they could not resolve then they either contact Anchorage or Darwin for further assistance. Our Anchorage office can handle most issues and if not, they ring up a trained technician in Darwin immediately.

Gavin Bates:

There is a data callback system, but Golovin did not purchase.

If we can't figure out a problem we have a test facility (actual power station) in Darwin that can recreate the actual failure from the data collected on the controller so we can figure out what happened.

Alan Langworthy:

We are the only ones in the world with this type of test facility.

Dale Letourneau:

The switchgear manufacturer, Applied Power, will also travel to the site if necessary. AEA has made it very clear that they want to be involved in the installation and maintenance of their facility.

Q:
The service you provide, where you're able to take the data live from a power plant and analyze it, is that sort of work covered by a maintenance contract. Or is there another form of contract?

A:
Alan Langworthy:

We have 70+ power stations with the power and water authority, we have a period contract for the service and support of those stations. It has clauses in it that allow for trips for visits, and for service technicians to provide those services.

The service is provided for a small monthly fixed fee, which includes dial-up and fault findings.

Q:
What are the warranty terms?

A:
Alan Langworthy:

Normally one year, but Alaska extended up to 5 years. This covers faulty parts and any set-up. The faulty part is returned to Powercorp so tests can be performed to try and figure out what went wrong.

Q:
Does the new part start over with a one year warranty or just continue from the original warranty?

A:
Alan Langworthy:

It depends.   Usually, if it's a simple part, then it assumes the old parts identity. If it is a major part like a controller, which is rare, then the warranty will start over.

Q:
What development of technology do you see will offer the greatest benefit in switchgear?

A:
Alan Langworthy:

The ability of switchgear to operate other technologies & systems such as alterative fuels, renewable energy and desalinization units, and provide demand-side management. Many communities are dependent on diesel fuel, and the likelihood that remote communities will be connected to the grid is diminishing. That means that dependence on diesel fuel is growing. As the diesel fuel supply becomes more difficult to get, the existence of these communities is at risk. It's not just lights, it's also sewer, and water, and heating or cooling. There are parallels between remote Australian communities and remote Alaskan communities.

Gavin Bates:

On the generator controller we are working on a CAN Bus extension that would allow us to control directly to engine control units, J1939 capable machines, such as the Detroit Diesel machines. This would reduce analog sensors, which are fragile. This will also reduce the cost of installation.

We are working on more sophisticated protection on the feeders, using the SEL-351 feeder protection devices, and a more sophisticated power meter which allows us to do waveform capture on any disturbances.

We have a data server product that allows us to collect data for management, and we are enhancing the data server to collect more data to make management style reports directly into programs such as Excel.

Alan Langworthy:

We make sure it is all migratable, that units in the field are able to be connected to the upgrade. We don't make the equipment in the field redundant.

Q:
Any problems in Golovin and how were they resolved?

A:
Gavin Bates:

We had an occasional issue with extra items such as the BTU meter. We had to add patches in the program to make it work. Otherwise, it was just standard construction type issues.

Dale Letourneau:

Other than typical construction issues we had to do changes in the unit conversions from metric to standard and fuel flow metering which AEA specified.

Erin McLarnon:

Most of the so-called problems were more with the graphical look they wanted, certain colors on generators, and the like, and not operational issues.

Gavin Bates:

We supplied our standard visualization program, SMSView, which we've used for quite some time. It's quite focused on its layout. We have made some modifications to it for Golovin, to show some environmental monitoring, e.g.: windspeed and BTU. At that time, we were in the process of developing ANYView, which is more powerful and flexible, and is now our premium product.

Q:
Is 50 Hz the standard is Australia?

A:
Gavin Bates:

Yes.

Q:
Why is the 50 Hz faceplate still on the Golovin GSS?

A:
Dale Letourneau:

New faceplate hadn't arrived from Woodward even though it is an American product. It shows 60 Hz, but the newer faceplate hasn't arrived yet.

Alan Langworthy:

The new faceplate wasn't available when we did the Golovin project, and after it was installed, it wasn't worth the cost of replacing those controllers to change a number on the faceplate.

Gavin Bates:

The new faceplate now shows "FN" in the middle, rather than a fixed frequency number, so no trouble where the GSS is used.

Q:
Were there any problems during the construction of the panel?

A:
Alan Langworthy:

Applied Power & Control is a fantastic company.

Gavin Bates:

I arrived three days before the full functional test of the switchgear to give necessary changes to gear before the test. I only found two minor wiring problems that took only an hour or so to fix.

Q:
What are some of your other relationships besides Woodward?

A:
Alan Langworthy:

Powercorp has partnered with Siemens to distribute our PowerStore power quality technology. Products will retain the Powercorp name and flexibility. This joint venture is a major step forward for the company.

Other relationships are: VECTEK, Western Power, Piller, among others that are listed on our site. The ENERCON relationship is coming to an end because ENERCON is pulling out of Australia.

Q:
What are some of the features that simplify tasks for the operator?

A:
Gavin Bates:

Thanks to Alan's hard work and our experience the operator interface is a simple diagram (e.g. if there are no numbers on a generator on the screen, then it isn't running). The system allows you to make modifications to it, assign levels of hierarchy, is tolerant of mistakes, is easy to clear buttons, and the displays are clear and uncluttered.

Automatic synchronization is an essential feature of the switchgear that eases the workload of the operator.

Since skilled labor can be far and few between, this type is system is needed to keep the power on.

Alan Langworthy:

We've found that the interface we've designed is easily understood by semi-skilled staff.

Q:
How easy is the maintenance?

A:
Alan Langworthy:

Really as simple as keeping the oil changed in the generators. It's a pretty straight-forward system. It's actually pretty boring. The more boring a power station is the more reliable they are. Exciting is bad!

Q:
Are there other displays available?

A:
Alan Langworthy:

Quite a number of displays are available. Golovin's display is fairly small. You can plug-in a laptop and get a normal display. We can upgrade Golovin screen to "normal" size quite easily, with a free exchange upgrade.

Erin McLarnon:

The reason Golovin's screen sizes are the size they are is because that version of the software was meant for smaller LCD screens and Golovin was one of the first stations to have a "normal" sized LCD screen in its switchgear.

Q:
How many indicator lights can your system have?

A:
Alan Langworthy:

As many as you want. But, the more lights you have, the more confusing it is. Especially if someone is color blind. The age of indicator lights is long gone. How do you know which light came on first, second …? It doesn't let you know what happened.

The Powercorp controller shows the sequence of events and you need no lights.

Q:
It seemed like the Golovin system was limited to the number of lights it could have.

A:
Alan Langworthy:

We can do as many as you want. Two areas of discussion that Powercorp seems to get into with utilities are the number of indicator lights, and the difference between red or green to indicate automatic operation of the plant.

Gavin Bates:

There is a limit on the I/O on the generator controller, but there is a PLC program that will allow more lights if the customer wants it.
Alan Langworthy:

The resistance by Powercorp of limiting the number of lights was more of an education to get AEA to move away from their old ideas. These weren't limitations.

Q:
How many DI or AI can be connected to your switchgear? How many DO or AO can be operated by your switchgear?

A:
Gavin Bates:

Able to hook a small PLC up to the data pool. You simply hook up a small PLC up and dump the data into the pools. You can also get data out this way too.

Q:
Do customers have the option to modify the program?

A:
Gavin Bates:

The system in Golovin gives flexibility in setting the parameters. If a customer expresses a strong desire to have additional features, there are other changes we can make based on those customer's desires.

Q:
Can the equipment be expanded?

A:
Gavin Bates:

Each out of the box Commander is equipped to maintain any combination of 8 generators and 6 feeders. This can be expanded, but that is our standard form. There is also a smaller scale unit – Microlink – than can handle 3 generators and 2 feeders.

Q:
How do you do your training? Does it happen before or after the powerplant is put on-line?

A:
Gavin Bates:

It depends. For a new station we do the training just before we connect. For upgrade work we do the training toward the end of commissioning and for larger customers the company will send people to Darwin to train. For this we visit a few communities so they can see first hand and then we spend a few days at the testing facility in Darwin.

Alan Langworthy:

Erin has the ability to connect system at take customers through a modified training – 80% training.

Q:
How has Mawson, Antarctica performed since its installation in 2003?

A:
Alan Langworthy:

Good. We go back quite a ways earlier than Mawson. Denim, Australia is one of our first systems in western Australia. The Denim system is very similar, the only difference with Mawson is that Mawson has a heat loop built into it that dumps power into a heat loop. Very similar technology at both sites. Used at a number of other sites (approximately 7 or 8 sites). www.aad.gov.au/apps/operations/electrical.asp is the website for the Antarctic Division's display of the electrical system at Mawson.

Q:
What types of systems can the Powercorp system integrate?

A:
Alan Langworthy:

Gas reciprocating engines
Wind turbines
Solar equipment
Hydro plants

Gavin Bates:

Haven't done it yet, but we're looking at fuel cells.

Q:
What features simplify those integrations?

A:
Gavin Bates:

The station master controller has a number of inputs, as well as a few algorithms to take care of renewables. For example, in a standard sort of configuration that a large wind/diesel customer would have, they would specify how much diesel standby (spinning reserve) must be available when the system is being fed from wind power, based on the load.

Q:
Can the Golovin system add wind to their system?

A:
Gavin Bates:

We may have to install the wind module software, since AEA didn't want it in the original contract. As far as hardware, it is all there.

Alan Langworthy:

We could do this from here, we just download it.

Q:
Is it freeware or cost ware?

A:
Alan Langworthy:

We would probably have to charge since it's after the fact and it was specifically ruled out as part of the original package. AEA didn't expect to have wind as part of their systems, and they were excluded from doing that part of it. It would be fair at this stage to charge for it.

Q:
What would the cost be?

A:
Alan Langworthy:

Don’t know because we usually give it for free. At the front end of a particular site, it is usually clear whether it is a diesel only, or a hybrid site. In those cases, everything is included when we start the project.

However, if someone were to ask nicely we’d probably download the software for free.

Q:
What is the expected service life of your gear?

A:
Alan Langworthy:

We’ve only just removed a controller from 18 years ago. It was still working fine they were just upgrading to change the configuration of the power station. We have a demonstrated 18-year long life on a piece of automation equipment. Based on our track record, a 20-year life is reasonable to expect for automation equipment.

Q:
When you commission your switchgear, what components or systems do you expect to last 10 years, 20 years, etc.?

A:
Gavin Bates:

Hard disks will typically get about 5 years of life, normally they would be replaced between 3 and 4 years. Circuit breakers are maintainable, and the lifespan is typically out to the full 20 years. The electronics are reasonably stable, and most of them should have a life span of 7 to 12-plus years. In the case of Golovin, it could be longer, since the switchgear is in a controlled environment. At Golovin, the electronics are isolated from the engines, and won’t have to cope with vibration and heat from the engines.

Q:
What about data management? Is it routed through the industrial PC?

A:
Gavin Bates:

SMS holds a minimum of six weeks of high resolution data, and up to 20 years long term data. The data can then be downloaded to an off-site database.

We can significantly increase our storage capability by only recording data exceptions (a change of state) for certain data types.

Q:
What communication channels are available?

A:
Gavin Bates:

Ethernet, dial-up modem, satellite modem, virtually any interface. Interfaces available are listed on the web site.

Q:
What are your quality controls? ISO 9000 certified?

A:
Alan Langworthy:

We have quality control, and follow the requirements of ISO 9000. We follow them, even though they are not required in Australia. Since they aren't required, we have not gone ahead and acquired the certification.

There are lots of standards the software engineers follow with respect to software documentation, change recording, and the like.

All equipment is manufactured to, and conforms with U.S. standards.

Q:
Does the Darwin office have the capability to manufacture the switchgear panels?

A:
Alan Langworthy:

We do have in-house manufacturing capability, but we farm some work out too. We have switchgear manufacturers that we work with to have them build our switchgear.

Q:
If you could be in our seat what questions would you ask your competition?

A:
Alan Langworthy:

Each of the switchgear manufacturers has a quality product. Given that, what capability do they have to integrate renewable energy; what capability do they have to discriminate feeders and ensure essential supply; what capability do they have in terms of fault finding and data recording; how simple is the communication or man-machine interface, so that the operator, when confronted with an emergency - does he make the right decisions very quickly and easily, or does he get confused and have to respond to somebody at a distance?

Thomson Technology Inc (TTI)
Monday, March 26, 2007
Langley, BC (outside of Vancouver, BC)
10:30 AM

Guy Anderson, Thomson Technology

John Cameron began the interview by reading the intent of the contract.

Q:
Describe the main features and benefits of the switchgear you manufacture:

A:
AEA specifies the features and benefits of the switchgear. There is no provision for varying from the specification. With respect to components, we have to use specified manufacturers. It's not the way they might build switchgear if they were given free reign.

TTI will build to customer exact specifications. Have flexibility in the manufacturing and design process and can build to any exact specification. Over 35 years experience. ISO 9000. Factory over 60,000 sq ft. UL 891, ANSI for 5kV and 15kV. UL1008 (ATS). UL508 for controls. UL loadbanks. Can provide a complete package. Can control each device (ATS). Work on DGAS/Prime power (auto-standby prime power). Can work with any brand of genset. TTI has a lot of experience with prime power systems, particularly in Alaska.

TTI manufactures its own line of controllers: PGS4000, MEC20, and remote communications software is available. Also have a line of remote annunciators and battery chargers.

Over 130 employees. In engineering, 4 PE's in R&D. 4 that do mechanical design (steel for bus/swgr). 3 or 4 that do programmable logic controllers. 5 or 6 more engineers that work on electrical design.

Q:
Where have you installed this switchgear, or similar switchgear?

A:
See project profile. HAARP, Tenakee Springs, Cordova Bay power (Hydro), Large list of jobs in Alaska. 85% of their projects are built to spec.

Q:
Are there any lessons learned on constructing equipment for the Alaska market?

A:
Weather (similar to Canada) is something that TTI is knowledgeable about. Handle Arctic type conditions. Can provide a lot of wear/tear during travel. Switchgear has to be built to be quite robust. Packaging has to be tough. TTI does their own packaging, but for wooden crating, can outsource. Thoroughly test all equipment before ships out. It can cost a lot if something goes wrong on-site. Power is more critical because remote prime power is critical service.

FAT test is optional for customer witnessing. Encourage it, because they want to make sure that the customer/consultant/client is satisfied. Can provide current injection for the CT's, can simulate a live genset. Devices that simulate I/O (engine faults, alarms, S/D's, etc) to go through full range of testing.

AEA is different because a site startup is not needed. AEA's techs are quite skilled, so a site startup is not required. Normally TTI provides a site startup tech. Oversee the job. Duration of stay depends on the complexity of the job.

Q:
Is your software built on an open architecture platform?

A:
We give a copy of the program to the client. In the case of AEA, the PLC program is owned by AEA. They don't want to rely on a switchgear manufacturer to make changes if they're needed. This is a mandatory spec requirement for AEA projects. We provide the PLC source code as well as the controller code.

For TTI's PGC 4000: the on-board code wouldn't be accessible, but the configuration software would be.

AEA designs their switchgear so they can change the size of the gensets. They can do that, and wouldn't need someone else to program it. Development software for the PLC is usually included in the spec.

Q:
Describe the availability of replacement parts:

A:
Specification requires basic parts to be available on-site. In the case of Alaska, it typically takes a day to get on-site. TTI keep basic parts in inventory. AEA uses parts

from large manufacturers; so don't have to rely on switchgear manufacturers. TTI does have all the TTI items on hand.

Q:
Do you provide support for obsolete technology?

A:
TTI was the first controller manufacturer in the US. As an example of their ability to provide support for obsolete technology, they can supply replacements of their MEC10 and MEC100. Have service stock for emergencies, and can build one up, even today. Those are 10 to 15 years old.

AEA specified Woodward GCP's and EGCP's, and these would have to be supported by Woodward.

Q:
Do you offer warranty terms?

A:
Warranty is 1-year parts and labor. After site startup to maximum of 18 months of shipment.

Q:
As you consider future technological developments, what technology do you see will offer the greatest benefit in switchgear?

