THE GVEA BESS – CHOOSING A MULTI-MILLION DOLLAR SYSTEM

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GVEA BACKGROUND

Golden Valley Electric Association, Inc (GVEA) is a Rural Utility (RUS) Co-op that was founded in 1946. GVEA owns and maintains 2200 miles of distribution line, 336 miles of transmission line, a 25 MW coal fired generation facility and 200 MW of diesel and oil fired gas turbine generation. GVEA has a system peak of 182 MW during the winter months while serving 38,000 meters (90,000 residents) spread across 2,200 square miles. GVEA's total MWh sales were over 1,000,000 the last three years.

GVEA SYSTEM HISTORY

Alaska is an electrical island. We are not connected electrically to Canada or to the Lower 48. Small loads, small population, long distances and challenging conditions make for an interesting life. Because of this isolation and limited backup resources, outages are a fact of life in Alaska. In Fairbanks, we experience a total blackout once every 2-3 years (on average). Until 1985, when the Intertie connected GVEA with the rest of the south central utilities, GVEA operated as an islanded system using coal and oil to generate electricity. In the 70's GVEA experienced rapid growth due to the construction of the Trans Alaska Pipeline System (TAPS) and the development of the North Slope oil fields. Studies conducted at the time showed system growth doubling every three years for the foreseeable future and GVEA took the steps necessary to meet those projections. Unfortunately the projections were wrong and GVEA was saddled with debt that required rates to go up which resulted in a further reduction in load as people switched from heating their homes electrically to heating their homes with fuel oil. Obviously GVEA is in a predicament. The engineering staff was asked to look at cost saving measures and the one that rose to the top was a plan that minimized fuel costs. GVEA implemented an under-frequency relay load shedding scheme on our substation feeders that allowed us to run generation without spinning reserves[1]. Under-frequency relaying was the best tool available for the supply of stability enhancements to reduce system blackouts and to provide an alternative to the operation of costly combustion based spinning reserves on an isolated system. This Shed in Lieu of Spin (SILOS) coupled with moderate load growth in the early 80's allowed GVEA to stabilize electric rates.

In 1985 the construction of the 186 mile 138kV Intertie connecting the Anchorage utilities with the GVEA system allowed GVEA to take advantage of low cost natural gas and hydro generation. This Intertie also increased GVEA's exposure to generation outages and transmission line disturbances in the central and southern load centers. The entire combined Railbelt power system has incredibly low inertia and is susceptible to large changes in frequency for relatively minor losses in generation. For example, the loss of a 110 MW unit in Anchorage will cause system frequency to decay to 59.0 Hz at a rate of 0.8 Hz/second. In the GVEA system, loss of the Intertie under heavy import conditions can cause frequency to decay at rates greater than 7.0 Hz/second. System disturbances have caused the central and northern load centers to go "out of step" with each other resulting in breaker trips and the islanding of the northern load center. To address these new system realities, GVEA implemented two new schemes. One scheme involved a SCADA controlled load-shedding application and the other scheme involved rate of change (ROC) under-frequency relays. The SCADA application was designed to monitor the spin requirement for GVEA, determine that requirement for each second and provide tripping of the substation feeders necessary to meet the requirement. The ROC under-frequency scheme was installed using relays at the substations and set to arm if the frequency was decaying at a rate greater than 1.5 Hz/sec. These ROC under-frequency relays allow for quick reaction to an Intertie faults/trip and when coupled with the standard under-frequency load shedding scheme provide for a simple and dependable protection scheme that has proven itself over and over again.

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[1] Spinning reserves is the excess generating capacity available above current system load.

So this is all fine and well from an engineer's perspective. We continue to operate a very economical utility by not providing real spin. We avoid not only the fuel costs but the wear and tear on combustion turbines. Throughout the past two decades GVEA continued to gain access to cheaper fuel supplies and with access to cheaper fuel supplies we were able to use this leverage with our existing fuel suppliers to further contain costs. Small but consistent load growth, coupled with fuel price declines, has allowed us to maintain electric rates at the same level for the last 20 years. With the building of the Intertie, GVEA also installed a SCADA system which decreased response time to distribution outages, allowed us to recover from system disturbances quicker and provided a way to monitor and trend system parameters. The dilemma that GVEA was facing (and continues to face) in the late 80's was an increasingly sophisticated consumer whose tolerance for outages and lower power quality was decreasing. What was perfectly acceptable in the late 70's, early 80's (do what ever it takes to keep the rates low) slowly changed as the number of outages decreased, the length of the outages decreased, rates stabilized and the real cost of power declined. Obviously with a radial transmission system there is a need to loop those systems if possible. But, as with any decision in Alaska, can you make the project pay for itself with small populations, small loads (small revenue), long distances and the associated high construction costs. Typically, without State assistance, the answer is no.