A:
PGC4000 is the best controller out on the market. Provides the most features. Industry is heading toward all-in-one controller. An all-in-one design simplifies startup, trouble shooting, and makes for easier communications protocols. Communication problems will dominate in the future, rather than wiring, as is the case today. Web enabled controllers is another direction that the industry is moving toward.

TTI's integrated controller: has revenue grade utility grade metering, power quality measurements, configurable screens (a standard15" color touch screen). Protection equivalent to utility grade protective relays. Has PT sensing for 3 sources (each unit controller): paralleling a number of gensets to each other and to the grid. Sense grid, load bus, as well as the genset – don't need a master controller.

Q:
Do you know of any problems that arose during the installation of your equipment in Tenakee, and how were any problem(s) resolved?

A:
A component failed, and AEA decided to go direct to Woodward and get it replaced under warranty.

Q:
Do you know of any problems that arose during the construction of your equipment in Tenakee, and how were any problem(s) resolved?

A:
None.

Business:

Number of years in business: 34
Year founded: 1973
Owners: Regal-Beloit (RBC, NSYE). Over $1B company. Sister company is Marathon generator. Marathon also manufactures equipment for AEA.
Legal ownership structure: Corporation

Q:
Describe any features that simplify maintenance requirements:

A:
Have a list of maintenance items. Fairly generic list that any manufacturer would recommend: Infra-red testing, calibrate meters, etc.

Q:
What kind of display is available? Are there options for display of stored or real-time data?

A:
AEA has an operator interface screen (Allen-Bradley).

Q:
How many indicator lights can a user add to your switchgear?

A:
AEA designed their spec for future expansion.

Q:
How many DI or AI can be connected to your switchgear? Do you expect to increase this number in future versions of your switchgear?

A:
The switchgear is built to specification, and the customer sets the number of AI/DI.

Q:
How many DO or AO can be operated by your switchgear? Do you expect to increase this number in future versions of your switchgear?

A:
The switchgear is built to specification, and the customer sets the number of AO/DO.

Q:
Can your equipment be expanded?

A:
AEA specifies the size of generators, the number of units, etc. They specify the generator breaker trip size. Can take full advantage of the breaker rating.

Q:
What training or maintenance support is available?

A:
Can use consultants, engine generator dealers and users that will come and receive training. TTI can provide on-site startup training, and that's usually part of the specification.

Q:
Describe your competent service organization:

A:
3 levels of service. Guys in-house, genset dealers, and local 3rd party NETA certified (switchgear-type people). First line of defense is the generator dealer. Call the generator dealer to identify the problem, and they'll send a tech. If there is a problem, TTI has 24/7 phone support. 3 or 4 people on call that take rotating calls. If it is an absolute emergency, they can get it worked out. Can use a 3rd party. If not an emergency, then can use someone from their factory.

Q:
Is your switchgear compatible with other non-diesel generation systems (e.g.: wind, hydro, solar, other internal combustion drivers)?

A:
We follow the specification. TTI has done a number of different generation systems, including reciprocating engines (diesel, gas, etc). Basically just changing the prime mover. Have done hydro turbines, solar turbines, steam, and natural gas. Doesn't believe that they've done any solar electric hybrids. Manufacturer of the generation equipment does all of the controls. They provide basic generator metering and protection.

Have you done any solar or wind? Just quoted a solar system. No jobs as far as he knows for solar and wind. However, doesn't expect it would be a problem. Have done a rotary UPS (runs all the time). Their Alaska representative, Renoso, also reps the solar flywheel.

Q:
What is the expected service life?

A:
For paralleling switchgear, usually the requirements change and the switchgear has to be replaced before it becomes non-functional or obsolete. If AEA specifies an Allen-Bradley 505 controller, and it becomes obsolete in 15 years, does it make sense to change out the component or change out the gear? Load size growth is also a consideration, and will drive the change out of switchgear.

Q:
Describe your utility data management options or requirements:

A:
They have a PC. It would be in the specification. Some of the components have built-in data logging. PC probably does the majority of the data logging. RSView will have

storage. A specification would typically lay out the requirements for data storage, such as: Excel files of data shall be spreadsheet for 30 different data points, logged every 15 minutes, and writes to hard drive.

Q:
Design capabilities:

A:
Quality controls (ISO 9000-2000 certified). QA department has 1 mgr and 2 other employees. After tests, there are specific QA tests. QA: FAT, site startup, all is involved with ISO-9000.

Q:
Annual sales:

A:
Approx $30M per year. Parent company is $1.5B

Q:
Do you provide service support over phone?

A:
TTI has a toll free number that puts the caller through to an answering service, and the answering service will have someone call back quickly. The more information the better. Their drawings are done in autocad.

Q:
Where are their manufacturing facilities?

A:
All is done at Factory in BC. Except specialty items such as walk-in enclosure. Spare parts are kept at the factory in BC.

Q:
How much fabrication work is done in-house?

A:
All of it, other than on-site work, and maybe some crating. TTI manufactures its own switchgear as well (rather than buying someone else's switchgear and adding controls).

Helps with UL listing. If a customer buys a panel from a UL shop and adds gear to it, it's not still UL listed.

WOODWARD

Product Specification
03240G

GCP-30 Series

Genset Control Package

Mains & Generator Protection & Control

APPLICATIONS

The GCP-30 Series genset control is designed to provide total control for multiple, medium to large sized applications.

A network of the compact, versatile GCP-30 controls is capable of controlling up to 14 gensets with automatic sequencing. Load management features include automatic base loading/peak shaving, import/export control and emergency power/back up power generation.

The GCP-31 has logic for one circuit breaker and the GCP-32 has logic for two circuit breakers including open/closed transition.

Fully integrated communication to engine ECUs including [via CAN bus] standard SAE J1939, Deutz EMR, Scania S6, Volvo EMS2, mtu ADEC, mtu MDEC; [via RS232] Caterpillar CCM to EMCP-II, and ECM.

DESCRIPTION

Features

- True RMS 8× voltage (generator/busbar/mains)
- True RMS 4× current (generator/mains)
- Start/stop sequence for Diesel/Gas engines
- Engine pre-glow or purge control
- Battery voltage monitoring
- Speed control with overspeed monitoring
- Idle speed mode operation
- kWh/operation hours/start/maintenance counter
- Load dependent start/stop for up to 14 generators
- Configurable trip/control set points
- Configurable delays for each protection/alarm
- Magnetic/switching Pickup input
- 16 configurable discrete alarm inputs
- 7 configurable/programmable relays
- Two-line LC display
- Synchroscope
- Push-buttons for direct control
- CAN bus communication
- Multi-level password protection
- Language manager (English/German switchable)

DESCRIPTION (continued)

Protection	ANSI #
• 3/4-line measurements	
Mains	
• Over-/undervoltage	(59/27)
• Over-/underfrequency	(81O/U)
• Phase/vector shift	(78)
Generator	
• Over-/undervoltage	(59/27)
• Over-/underfrequency	(81O/U)
• Overload	(32)
• Reverse/reduced power	(32R/F)
• Unbalanced load	(46)
• Time-overcurrent (TOC)	(50)

Controller (all versions)

- Speed/frequency/real power
- Voltage/power factor cosphi
- Mains import/export power
- Load/var sharing for up to 14 generators

Controller (GCP-31)

Synchronizer for 1 CB

- Isolated operation
- Softloading
- Mains parallel operation

Controller (GCP-32)

Synchronizer for 2 CB

- same as GCP-31 plus following
- Open transition (break-before-make)
- Closed transition (make-before-break)

Special (Version dependent)

- 2 configurable analog outputs (0/4 to 20 mA)
- Generator real power setpoint via 0/4 to 20 mA
- Mains import/export power via 0/4 to 20 mA
- Discrete outputs raise/lower for n/f/V/P/Q
- Analog outputs raise/lower for n/f/V/P/Q
- PWM outputs raise/lower for n/f/P
- 7 conf. analog measuring inputs (0/4 to 20 mA, Pt100, VDO)
- Coupling to LS 4 (GCP-31 only; for details see product specification 37167)
- Event recorder with real time clock

- J1939 (Volvo EMS2, mtu ADEC, Scania S6, Deutz EMR), mtu MDEC, and CAT CCM (EMCP-II, and ECM) coupling
- AMF auto start/stop
- Complete engine, generator, and mains protection and controller in one unit
- True RMS sensing of generator, busbar and mains voltage as well as generator and mains current
- Synchronization for one/two breakers
- Load management-automatic base load/peak shaving, import/export power control, automatic sequencing
- Load/var sharing for up to 14 generators incl. auto start/stop
- Counters for kWh, engine starts, operating hours, maintenance call
- Freely configurable discrete and analog alarm inputs
- Freely configurable relay and analog outputs
- Configurable via PC or front panel
- CAN bus based communication
- CE marked
- UL/cUL Listed

SPECIFICATIONS (for more see manual 37364)

Accuracy ... Class 1
Power supply ... 12/24 Vdc (9.5 to 32 Vdc)
Intrinsic consumption ... max. 20 W
Ambient temperature — Operation ... -20 to 70 °C
Storage ... -30 to 80 °C
Ambient humidity ... 95 %, non-condensing

Voltage ... Rated ⅄/Δ: [1] 66/115 Vac or [4] 230/400 Vac
$V_{ph\text{-}ph}$ max. (UL): [1] 150 Vac or [4] 300 Vac
Rated $V_{ph\text{-}ground}$: [1] 150 Vac or [4] 300 Vac
Rated surge voltage: [1] 2.5 kV or [4] 4.0 kV
Setting range (prim.): 0.050 to 65.000 kVac
Measuring frequency ... 50/60 Hz (40 to 70 Hz)
Linear measuring range up to ... $1.3 \times V_{rated}$
Input resistance ... [1] 0.21 MΩ, [4] 0.7 MΩ
Max. power consumption per path ... < 0.15 W

Current (rated values; I_{rated}) ... ../5 A
Linear measuring range up to ... $I_{gen} = 3.0 \times I_{rated}$
$I_{mains} = 1.5 \times I_{rated}$
Load ... < 0.15 VA
Rated short-time current (1 s) ... $10 \times I_{rated}$

Discrete inputs ... isolated
Input range ... 12/24 Vdc (6 to 32 Vdc)
Input resistance ... approx. 6.8 kΩ

Analog inputs ... freely scaleable
Type ... 0/4 to 20 mA, Pt100, VDO
Resolution ... 10 Bit

Relay outputs ... potential free
Contact material ... AgCdO
Load (GP) ... 2.00 Aac@250 Vac
2.00 Adc@24 Vdc / 0.36 Adc@125 Vdc / 0.18 Adc@250 Vdc
Pilot duty (PD) ...
1.00 Adc@24 Vdc / 0.22 Adc@125 Vdc / 0.10 Adc@250 Vdc

Analog outputs ... isolated
Type ... 0/4 to 20 mA, freely scaleable
Resolution ... 8/12 Bit (depending on model)
Max. load 0/4 to 20 mA ... 500 Ω
Insulating voltage ... 1,500 Vdc

Housing ... Type APRANORM DIN 43 700
Dimensions ... 144×144×118 mm
Front cutout ... 138[+1.0]×138[+1.0] mm
Connection ... screw/plug terminals depending on connector 1.5 mm² or 2.5 mm²
Front ... insulating surface

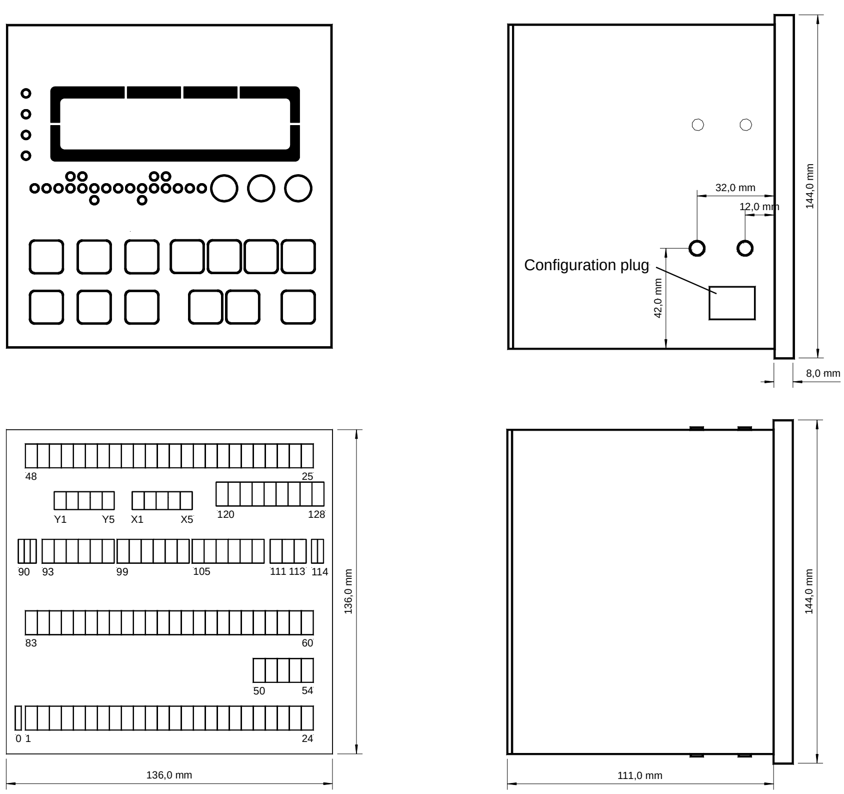
Protection system ... with correct installation
Front ... IP42
(sealed IP54; gasket kit = P/N 8923-1039)
Back ... IP21

Weight ... depending on version, approx. 1,000 g

Disturbance test (CE) ... tested according to applicable EN guidelines

Listings ... UL/cUL listed (File No.: E231544)

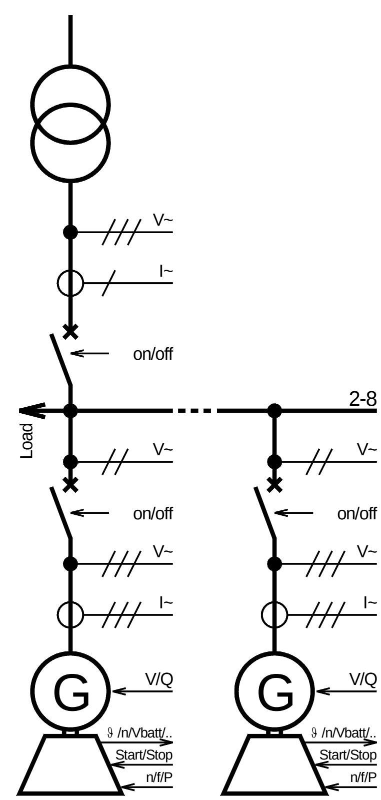
DIMENSIONS



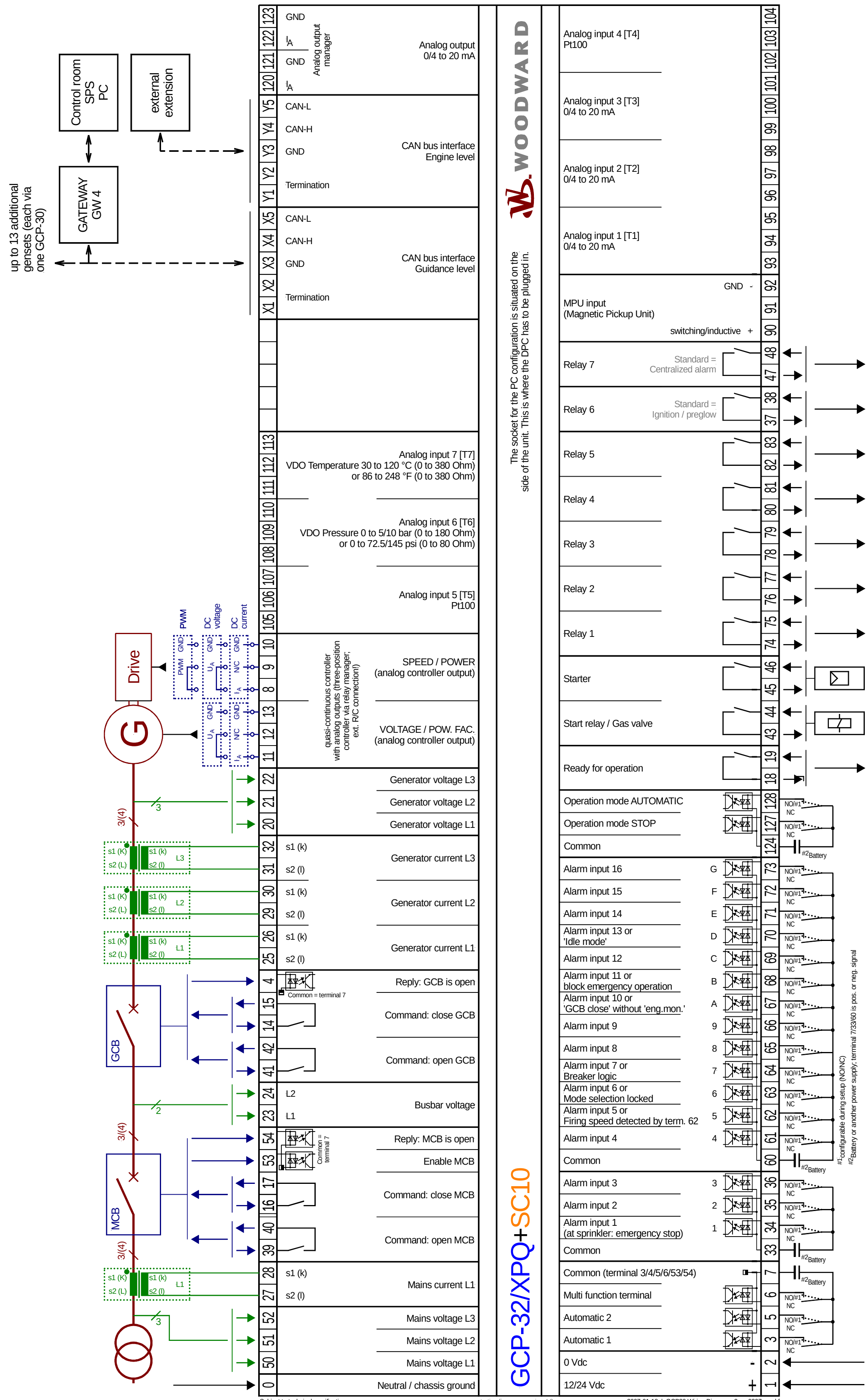
2002-11-21 | GCP30-AMG2 Dimensions g2ww-4702-ab.skf

APPLICATIONS

Typical application for the GCP-32 (GCP-31 same but without MCB)



WIRING DIAGRAM (example: GCP-32/XPQ+SC10; for more see manual 37364)



Subject to technical modifications.

starting firmware version 4.2xxx

2007-01-18 | GCP30 Wiring Diagram g2ww-0307-ap.skf

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stgt-doc@woodward.com

03240G - 2007/2/Stuttgart

FEATURES OVERVIEW

GCP-30 Series Genset Control	GCP-31					GCP-32				
Package	BPQ	XPD	XPQ	XPQ+SB03	XPQ+SC10	BPQ	XPD	XPQ	XPQ+SB03	XPQ+SC10
Control										
Breaker control logic	1	1	1	1	1	2	2	2	2	2
Synchronization	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Isolated single-unit operation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AMF (auto mains failure operation)		✓ #1	✓ #1	✓ #1	✓ #1	✓	✓	✓	✓	✓
Stand-by operation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peak load op. (auto start/stop)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mains parallel operation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Open transition (break-before-make)						✓	✓	✓	✓	✓
Closed transition (make-before-break)						✓	✓	✓	✓	✓
Softloading	✓ #2	✓ #2	✓ #2	✓ #2	✓ #2	✓	✓	✓	✓	✓
Accessories										
Start/stop logic for Diesel/Gas engines	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
kWh counter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Operating hours/start/maintenance counter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Configuration via PC #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Event recorder, real time clock		50	50	50	50		50	50	50	50
Language manager (English/German)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Protection										
Generator: voltage/frequency	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mains: volt./freq./phase shift	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Generator: overload/unbalanced load	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Generator: reverse/reduced power	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Generator: time-overcurrent (TOC)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controller										
Discrete raise/lower: n/f & P #4	✓ #5	✓	✓ #5	✓ #5	✓ #5	✓ #5	✓	✓ #5	✓ #5	✓ #5
Discrete raise/lower: V & Q #4	✓ #5	✓	✓ #5	✓ #5	✓ #5	✓ #5	✓	✓ #5	✓ #5	✓ #5
Analog raise/lower: n/f & P #4 #5	✓		✓	✓	✓	✓		✓	✓	✓
Analog raise/lower: V & Q #4 #5	✓		✓	✓	✓	✓		✓	✓	✓
PWM raise/lower: n/f & P #4 #5	✓		✓	✓	✓	✓		✓	✓	✓
Mains import/export power via 20 mA		✓	✓	✓	✓		✓	✓	✓	✓
Mains import/export power control	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Load-dependent start/stop	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Active power setpoint 0/4 to 20 mA #6		✓	✓	✓	✓		✓	✓	✓	✓
Load/var sharing for 14 generators	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
I/O's										
Magnetic/switching Pickup	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Discrete alarm inputs (configurable)	16	16	16	16	16	16	16	16	16	16
Relay outputs (configurable)	7	7	7	7	7	7	7	7	7	7
Analog inputs (configurable) #6		7	7	7	7		7	7	7	7
Analog outputs 0/4 to 20 mA (configurable)		2	2	2	2		2	2	2	2
External operation mode selection via DI		✓	✓	✓	✓		✓	✓	✓	✓
CAN bus comm., Guidance level #7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CAN bus comm., Engine level #8					✓					✓
RS-232 comm., Engine level #9				✓					✓	
LS 4 - Circuit Breaker Control #10		✓	✓	✓	✓					
Listings/Approvals										
CE Marked	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UL/cUL Listed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Part numbers P/N										
Measuring inputs 100 Vac, ../5 A (8440-	-1609	-1554	-1558	-1562	-1560	-1613	-1570	-1574	-1578	-1576
Measuring inputs 400 Vac, ../5 A (8440-	-1610	-1555	-1559	-1563	-1561	-1614	-1571	-1575	-1579	-1577

#1 External unit LS 4 necessary
#2 In isolated parallel operation with min. 2 gensets in parallel
#3 Cable incl. software necessary (DPC; P/N 5417-557)
#4 n = speed; f = frequency; V = voltage, P = real power; Q = reactive power
#5 +/-20 mA and +/-10 Vdc and PWM signal (type and range configurable); bias/discrete setpoint via relay manager
#6 [T1]-[T3] = 0/4 to 20 mA, [T4]/[T5] = Pt100, [T6] = VDO 0 to 180ohm, [T7] = VDO 0 to 380ohm; function of 20 mA inputs is configurable between alarm input, remote setpoint value for generator real power, mains import/export real power measuring value; others upon request
#7 Remote monitoring, control, configuration (GW 4 could be used for several interfaces; refer to product specs 37170 / manual 37360)
#8 CAN bus connection to IKD1, mtu MDEC, mtu ADEC, Volvo EMS2, Scania EMS/S6, CAN SAE J1939 and/or ST3 (configurable; refer to manual 37382)
#9 RS-232 connection via Caterpillar CCM to Caterpillar EMCP-II, and ECM (configurable; refer to manual 37200)
#10 External unit LS 4 (refer to product specs 37167 / manual 37105)

GENERATOR CONTROLLER

The Commander System

The Commander control system is based on a modular design, enabling flexible solutions using the very best in automation technology. Components of the Commander control system are:

- Commander Master Controller
- Commander Software
- Commander Communications
- Generator Controller
- Feeder Controller

The central focus of the Commander control system is a comprehensive data pool that is formulated using data collected from the Commander Master Controller, Generator Controller and Feeder Controller. The values contained in the data pool can be visualised via the IPSview software and can be accessed locally in the power station or remotely via a dial up connection.

The values in the data pool are sampled on a priority basis, ensuring that all activities and actions are managed in a safe and efficient manner within the power station. The data pool is a key element of the software architecture and as such provides visual representation, alarm reporting and plant information in a high speed environment, aiding accurate data analysis and trending of data.

General Description & Function

OVERVIEW

The Generator Controller is primarily a microprocessor based control unit capable of controlling, monitoring and displaying all aspects of diesel or gas generator set operation. The genset may be used for isolated applications.

The Generator Controller is designed to provide total control for medium sized to big applications with multiple gensets.

Up to 8 Generator Controller units can be operated in parallel on the same field-bus.

BASIC FEATURES

- Complete engine, generator, and mains protection and controller into one unit.
- True RMS sensing.
- Synchronisation for one breaker.
- Load/var sharing
- Counters for kWh, engine starts, operating hours, maintenance call.
- Freely configurable discrete and analog alarm inputs.
- Freely configurable relay and analog outputs.
- PC and front panel configurable.
- CAN bus based communication.
- UL/cUL Listed.

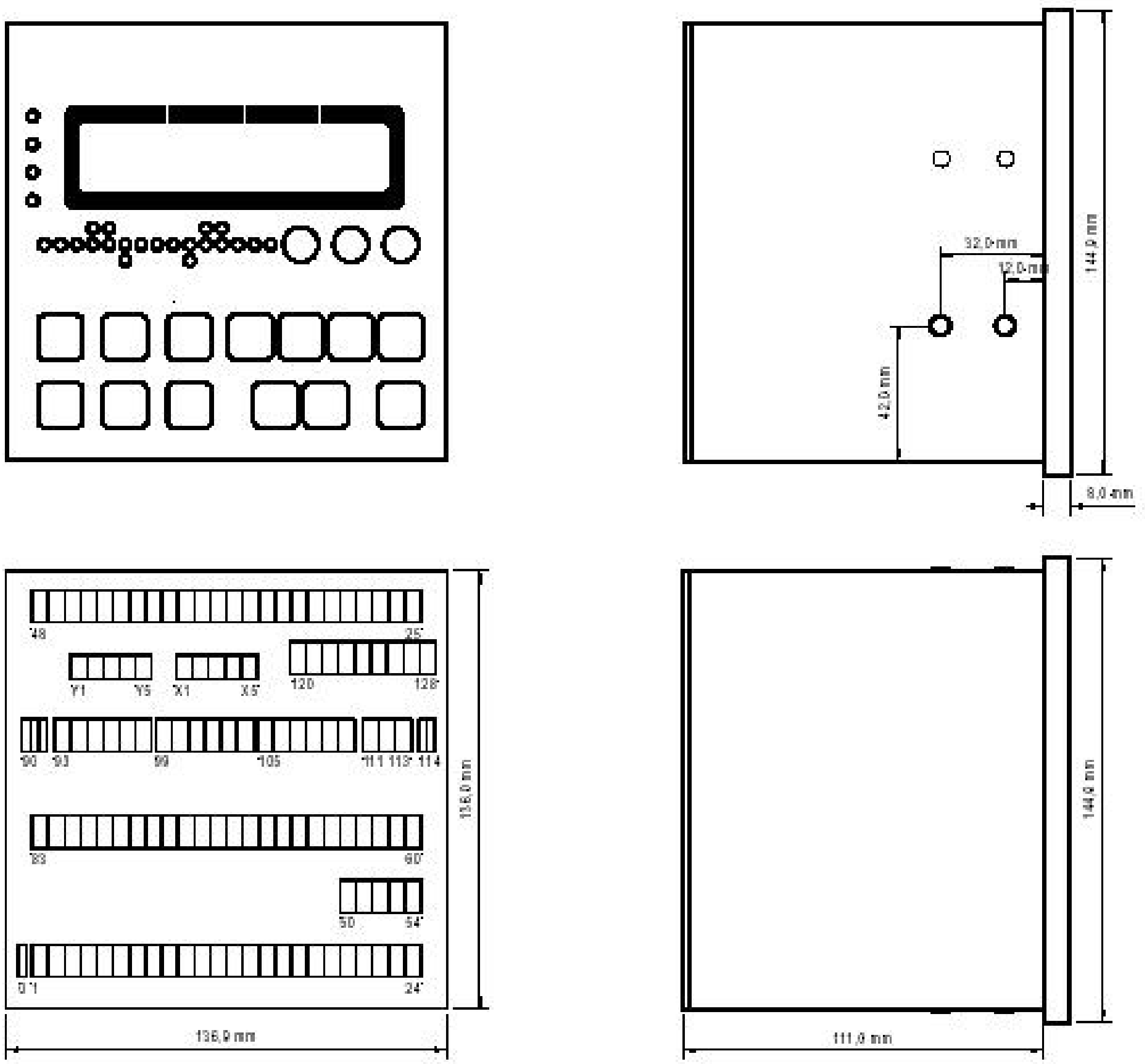
FEATURES

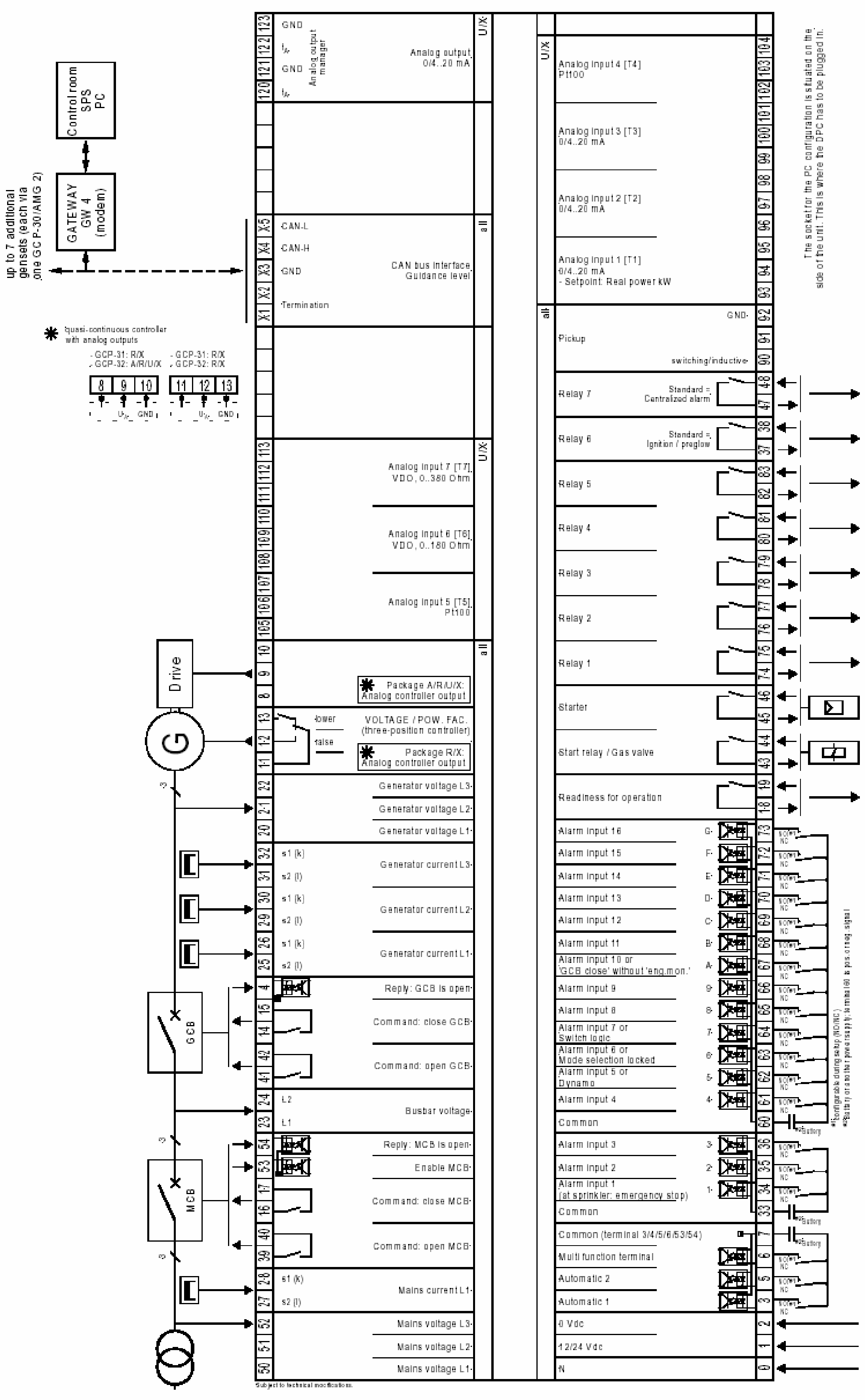
- True RMS 6x voltage (gen/bus)
- True RMS 3x current (gen)
- Start/stop logic for diesel/gas engines
- Engine pre-glow or purge control
- Battery voltage monitoring
- Speed control with overspeed monitoring
- kWh/oper.hours/start/maintenance counter
- Configurable trip/control set points
- Configurable delays for each protection
- Magnetic/switching Pickup input
- 16 configurable discrete alarm inputs
- 5 configurable/programmable relays
- Two-line LC display
- Synchroscope
- Push-buttons for direct control
- CAN bus communication
- Multi level password protection

TECHNICAL DATA

Accuracy	Class 1
Power supply	24 Vdc (9.5..32 Vdc)
Intrinsic consumption	max. 15 W
Ambient temperature	-20..70 °C
Ambient humidity	95 %, non-condensing
Voltage Rated:	[1] 57/100(120) Vac or [4] 230/400 Vac
UL:	[1] max. 150 Vac or [4] max. 300 Vac
Setting range:	[1] 50..125 Vac or [4] 200..440 Vac
Measuring frequency	50/60 Hz (40..70 Hz)
Linear measuring range up to	1.3×Un
Input resistance	[1] 0.21 MΩ, [4] 0.7 MΩ
Max. power consumption per path	< 0.15 W
Current#	[../1] ../1 A or [../5] ../5 A
Current-carrying capacity	Igen = 3.0×In Imains = 1.5×In
Load	< 0.15 VA
Rated short-time current (1 s)	[../1] 50×In, [../5] 10×In
Discrete inputs	metallically separated
Input range	12/24 Vdc (4..40 Vdc)
Input resistance	approx. 6.7 kΩ
Relay outputs	metallically separated
Contact material	AgCdO
Load (GP)	24 Vdc@2 Adc, 250 Vac@2 Aac
Pilot duty (PD)	24 Vdc@1 Adc
Analog input#	freely scaleable
Type	0/4..20 mA, Pt100, VDO
Resolution	10 Bit
Analog output	metallically separated
Type	0/4..20 mA, freely scaleable
Resolution	8/12 Bit (depending on model)
Max. load 0/4..20 mA	500 Ω
Insulating voltage	3,000 Vdc
Housing	Type APRANORM DIN 43 700
Dimensions	144×144×118 mm
Front cutout	138×136 mm
Connection	screw/plug terminals depending on connector 1.5 mm² or 2.5 mm²
Front	insulating surface
Protection system	IP 21
Weight	depending on version, approx. 1,000 g
Disturbance test (CE)	tested according to applicable EN guidelines
Listings	UL/cUL listed (voltages up to 300 Vac) for ordinary loc., file E212970

DIMENSIONS





Benefits

- Remote control and monitoring
- Reduced fuel consumption
- Reduced operation and maintenance costs
- Easy asset management
- Better genset efficiencies
- Reduced need for on-site staff

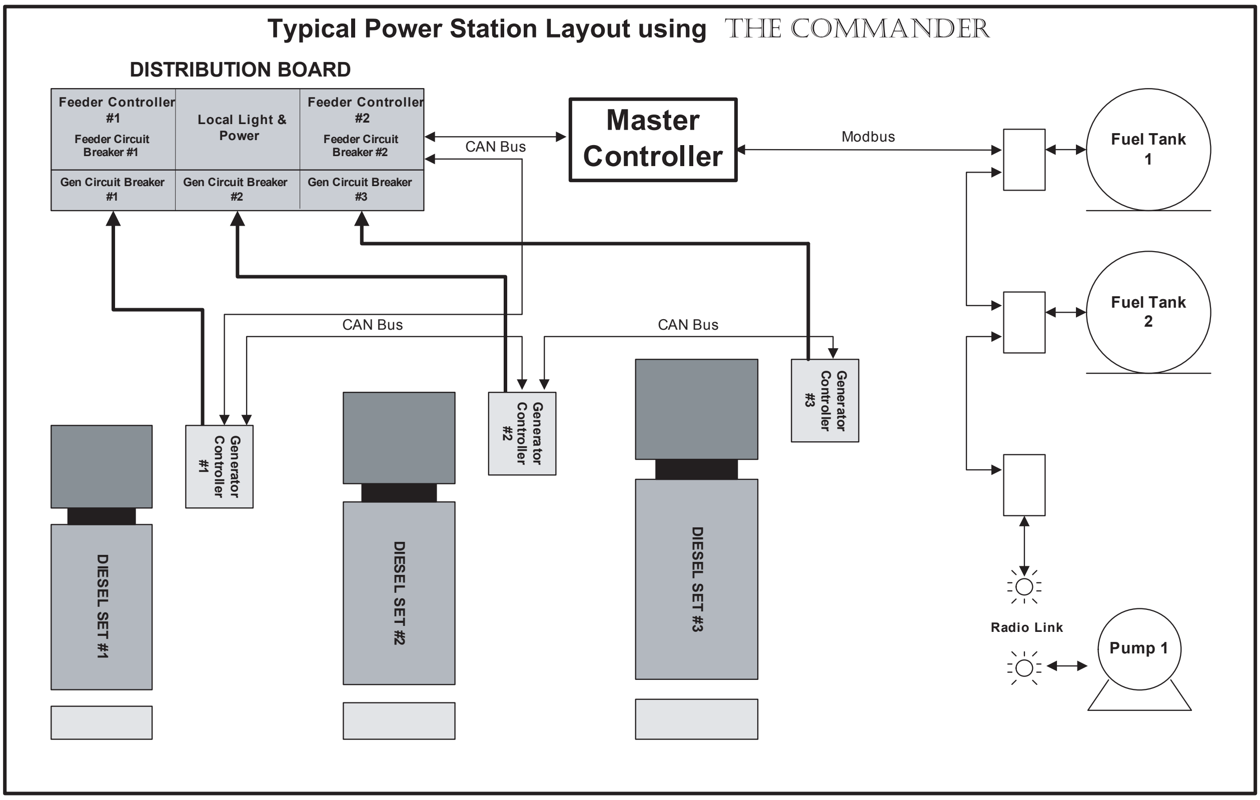
Applications

- Mining operations
- Telecommunication sites
- Defence applications
- Remote or island communities
- Hotel and tourist resorts
- Individual towns or villages
- Industrial estates
- Emergency services and disaster relief
- Construction sites

Unique Features

- User friendly, parameter driven interface.
- Fax or voice annunciations for automotive alarms.
- Optional performance reporting based on Web access to a Data Server.
- Ethernet service interface.
- User configurable trending of all power station readings.
- Mission critical control (i.e. load shedding) achieved via CAN bus.
- Ability to interface to diesel and/or gas generators.
- High flexibility for future changes to the power station configuration.
- Compatibility to most prime mover types.
- Distributed architecture of the control system minimises the risk of outages from a single hardware failure.

Typical Application for the Generator Controller



Future Features for Commander

The following table contains a list of features that are currently under development. These features will be included in future releases of the Commander software.

Feature	Description
Commander Master Controller Time Synchronisation	The time in the Commander Master Controller is set during the manufacturing process. Currently it cannot be changed, although the time zone to adjust the clock to your local time can be changed. In the next release of the Commander Master Controller, the time will be automatically adjusted to synchronise with the computer that IPSview is installed on.
IPSview Multiple Users Access	More than one user can access the Commander Master Controller using IPSview. However, the Commander Master Controller can currently only administer one user. This means that when more than one user is connected, they both share the same access level. Future upgrades will allow user names and passwords for multiple users.

Commander Package

The Commander package includes the following items:

- Commander Master Controller
- Generator Controller
- Feeder Controller
- IPSview software
- Folder with manuals
- RJ-45 Communication crossover cable
- Commander Master Controller 24VDC power supply plug
- Power pack 100-240Vac/50-60Hz/50W, 24dc
- Modem
- Modem RS232 cable
- CAN bus termination plug
- WAGO Remote I/O Interface

Other Commander Product Specifications Available

- Commander Master Controller Product Specification
- Feeder Controller System Product Specification
- Commander Communications Product Specification
- Commander Software Product Specification

More Information

For more information or queries about Commander please contact us direct or visit our website. We look forward to hearing from you!

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COMMANDER MASTER CONTROLLER

The Commander System

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- Commander Master Controller
- Commander Software
- Commander Communications
- Generator Controller
- Feeder Controller

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The values in the data pool are sampled on a priority basis, ensuring that all activities and actions are managed in a safe and efficient manner within the power station. The data pool is a key element of the software architecture and as such provides visual representation, alarm reporting and plant information in a high-speed environment, aiding accurate data analysis and trending of data.

General Description & Function

The Commander system enables a power station to operate automatically without human intervention, except for monitoring, maintenance of plant and fuel supplies.

The controllers used in the Commander control system are:

- Commander Master Controller
- Generator Controller
- Feeder Controller

The Commander Master Controller automatically controls and monitors all diesel and/or gas generator sets, consumer feeders and fuel tanks in a power station. It provides alarm/event reporting, trending, remote access and external alarm notification.

Depending on system load conditions, the Commander Master Controller starts and stops generators to optimise station fuel efficiency. The Commander Master Controller maintains optimum loading and spinning reserve on all in-service generator sets. The Commander Master Controller power management continuously monitors the feeder load and matches the most economical configuration of the generator sets to the demand. By doing so it ensures that the following criteria are met:

- Maintaining the required spinning reserve
- Optimising the loading of generator sets
- Preventing low loading of generator sets

The Commander Master Controller is based on an open controller hardware architecture. Embedded industrial PC hardware is used with distributed I/O to achieve mission critical and highly reliable power station control. The Commander Master Controller is specifically designed for power station applications and can withstand temperatures between -40ºC and +50ºC.

Communications between the Commander Master Controller, the generator sets and the consumer feeder circuit breakers takes place via fieldbus using the CAN protocol.

(Commander Master Controller)

The Commander Master Controller enables fuel savings due to better loading of generator sets and fewer operation and maintenance costs due to much improved management of plant assets.

The Commander Master Controller is able to control and monitor:

- Up to 8 Generator Controllers.
- Up to 6 Feeder Controllers.
- An additional 1 Feeder Controller for use as a Local Light and Power Meter.
- Up to 12 Bulk Fuel Storage Tanks.
- Up to 3 Temperature Measurement Inputs.

TECHNICAL DATA

Standard Features

CONTROL

- Diesel and/or gas generator manual / operator / auto control for up to 8 generators.
- Feeder manual / operator / auto control for up to 6 HV or LV feeders.
- Station automatic black start.
- Configuration management for automatic call-up of generators.
- Automatic call-up of replacement gensets before an alarm shutdown.
- Automatic connection and disconnection of consumer feeders (load shedding).

MONITORING

- Station data monitoring, recording and trending.
- Generator data monitoring, recording and trending.
- Feeder data monitoring, recording and trending.
- Fuel farm monitoring.
- Remote control and monitoring access.
- Monitoring of station batteries and battery charger.
- Alarm/event reporting, trending, remote control and external alarm notification via voice, or fax.

OTHER

- Automatic upload of data records and trends to a central remote database (eg a head office).
- Parameter driven operation.
- Up and download facility of parameter sets.
- RS232 service interface.
- The Commander Master Controller meets UL and CE approval requirements .

Hardware Features

The Commander Master Controller hardware is based on an industrial PC platform, especially designed for rugged industrial environments.

- Dimensions (W x D x H)…………… 228 x 143 x 92mm
- Weight……………………………………………….…… 2 kg
- Fan………………………………… Operates without fan
- Nominal supply voltage range.………………10 to 30Vdc
- Max. power consumption at rated voltage.…………………………….Maximum 13.2W
- Ambient humidity.……………………5% - 90% at +40ºC Non-condensating
- Operating temperature.……………………… 0ºC to 50ºC
- Storage temperature.…………………….… -40ºC to +50ºC
- Flammability…………………………….………….… 94V-0
- Vibration………………………..… TBD G @ 5 to TBD Hz
- Incorporated CAN bus for direct connection to Generator Controller and Feeder Controller
- Additional Modbus interface for connection with auxiliary devices
- Service laptop interface via Ethernet 10BaseT
- Warranty……………………………………….. 12 months
- Standards:
  - UL approval E214940
  - CE compliant, EN 50082-2 (immunity) and EN50081-2/55022 (emission)
- Optional extended operating temperature range of -40ºC to +50ºC

Software Features

Please refer to the Commander Software Product Specification for more details.

- Full automatic operation of power station plant.
- Real-time visualisation of the power station.
- Visualisation of individual generators and feeders via data on CAN bus.
- Secured access to all parameters including those in the Generator Controller.
- Customisable via user configurable files.
- Trending of all power station data including generators and feeders.

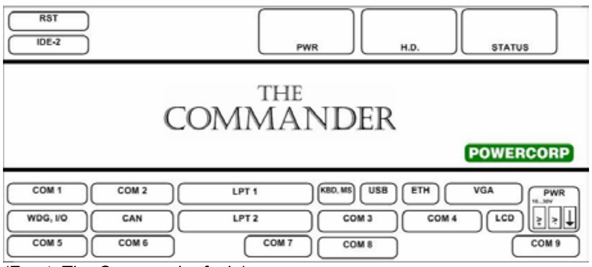
Communication Features

Please refer to the Commander Communications Product Specification for more details

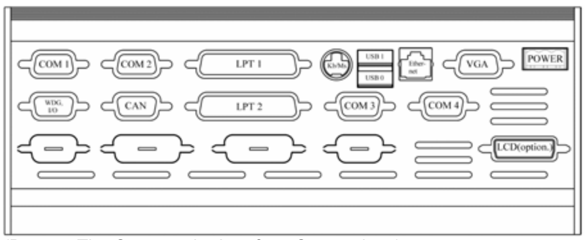
- Interfacing to the diesel generators, feeders and fuel tanks is realised via fieldbus – using CAN bus and Modbus.

- Physical Layers:
  - CAN bus
  - Ethernet 10baseT
  - Serial RS232 point-to-point link
  - Serial RS-422/RS-485

- Communication protocols:
  - CAN 2.0 Part A
  - TCP/IP
  - Modbus/TCP and Modbus RTU



(Front: The Commander facia)



(Bottom: The Commander Interface Connections)

Control Functions

Station Automatic Control
- Automatic station black start.
- Spinning reserve management.
- Station overload feeder load shedding.
- Station under frequency feeder load shedding.

Generator Control
- Semi-automatic (operator) control of each generator.
- Automatic generator starting and stopping based on engine priorities.
- Automatic call-up of replacement generators before alarm shutdown.
- Fuel consumption recording.

Feeder Control
- Semi-automatic (operator) control of each feeder.
- Automatic feeder closing during black start.
- Automatic feeder load shedding based on station overload.
- Automatic feeder load shedding based on station under frequency.
- Automatic feeder rotation in case of lack of generation capacity.
- Priority based feeder connection and disconnection.

Monitoring Functions

Bulk Fuel Storage Tanks
- Tank alarm reporting for low levels.
- Individual size volume calculations.
- Supervision of the Commander Master Controller to tank level sensor communication system.

Temperature Measurement Inputs
- Analogue temperature measurement (for example, engine hall temperature).
- Supervision of the Commander Master Controller to temperature sensor communication system.

Alarm Monitor
- External alarm notification using voice and fax.
- Voice messaging of alarms to multiple telephone numbers.
- Fax messaging of alarms to multiple facsimile numbers.
- Alarm filtering to send highest priority alarms first.

Data Recording
- Station load, frequency, voltage etc.
- Station number of blackouts, total station outage time etc.
- Generator power, temperatures, currents.
- Generator kWh, engine hours, fuel consumptions etc.
- Feeder power, frequency, voltage
- Feeder kWh, number of open/close cycles, total feeder outage time etc
- Tank levels, tank volume
- Temperatures

Other Functions

Operator Interface
- Real-time visualisation of the power station.
- Access to semi-automatic (operator) control of generators.
- Access to semi-automatic (operator) control of feeders.
- Viewing of trending/graphic information.
- Password protection.
- Access to parameters for system commissioning and setup.

Remote Access
- Remote control of the power station.
- Remote monitoring of the power station.
- Remote alarm reset.
- Remote access to trending information.
- Remote access to parameters.

Operation Modes

Each device (generator sets, feeders) controlled by the Commander Master Controller can operate in one of three modes:

- **Operation Mode – MANUAL**

  If a sub-system is in manual operation, all commands from the Commander Master Controller are isolated from the manual control system. This means that the Commander Master Controller has no control over the dedicated device. In manual operation, interference of operations via the SCADA system or the Commander Master Controller is impossible. The Commander Master Controller continues to log alarms recorded on the devices, as well as to monitor device status but no control functions take place.
- **Operation Mode – AUTOMATIC**

  If a sub-system is in automatic operation it is automatically controlled by the Commander Master Controller. Manual controls are overridden by the Commander Master Controller commands. In this operation mode manual controls at the device switchboards are disabled.
- **Operation Mode – OPERATOR**

  In operator mode each device can be started via the on-site or remote SCADA system. In this operation mode manual controls at the device switchboards are disabled.

The Commander Master Controller monitors the status of each device in the power station. Every time an event occurs that has been customised to trigger an alarm, an alarm is logged for that device. Alarms can be viewed on the Operator Interface using the IPSview software.

ALARMS

Types of alarms:

- **SYSTEM ALARM (SA)**

  The Commander Master Controller monitors and check the status of the communication to all devices. If an abnormal situation occurs, the Commander Master Controller raises a system alarm. System alarms are generated by the Commander Master Controller, not individual device controllers. System alarms reset automatically once the alarm condition has been rectified.
- **WARNING ALARM (WA)**

  The operation of the power station is uninterrupted and the device continues to function normally. The operator should investigate the cause of the warning alarm in due course. The warning alarm will be reset when the alarm condition has been rectified.
- **NON-CRITICAL ALARM (NCA)**

  Non-critical alarms only occur on the generators. The operation of the power station is uninterrupted but the Commander Master Controller starts replacement generators and takes the generator with the non-critical alarm off line when sufficient replacement capacity is online. The operator should investigate the cause of the non-critical alarm immediately. The non-critical alarm will be reset when the alarm condition has been rectified and the operator has acknowledged the alarm.
- **CRITICAL ALARM (CA)**

  The operation of the power station may be interrupted, potentially causing a blackout. The Commander Master Controller attempts to stabilise the power system and restore grid voltage and frequency. The operator should investigate the cause of the critical alarm immediately. The critical alarm will be reset when the alarm condition has been rectified and the operator has acknowledged the alarm.

Station Alarms

Defines the various alarms that can occur in the power station.

- Station Black Alarm.
- Station No Generators Alarm.
- Station No Feeders Alarm.
- Station Power Supply Failed Alarm.
- Station Fire Alarm.
- Station Battery Charger Failed Alarm.
- Station Under Frequency Alarm.
- Station Over Load Alarm.
- Station Intruder Alarm.
- Station Lack of Capacity Alarm.
- Station Temperature Communications Alarm.
- Station LLP (Local Light & Power) Power Monitor Alarm.
- System CPU Over Temperature Alarm.
- System CMOS Battery Low Alarm.
- System CPU Watchdog Alarm.
- System Parameter Write Alarm.
- System Operation Data Lost Alarm.
- System Reboot Alarm.
- System Fatal Alarm.
- Station Emergency Stop Alarm.

Tank Alarms

Defines the various alarms that can occur on each fuel tank

- Tank Empty Alarm.
- Tank Low Alarm.
- Tank I/O Alarm.
- Tank Communications Alarm.

Generator Alarms

The Commander Master Controller logs these general alarms for each generator. Specific generator alarms (like under voltage or loss of coolant) are monitored at the Generator Controller level and can be viewed on the front panel of the Generator Controller or using the IPSview software.

- Generator Warning Alarm.
- Generator Non-Critical Alarm.
- Generator Critical Alarm.
- Generator Fail to Open Alarm.
- Generator Fail to Start Alarm.
- Generator Fail to Stop Alarm.
- Fail to Synchronise Alarm.
- Generator Power Monitor Alarm.
- Generator Digital I/O Alarm.

Feeder Alarms

Defines the various alarms that can occur on an individual feeder

- Feeder Trip Alarm.
- Feeder Fail to Close Alarm.
- Feeder Fail to Open Alarm.
- Feeder Sensitive Earth Fault (HV) Alarm.
- Feeder Earth Fault (LV) Alarm.
- Feeder Over Current Alarm.
- Feeder Power Monitor Alarm.
- Feeder Digital IO Alarm.

The Commander Master Controller monitors changes in the state of each device in the power station. Every time a change occurs, an event is logged for that device. Events can be viewed on the Operator Interface using the IPSview software.

Station Events

- Station Initialisation State.
- Station Stop State.
- Station Power-up State.
- Station Run State.
- Station Shutdown State.

Generator Events

Generator Commands

The Commander Master Controller can issue the following commands to a Generator Controller:

- Online command.
- Offline command.
- Operator command.
- Automatic command.
- Alarm reset command.
- Service done command.
- Clear start command.
- First start command.
- Last start command.
- Start command.
- Close command.
- Open command.
- Unload command.
- Stop command.

Generator States

The Commander Master Controller receives the following feedback information from a Generator Controller:

- Stop state.
- Run state.
- Circuit breaker open state.
- Circuit breaker closed state.
- Temperature derating state.
- Starting state.
- Stopping state.
- Black bus state.
- Pre-glow state.
- Warm up state.
- Synchronization state.
- Unload state.
- Cool down state.
- Healthy state.
- Alarm state.

Generator Modes

A generator can operate in the following modes:

- Manual mode.
- Operator mode.
- Auto mode.
- First start mode.
- Last start mode.

Feeder Events

Feeder Commands

The Commander Master Controller can issue the following commands to a Feeder Controller:

- Close command.
- Open command.
- Operator command.
- Automatic command.
- Alarm reset command.

Feeder States

The Commander Master Controller receives the following feedback information from a Feeder Controller:

- Open state.
- Closed state.
- Closing state.
- Opening state.
- Black Bus state.
- Healthy state.
- Alarm state.

Feeder Modes

A feeder can operate in the following modes:

- Manual mode.
- Operator mode.
- Automatic mode.

Parameter Overview

The following lists contain the parameters that can be changed using the IPSview software. The parameters can be changed locally or via remote control. The parameters are protected by a series of security levels as follows:

Level 0: Read only level.
Level 1: Operator password level is required to change the parameter.
Level 2: Maintenance password is required to change the parameter.
Level 3: Engineer password is required to change the parameter.
Level 4: Commissioning password is required to change parameter.

Station Manager Parameters

Parameter Name	Unit	Minimum	Maximum	Password
Station local light and power demand	kW	0	100	3
Station averaging time for generated power	sec	0	100	3
Station minimum long-term spinning reserve	kW	0	1000	3
Station minimum short-term spinning reserve	kW	0	1000	3
Station spinning reserve	kW	0	1000	3
Station averaging time for the long-term	min	1	60	3
Station averaging time for the short-term	sec	1	600	3
Station number of black start attempts	-	0	5	3
Station commissioned date	-	01/01/1970	31/12/2039	4
Station control mode	-	0	1	5
Station local light and power meter	-	0	1	4
Station number of demand managed devices	-	0	12	5
Station number of feeders	-	0	6	5
Station number of generators	-	0	8	5
Station number of fuel tanks	-	0	12	5

System Parameters

Parameter Name	Unit	Minimum	Maximum	Password
System IP address	-	0	FFF FFF FFF FFF	5
System netmask address	-	0	FFF FFF FFF FFF	5
System engineering password	-	0	0	5
System ID	-	0	99999999	3
System I/O Configuration of the CPU	-	0	0xFFFF	5
System maintenance password	-	0	99999999	5
System operator password	-	0	99999999	5
System commissioning password	-	0	99999999	5

System I/O Parameters

Parameter Name	Unit	Minimum	Maximum	Password
System CAN Bus Timeout	sec	0	9999999	4
Control room temperature normalisation high boundary	degC	-1000.00	1000.00	5
Control room temperature normalisation low boundary	degC	-1000.00	1000.00	5
Control room temperature sensor high boundary	-	-32767	32768	5
Control room temperature sensor low boundary	-	-32767	32768	5
Engine room temperature normalisation high boundary	degC	-1000.00	1000.00	5
Engine room temperature normalisation low boundary	degC	-1000.00	1000.00	5
Engine room temperature sensor high boundary	-	-32767	32768	5
Engine room temperature sensor low boundary	-	-32767	32768	5
Outside ambient temperature normalisation high boundary	degC	-1000.00	1000.00	5
Outside ambient temperature normalisation low boundary	degC	-1000.00	1000.00	5
Outside ambient temperature sensor high boundary	-	-32767	32768	5
Outside ambient temperature sensor low boundary	-	-32767	32768	5
Control room temperature register address	-	0	6	5
Control room temperature slave address	-	0	255	5
Engine room temperature register address	-	0	6	5
Engine room temperature slave address	-	0	255	3
Outside ambient temperature register address	-	0	6	5
Outside ambient temperature slave address	-	0	255	5

Generator Manager Parameters

Parameter Name	Unit	Minimum	Maximum	Password
Generator configuration table	-	0x0	0xE0FF	2
Generator configuration priorities	-	0x0	0x-FFFFFFFF	2
Generator kilowatt hysteresis	kW	0	500	3
Generator percentage hysteresis	-	0	100	3
Generator actual power smoothing	sec	0	100	3
Generator power configuration setpoint smoothing	sec	0	100	3
Generator reset minimum load long-term	kW	0	100	3
Generator configuration minimum run time	min	0.0	180.0	2
Generator off separation time	sec	10	900	3
Generator black start configuration	-	0	255	-
Generator call-up strategy	-	1	3	2

Generator Parameters

Parameter Name	Unit	Minimum	Maximum	Password
Generator # fuel pulse scaling	Litres/pulse	0.0000	99.0000	5
Generator # maximum derating percentage	-	0.0	100.0	2
Generator # optimum operating range lower limit	-	0.0	100.0	2
Generator # optimum operating range upper limit	-	0.0	100.0	2
Generator # prime power rating	kW	0	2000	2
Generator # temperature derating lower limit	degC	0.0	120.0	2
Generator # temperature derating upper limit	degC	0.0	120.0	2
Generator # minimum run time	min	0.00	180.00	2
Generator # open timer	sec	0	900	3
Generator # start timer	sec	0	900	3
Generator # stop timer	sec	0	900	3
Generator # synchronisation timer	sec	0	900	3
Generator # control type	-	0	341	5
Generator # fuel economy update counter	kWh	0	200	3
Generator # manager type	-	1	3	3

Feeder Manager Parameters

Parameter Name	Unit	Minimum	Maximum	Password
Feeder overload	-	0.00	150.00	3
Feeder averaging time for the power demand	sec	0.01	750.00	3
Feeder time close next	sec	0.00	600.00	3
Feeder overload delay time	sec	0.00	3600.00	3
Feeder tie shed next	sec	0.01	20.00	3
Feeder underfrequency delay time	sec	0.00	10.00	3
Feeder underfrequency	Hz	0.00	60.00	3
Feeder close strategy	-	0	2	3

Feeder Parameters

Parameter Name	Unit	Minimum	Maximum	Password
Feeder # minimum power demand	kW	0.00	2000.00	3
Feeder # power demand safety factor	-	0	200	2
Feeder # closing time	sec	0.00	900.00	2
Feeder # opening time	sec	0.00	900.00	3
Feeder # maximum outage time	min	0.00	180.00	2
Feeder # reconnection delay time	min	0.00	180.00	3
Feeder # extended open time	sec	0.0	60.0	2
Feeder # control type	-	0	117	3
Feeder # priority	-	0	6	2

Tank Parameters

Parameter Name	Unit	Minimum	Maximum	Password
Tank # capacity	litres	0	99999	5
Tank # diameter	mm	0	99999	5
Tank # empty level	litres	0	999999	4
Tank # length	mm	0	99999	5
Tank # low level	-	0	100.00	4
Tank # fuel level normalisation low boundary	litres	-99999.00	99999.00	5
Tank # fuel level normalisation low boundary	litres	-99999.00	99999.00	5
Tank # fuel level sensor high boundary	-	-32767	32768	5
Tank # fuel level sensor low boundary	-	-32767	32768	5
Tank # fuel level register address	-	0	6	5
Tank # fuel level slave address	-	0	255	5

Alarm Notification Parameters

Parameter Name	Unit	Minimum	Maximum	Password
Alarm monitor time off	sec	2	1800	-
Alarm monitor communications port	-	0	6	-
Alarm monitor fax configuration	-	0	100	-
Alarm monitor fax minimum retries	-	0	9	-
Alarm monitor fax time before redial	sec	2	1800	-
Alarm monitor phone configuration	-	0	15	-
Alarm monitor phone maximum retries	-	0	9	-
Alarm monitor phone time before redial	sec	2	1800	-
Alarm monitor time delay	sec	0	1800	-

Benefits

- Remote control and monitoring
- Reduced fuel consumption
- Reduced operation and maintenance costs
- Easy asset management
- Better genset efficiencies
- Reduced need for on-site staff

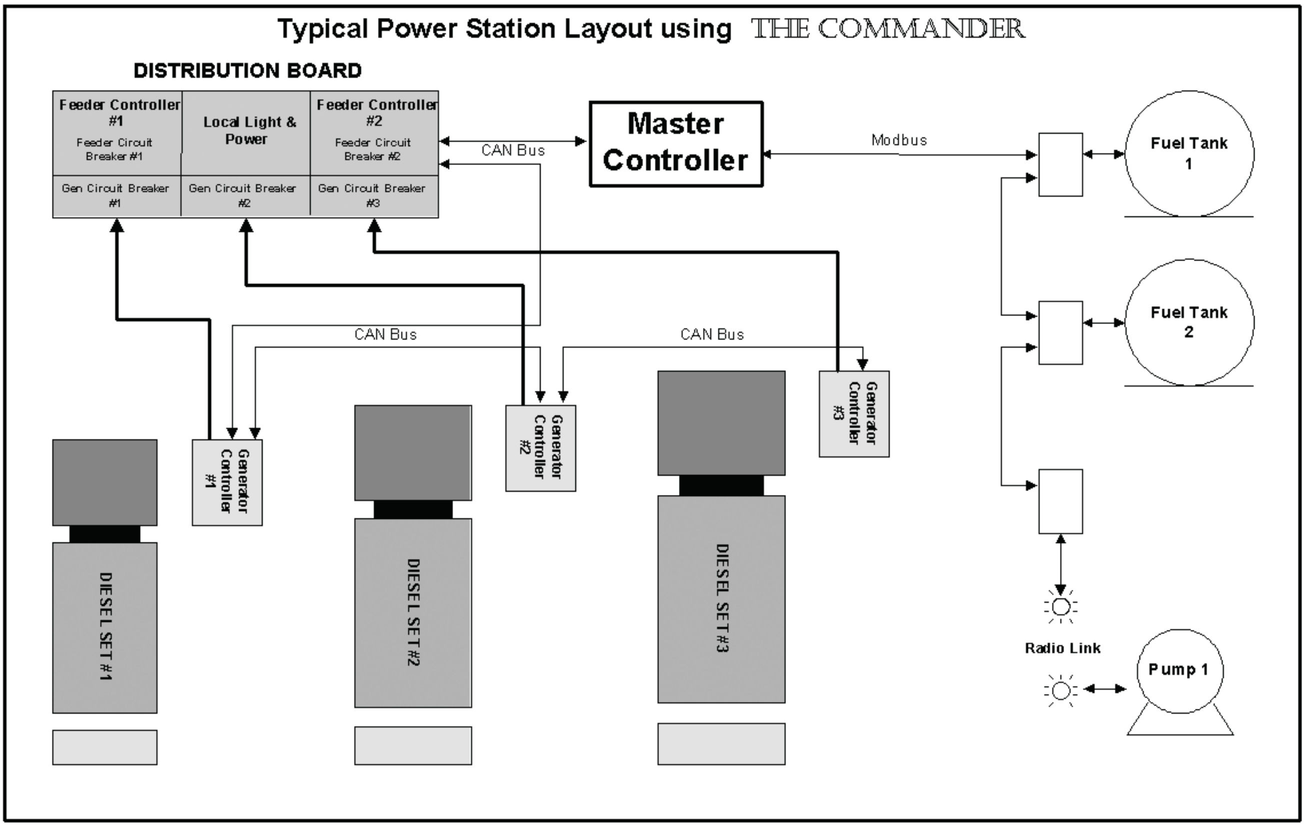
Applications

- Mining operations
- Telecommunication sites
- Defence applications
- Remote or island communities
- Hotel and tourist resorts
- Individual towns or villages
- Industrial estates
- Emergency services and disaster relief
- Construction sites

Unique Features

- User friendly, parameter driven interface.
- Fax or voice annunciations for automotive alarms.
- Optional performance reporting based on Web access to a Data Server.
- Ethernet service interface.
- User configurable trending of all power station readings.
- Mission critical control (i.e. load shedding) achieved via CAN bus.
- Ability to interface to diesel and/or gas generators.
- High flexibility for future changes to the power station configuration.
- Compatibility to most prime mover types.
- Distributed architecture of the control system minimises the risk of outages from a single hardware failure.

Typical Application



Future Features for Commander

The following table contains a list of features that are currently under development. These features will be included in future releases of the Commander Master Controller software.

Feature	Description
Commander Master Controller Time Synchronisation	The time in the Commander Master Controller is set during the manufacturing process. Currently it cannot be changed, although the time zone to adjust the clock to your local time can be changed. In the next release of the Commander Master Controller, the time will be automatically adjusted to synchronise with the computer that IPSview is installed on.
IPSview Multiple Users Access	More than one user can access the Commander Master Controller using IPSview. However, the Commander Master Controller can currently only administer one user. This means that when more than one user is connected, they both share the same access level. Future upgrades will allow user names and passwords for multiple users.

Commander Package

The Commander package includes the following items:

- Commander Master Controller
- Generator Controller
- Feeder Controller
- IPSview software
- Folder with manuals
- RJ-45 Communication crossover cable
- Commander Master Controller 24VDC power supply plug
- Power pack 100-240Vac/50-60Hz/50W, 24dc
- Modem
- Modem RS232 cable
- CAN bus termination plug
- RS232/485 converter

Other Commander Product Specifications Available

- Generator Controller Product Specification
- Feeder Controller Product Specification
- Communications Product Specification
- Commander Software Product Specification

More Information

For more information or queries about Commander please contact us direct

or visit our website. We look forward to hearing from you!

www.pcorp.com.au

The Powercorp Group

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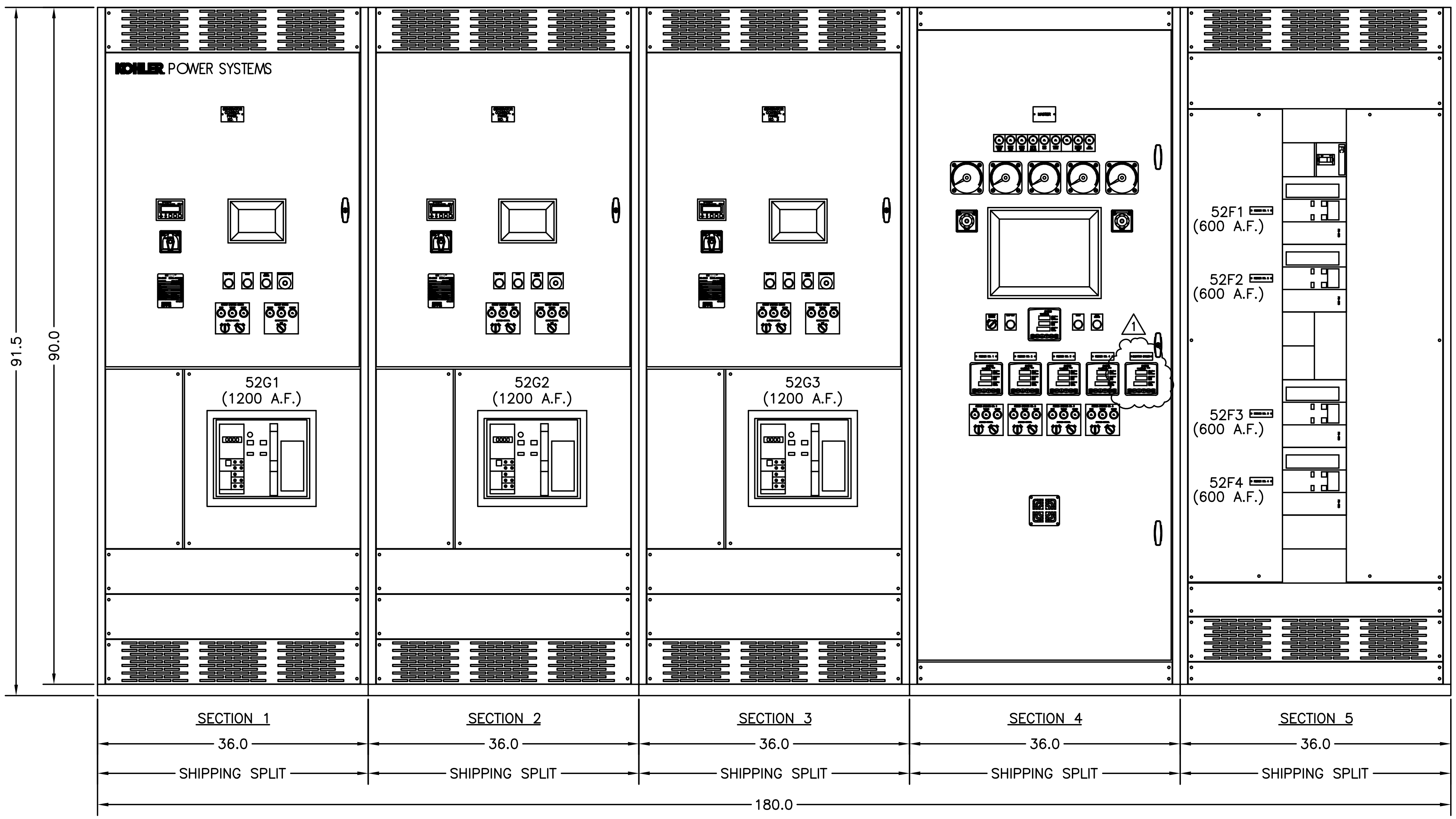
Web: www.pcorp.com.au

Physical: Export Drive, Darwin Business Park, Berrimah, Northern Territory, Australia, 0828
Postal: PMB 88, Berrimah, Northern Territory, Australia, 0828

UL LISTING: UL891
COLOR: ANSI 49 GRAY
NOTES: 1. NEMA 1 CONSTRUCTION, FREE STANDING—FLOOR SUPPORTED. 2. DESIGNED FOR FRONT ACCESS ONLY. 3. CONTROL DOORS SUPPLIED WITH LOCKABLE HANDLES AND COMMON KEYING.
APPROX. WEIGHTS: SECTION 1: 1400 LBS. SECTION 2: 1400 LBS. SECTION 3: 1400 LBS. SECTION 4: 1200 LBS. SECTION 5: 1300 LBS.



FRONT VIEW

CAE GENERATED DRAWING			
REV	DATE	REVISION	BY
–	4–27–05	NEW DRAWING [74905]	DDD
1	1–9–06	ADDED "ELECTRIC BOILER" LABEL	JAF

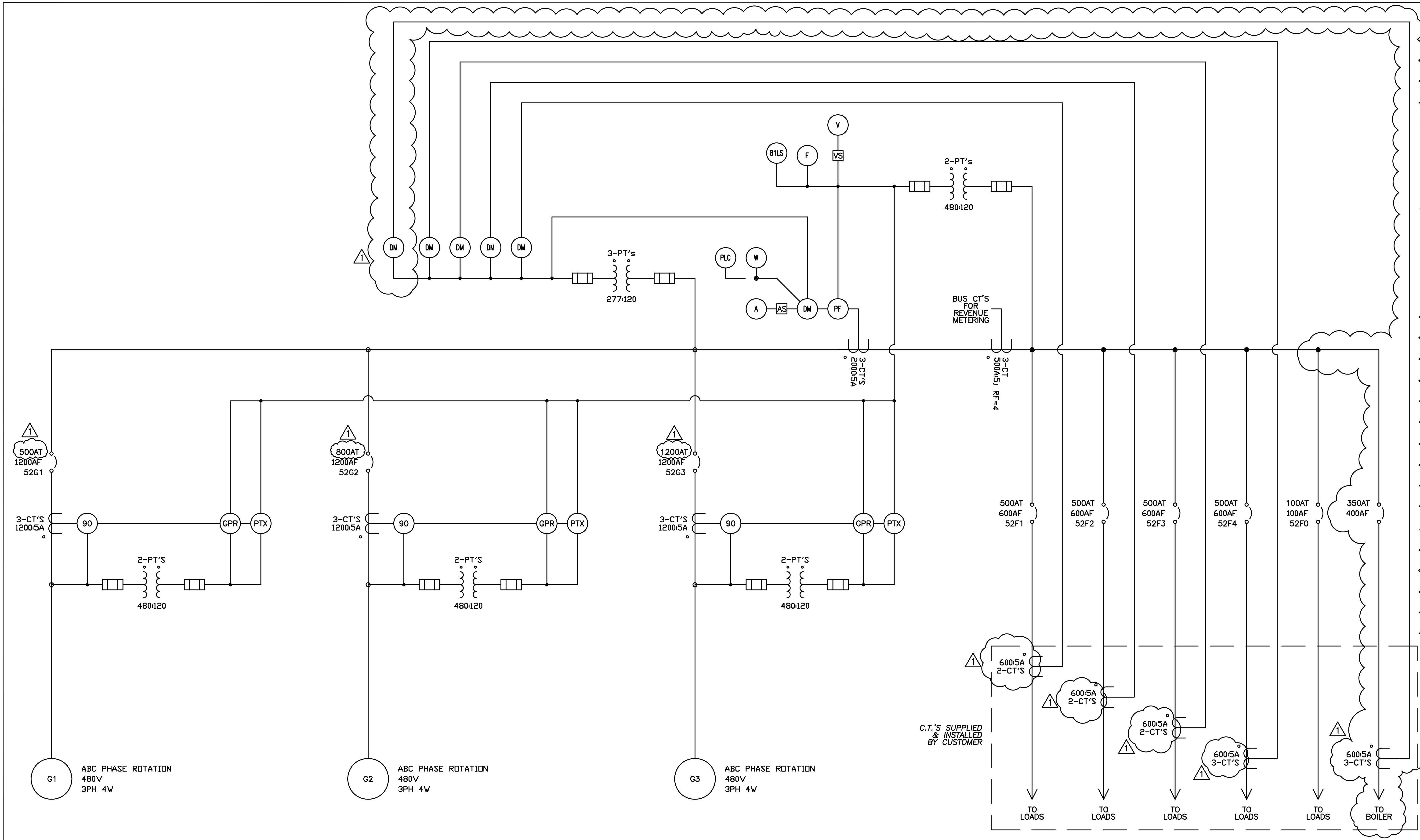
SECTION/FUNCTION

PROJECT NO.: SGP–1085	
PROJECT NAME: A.V.E.C. – KASIGLOK	
ES NO.: ES–29940	ITEM: SWGR.
APPROVALS	DATE
DRAWN DDD	4–27–05
CHECKED DDD	4–27–05
APPROVED MJK	4–27–05

KOHLER CO.
POWER SYSTEMS, KOHLER, WI 53044 U.S.A.

TITLE: DIMENSION PRINT OUTLINE DRAWING

SCALE 3/32	CAD NO. SGP1085M1.DWG	SHEET M1 OF 5
PLOTTED	DWG. NO. SGP–1085	D



CAE GENERATED DRAWING

REV	DATE	REVISION	BY
—	4-29-05	NEW DRAWING [74905]	RTR
1	11-14-05	ADDED CIRCUIT TO BOILER	JAF

SECTION/FUNCTION

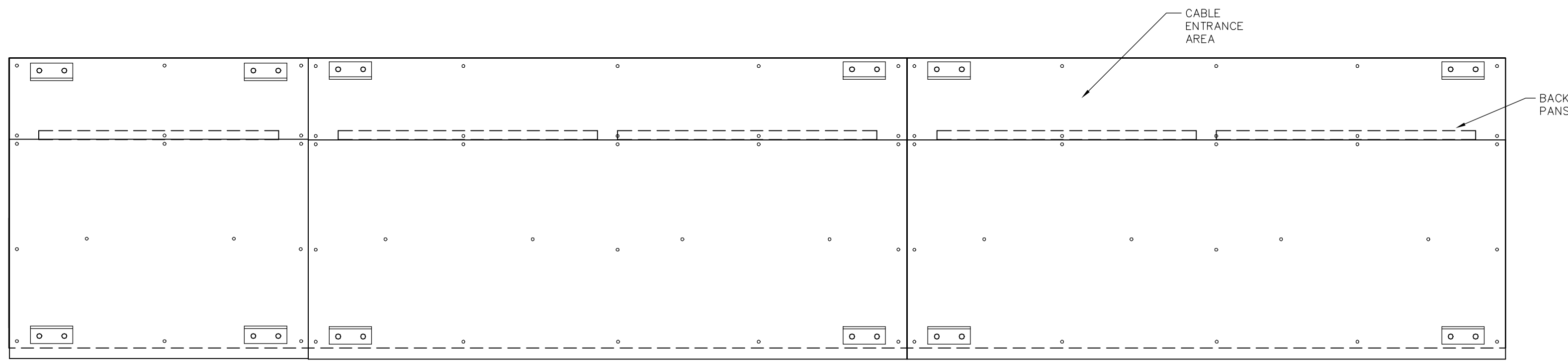
PROJECT NO.: SGP-1085
PROJECT NAME: A.V.E.C. – KASIGLOK
ES NO.: ES-29940 ITEM SWGR

APPROVALS		DATE
DRAWN	RTR	4-29-05
CHECKED	MEP	4-29-05
APPROVED	MEP	4-29-05

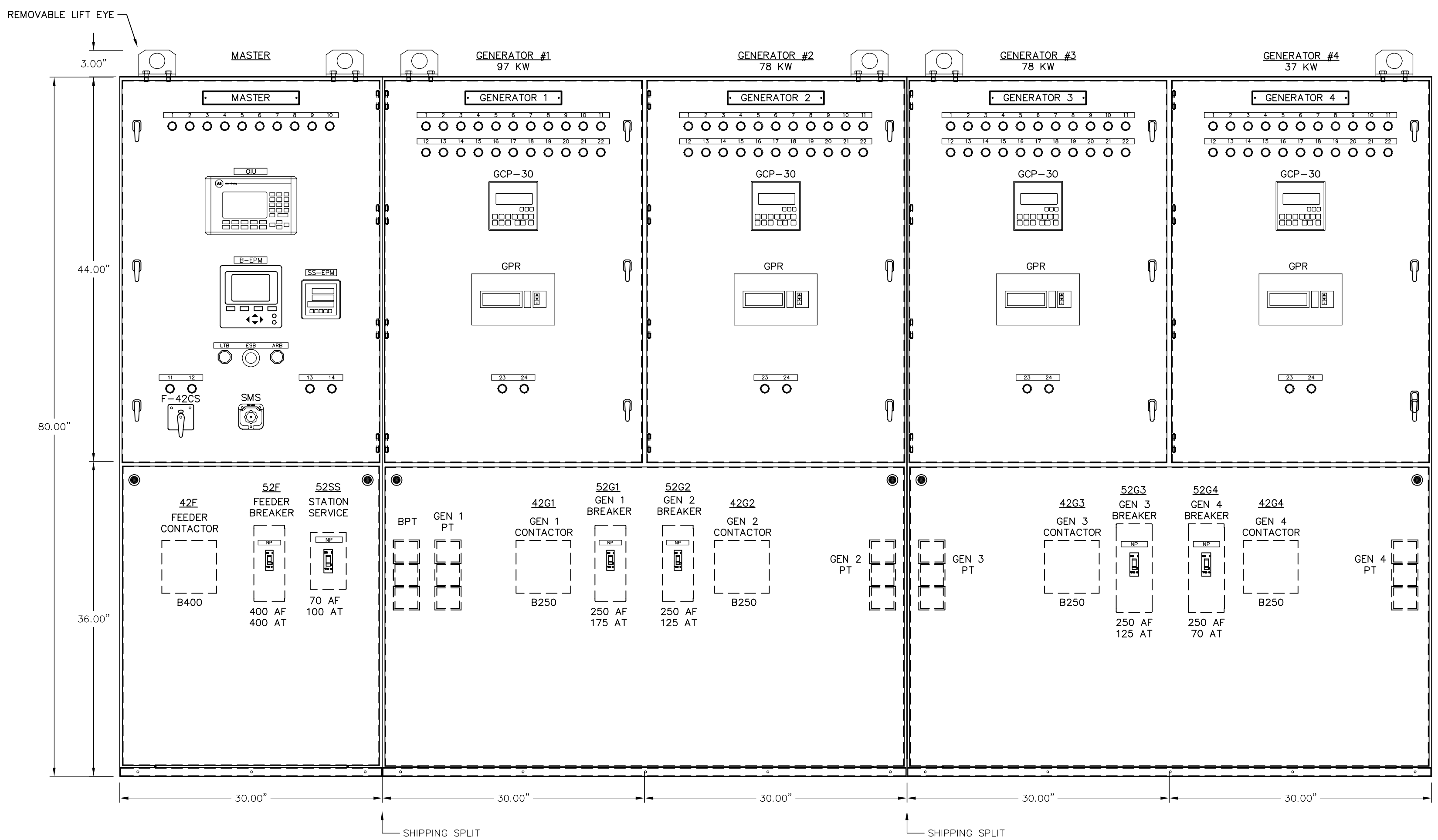
KOHLER CO.
POWER SYSTEMS, KOHLER, WI 53044 U.S.A.

TITLE DIAGRAM, SINGLE LINE

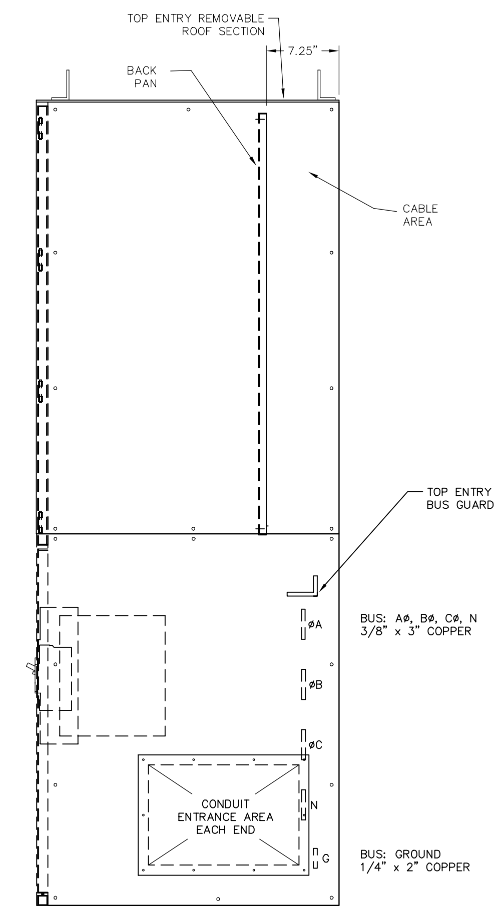
SCALE | CAD NO. SGP1085.DWG | SHEET E1 OF 88
PLOTTED | DWG. NO. SGP–1085 | D



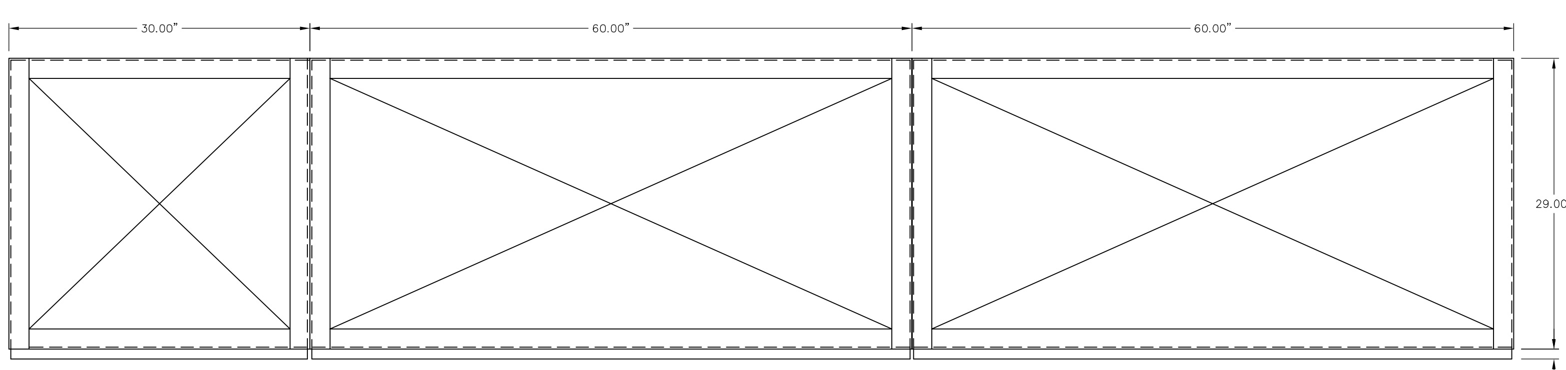
GENERATOR SWITCHGEAR – TOP VIEW



GENERATOR SWITCHGEAR – FRONT VIEW



GENERATOR SWITCHGEAR – SIDE VIEW



GENERATOR SWITCHGEAR – PLAN VIEW

GCP READOUT

* INCLUDES, BUT IS NOT LIMITED TO THE FOLLOWING LIST OF METERING, STATUS, AND ALARMS.

METERING LEGEND

1. VOLTS: Aø, Bø, Cø
   L–N, L–L
2. AMPS: Aø, Bø, Cø
3. KW
4. PF
5. KWH

ALARM LEGEND

1. LOW OIL PRESSURE ALARM
2. LOW OIL PRESSURE SHUTDOWN
3. HIGH WATER TEMPERATURE ALARM
4. HIGH WATER TEMPERATURE SHUTDOWN
5. OVERCRANK
6. OVERSPEED
7. LOW OIL LEVEL

ANALOG INPUT LEGEND

1. OIL PRESSURE (PSI)
2. WATER TEMP (°F)

MISC. LEGEND

1. ENGINE HOURS
2. ENGINE START COUNTER
3. MAINTENANCE CALL

GPR FUNCTIONS

* INCLUDES, BUT NOT LIMITED TO:

27/59
81 o/u
32
50/51
40
47

NOMENCLATURE

SYMBOL:	DESCRIPTION:
B–EPM	BUS ELECTRONIC POWER METER – 6200ION
ESB	EMERGENCY STOP BUTTON
F–EPM	FEEDER ELECTRONIC POWER METER – 7500ION
GCP	GENERATOR CONTROL PACKAGE
GPR	GENERATOR PROTECTIVE RELAY
SS–EPM	STATION SERVICE POWER METER – 6200ION
42xx	CONTACTOR
42CS	CONTACTOR CONTROL SWITCH
52xx	CIRCUIT BREAKER

GENERATOR ANNUNCIATOR LEGEND:

1. ENGINE RUN
2. ENGINE IDLE
3. LOW OIL PRESSURE
4. HIGH WATER TEMPERATURE
5. OVERCRANK
6. OVERSPEED
7. ENGINE ALARM
8. COOLDOWN/LOCKOUT
9. LOW OIL LEVEL
10. (SPARE)
11. REVERSE POWER
12. FAIL TO SYNCHRONIZE
13. NORMAL STOP
14. OVERCURRENT
15. UNDER VOLTAGE
16. OVER VOLTAGE
17. UNDER FREQUENCY
18. OVER FREQUENCY
19. NOT IN AUTO
20. GENERATOR BREAKER OPEN
21. (SPARE)
22. (SPARE)
23. CONTACTOR OPEN
24. CONTACTOR CLOSED

MASTER ANNUNCIATOR LEGEND

1. FIRE ALARM LIGHT
2. EMERGENCY STOP LIGHT
3. SYSTEM LOW WATER LEVEL LIGHT
4. DAY TANK CRITICAL LOW LIGHT
5. BUS UNDER/OVER VOLTAGE LIGHT
6. BUS UNDER/OVER FREQUENCY LIGHT
7. FEEDER BREAKER OVERCURRENT LIGHT
8. PRIMARY PLC FAILURE
9. OPERATING ON BACKUP PLC
10. BACKUP PLC FAILURE
11. FEEDER CONTACTOR OPEN
12. FEEDER CONTACTOR CLOSED
13. STATION SERVICE CONTACTOR OPEN
14. STATION SERVICE CONTACTOR CLOSED

PRELIMINARY

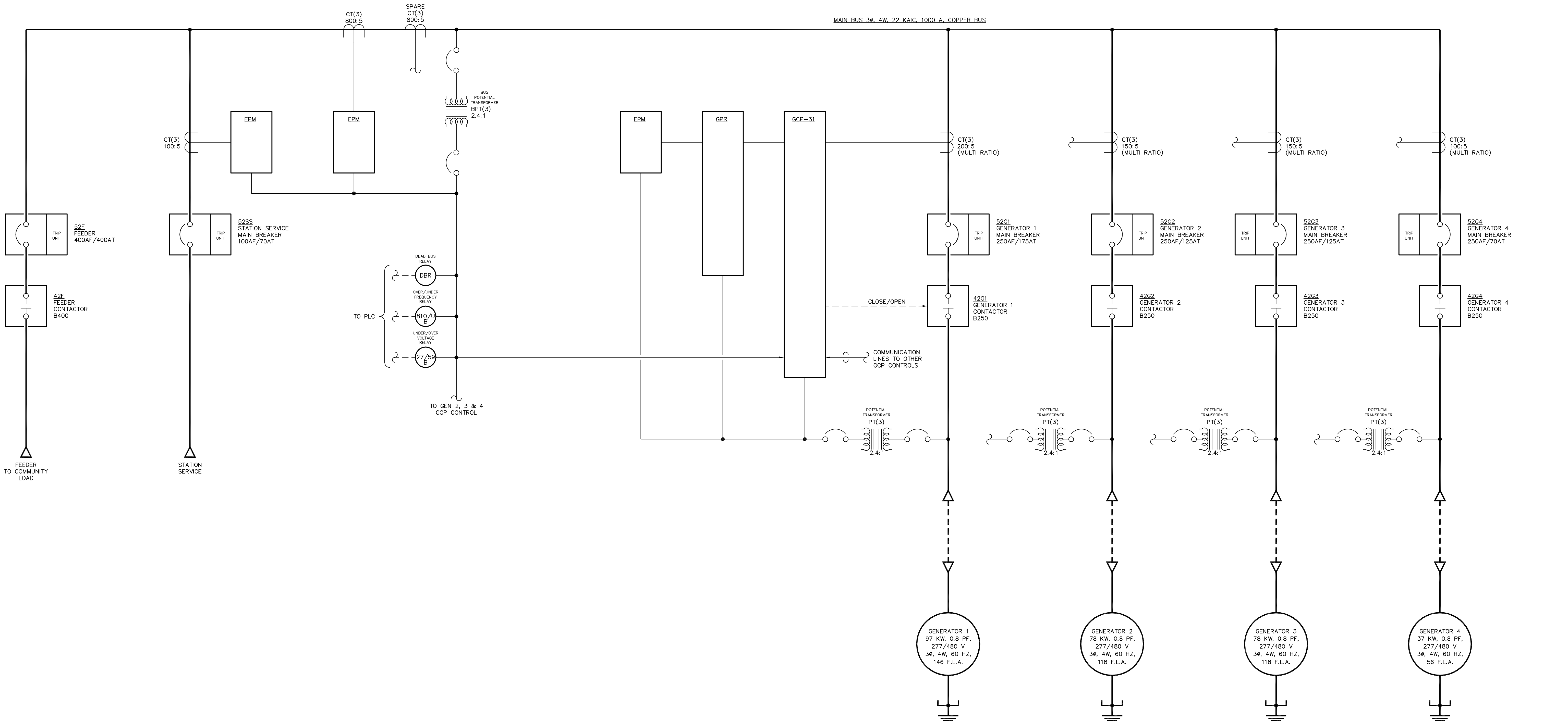
25.4mm 0 25.4mm 50.8mm
10" 0 10" 20"
SCALE: 1"=10"

REV.	DATE	BY	DESCRIPTION
A	04–23–03	GPN	SUBMITTAL

Controlled Power, Inc.
17909 Bothell Hwy. S.E. Suite 102
Bothell, Washington 98012 USA

SCALE : 1/10	STEVENS VILLAGE	ENGR : JMD
DATE : 05–29–03		DRAFTED BY: GPN
ALASKA ENERGY AUTHORITY P.O. No.		JOB No. 5400
GENERATOR SWITCHGEAR, OUTLINE DIAGRAM		DRAWING NUMBER 11366

Plot date: 2003/10/21 – 13:06



NOTES:

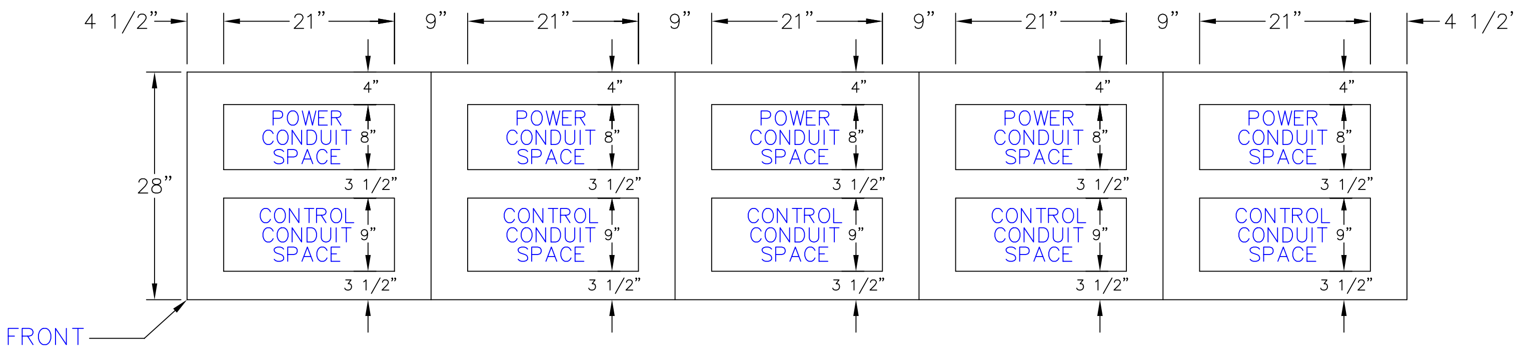
1. ALL BREAKERS ARE MANUALLY OPERATED NON-DRAWOUT TYPE
2. ALL BREAKERS ARE G.E. SPECTRA TYPE, LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS.
3. GENERATORS 2 , 3 & 4 SIMILAR TO GENERATOR 1

REV.	DATE	BY	DESCRIPTION
A	08-10-03	CMD	SUBMITTAL

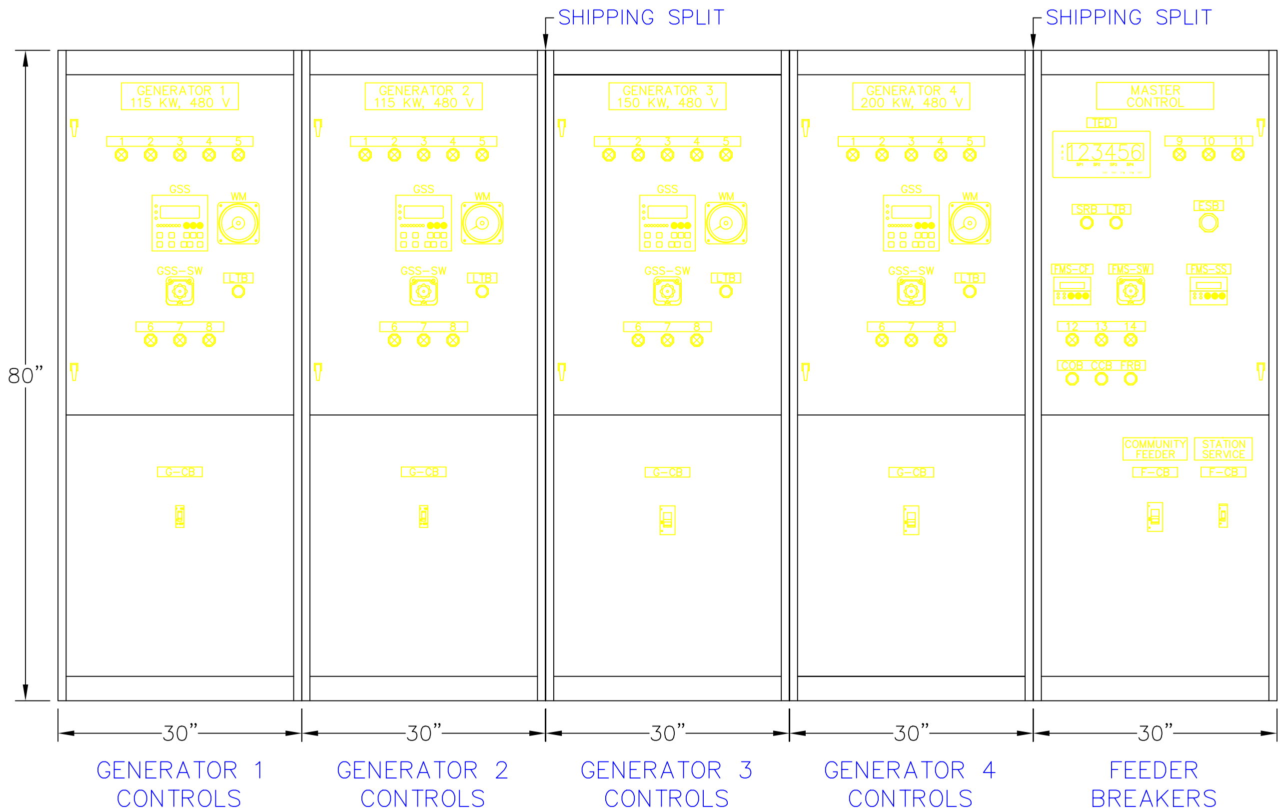
Controlled Power, Inc.
17909 Bothell Hwy. S.E. Suite 102
Bothell, Washington 98012 USA

SCALE : NONE	STEVENS VILLAGE	ENGR : JMD
DATE : 08-25-03		DRAFTED BY: CMD
ALASKA ENERGY AUTHORITY P.O. No.		JOB No. 5400
SINGLE LINE SCHEMATIC DIAGRAM		DRAWING NUMBER 11369

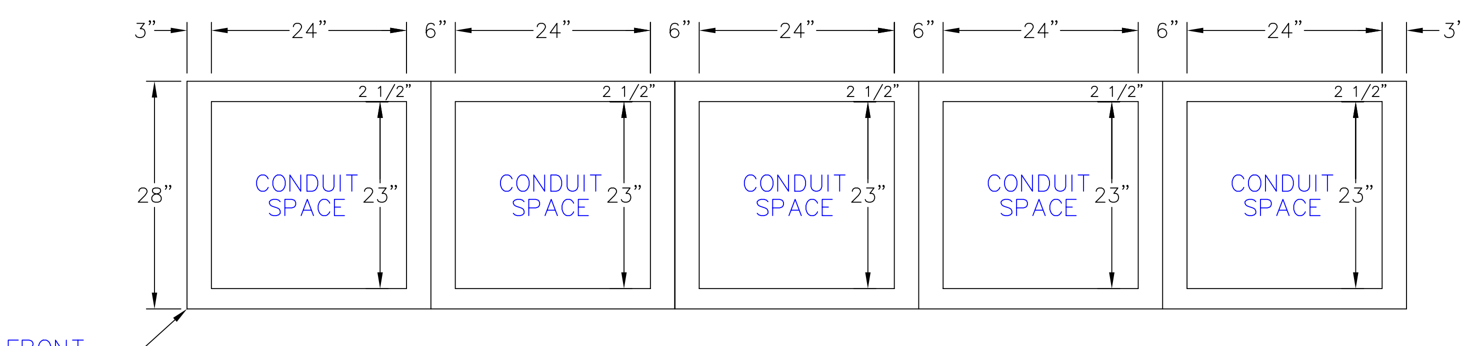
Plot date: 2003/10/21 – 13:12



GENERATOR SWITCHBOARD CONDUIT ENTRY DETAIL – TOP



GENERATOR SWITCHBOARD FRONTAL ELEVATION



GENERATOR SWITCHBOARD CONDUIT ENTRY DETAIL – BOTTOM

LEGEND

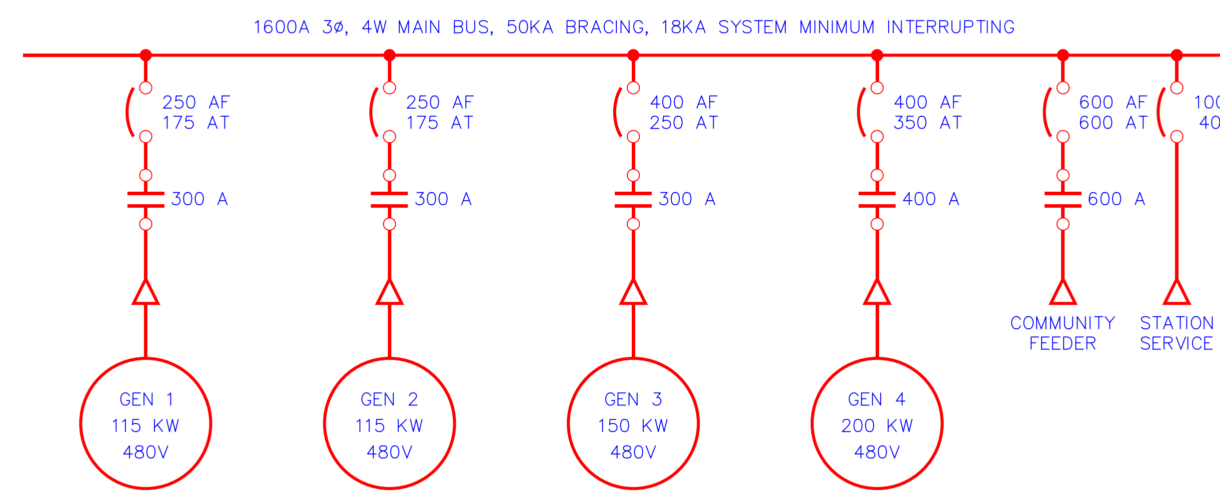
SYMBOL	DESCRIPTION
CCB	CONTACTOR CLOSE BUTTON
COB	CONTACTOR OPEN BUTTON
ESB	EMERGENCY STOP BUTTON
F-CB	FEEDER CIRCUIT BREAKER
FMS-CF	FEEDER CONTROLLER – COMMUNITY FEEDER
FMS-SS	FEEDER CONTROLLER – STATION SERVICE
FMS-SW	FEEDER CONTROLLER – SELECTOR SWITCH, AUTO-MANUAL
FRB	FAULT RESET BUTTON
G-CB	GENERATOR CIRCUIT BREAKER
GSS	GENERATOR CONTROLLER
GSS-SW	GENERATOR CONTROLLER – SELECTOR SWITCH, OFF-ON
LTB	LAMP TEST BUTTON
SRB	SYSTEM RUN ILLUMINATED PUSHBUTTON – GREEN
TED	TOTAL ENERGY DISPLAY
WM	WATTMETER

ANNUNCIATION LEGEND

SYMBOL	DESCRIPTION
1	GENERAL ALARM – RED
2	NOT IN AUTO POSITION – AMBER
3	LOCKOUT – RED
4	GENSET RUNNING – GREEN
5	GENSET STOPPED – RED
6	CIRCUIT BREAKER OPEN – RED
7	CONTACTOR OPEN – GREEN
8	CONTACTOR CLOSED – RED
9	FIRE ALARM – RED
10	EMERGENCY STOP – RED
11	COMMON FAULT – RED
12	CONTACTOR OPEN – GREEN
13	CONTACTOR CLOSED – RED
14	FAULT – RED

NOTES:

1. CONSTRUCTION: CODE GAUGE SHEET STEEL, NEMA 1A TYPE INDOOR ENCLOSURE.
   A. SWITCHBOARD SHALL MEET REQUIREMENTS PER UL 891
   B. SWITCHBOARD SHALL BE FRONT ACCESSIBLE FOR INSTALLATION AND MAINTENANCE
2. FINISH: EXTERIOR: ASA #61 LIGHT GRAY, INTERIOR PANELS: GLOSS WHITE
3. MAXIMUM PROJECTION OF DOOR MOUNTED COMPONENTS: 3 INCHES
4. NAMEPLATES TO BE BLACK WITH WHITE LETTERING, SECURED TO PANEL WITH CORROSION RESISTANT HARDWARE
5. INTERNAL WIRING CONNECTIONS TO BE #16 AWG MINIMUM, TYPE SIS RATED 600 VOLTS, 90 DEGREE EXCEPT AS NOTED. ALL WIRING TO BE NUMBERED AT BOTH ENDS.
6. SPECIAL CONSTRUCTION NOTES:
   A. CONTROL COMPARTMENTS TO BE OPEN BETWEEN SECTIONS
   B. BREAKER COMPARTMENTS TO BE ENCLOSED/BARRIERED BETWEEN SECTIONS. BARRIERS TO BE REMOVEABLE.
   C. DOORS TO HAVE 120° MAXIMUM SWING WITH LOCKING STOPS
   D. ALL DOORS TO BE PROVIDED WITH "SOUTHCO" TYPE LIFT-AND-TURN 1/4-TURN LATCHES
   E. MAIN BUS TO HAVE GLASTIC COVER FOR ISOLATION OVER THE ENTIRE LENGTH



POWER ONE LINE DIAGRAM

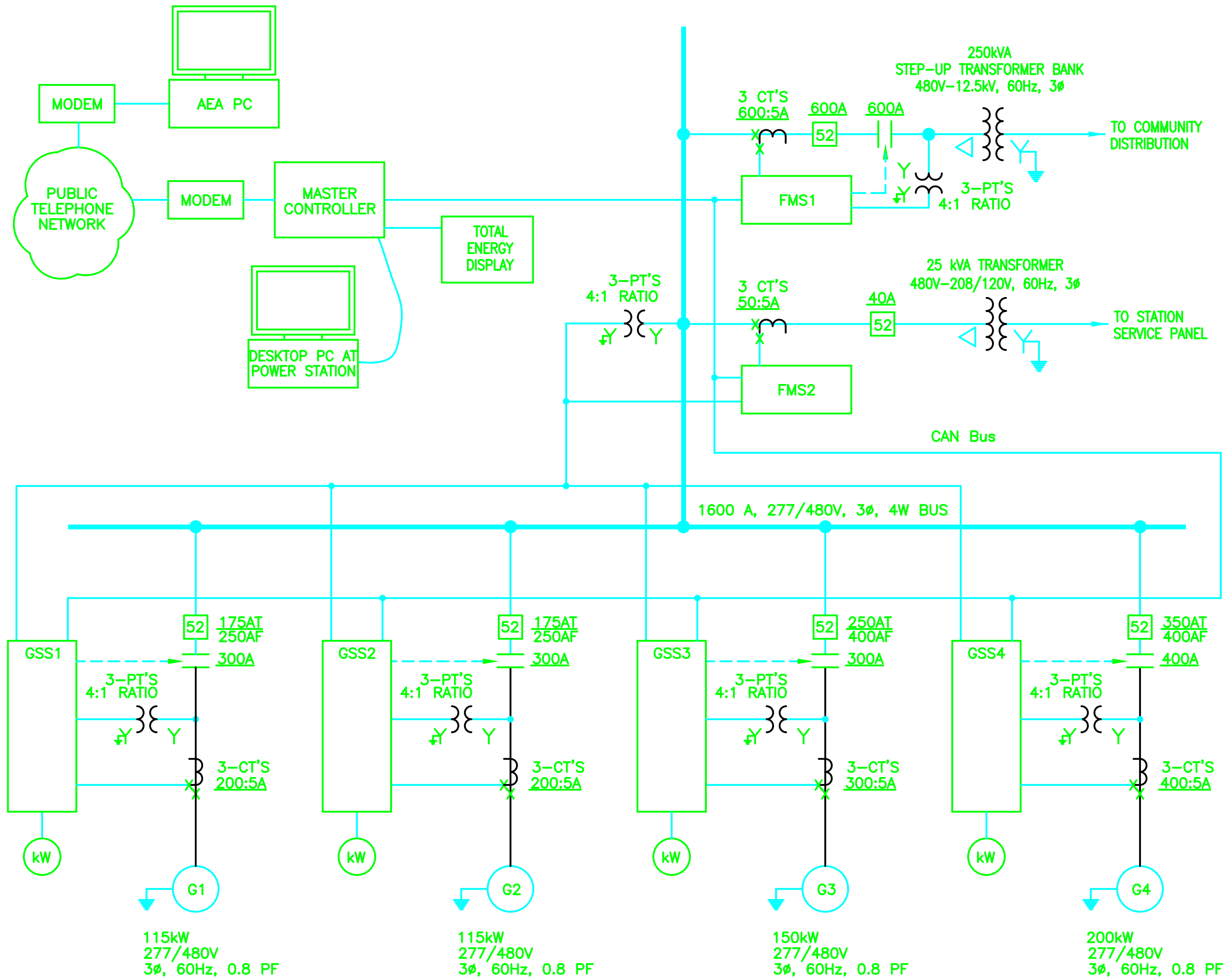
Rev	Date	Revision Description	By	Chk
02	01-14-04	AEA Submittal Review	DMJ	DBB
01	12-19-03	Initial Submittal Review	DMJ	DBB

POWERCORP
Powercorp Alaska, LLC
135 Christensen Drive, Suite 200, Anchorage, AK 99501 USA
Phone: 907-646-9997 Fax: 907-646-9079
E-mail: mail@pcorp.com.au Web: www.pcorp.com.au

Engineer	Dale Letourneau
Designed by	Powercorp Group
Drawn by	Applied Power & Control, Inc.
Date Drawn	10 December 2003
Checked by	Kersten Schmidt
Client	AEA
Client's Eng.	Lenny Landis

State of Alaska
Department of Community and Economic Development
AIDEA/AEA
Rural Energy Group
813 West Northern Lights Blvd.
Anchorage, Alaska 99503
ALASKA ENERGY AUTHORITY

Drawing No. P191, Sheet 13, Rev 02
Golovin Switchboard Layout



Rev	Date	Revision Description	By	Chk
01	10-05-03	Add Total Energy Display	Bob	K.S.

POWERCORP
Powercorp Alaska, LLC
135 Christensen Drive, Suite 200, Anchorage, AK 99501 USA
Phone: 907-646-9997 Fax: 907-646-9079
E-mail: mail@pcorp.com.au Web: www.pcorp.com.au

Engineer	Dale Letourneau
Designed by	Powercorp Group
Drawn by	Applied Power & Control, Inc.
Date Drawn	10 December 2003
Checked by	Kersten Schmidt
Client	AEA
Client's Eng.	Lenny Landis

State of Alaska
Department of Community and Economic Development
AIDEA/AEA
Rural Energy Group
ALASKA ENERGY AUTHORITY

Drawing No. P191, Sheet 15, Rev 01
Golovin One-Line Diagram