BESS PLANNING

Recognizing that the State of Alaska needed to help the utilities with electrical infrastructure, the 1993 Alaska State Legislature approved a grant for the Northern Intertie Project. The Northern Intertie would build a second transmission line between Healy and Fairbanks. For the Northern Intertie, an Intertie Participants Group (IPG) was formed that included Homer Electric Association (HEA), Matanuska Electric Association (MEA), Anchorage Municipal Light and Power (AML&P), Fairbanks Municipal Utilities Services, Chugach Electric Association (CEA), the City of Seward and GVEA. Various studies were initiated for this project and assigned to subcommittees. One subcommittee looked at the best way to provide voltage compensation for the Northern Intertie. This subcommittee investigated more than a dozen SVC, substation and voltage options before selecting the Battery Energy Storage System (BESS) as the preferred option.
Using an abbreviated life cycle cost analysis, this subcommittee determined that a Battery Energy Storage System (BESS) was the best option and provided the greatest benefit potential.

Benefits of the BESS

The IPG identified three primary benefit areas; T&D, Generation and Strategic.

- T&D benefits include: Voltage regulation, First swing stability, Loss reduction.

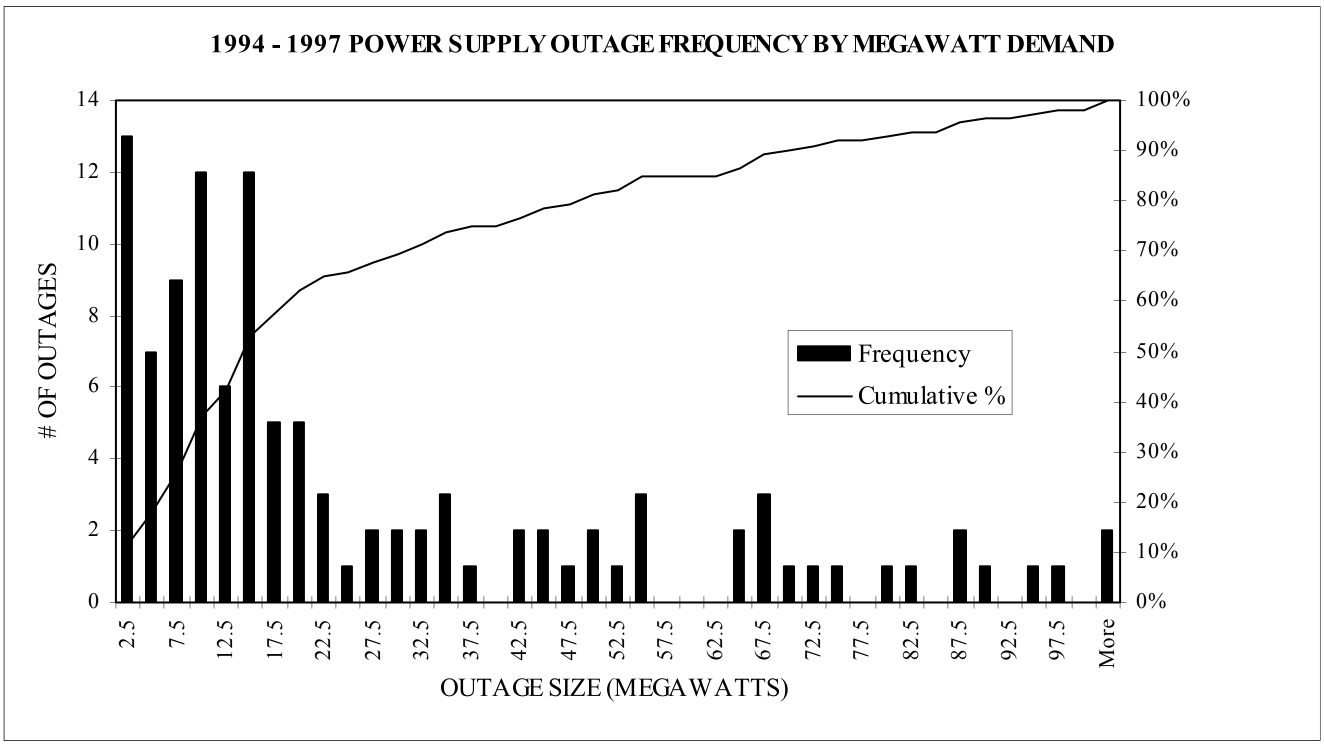
- Generation benefits include: Spinning reserves, Ramp-rate constraint relief , Load following, Black start, Load leveling, Reduced or deferred turbine starts.

- Strategic benefits include: Improved power quality, Reduced demand peaks, Enhanced service reliability through reduced power supply generated outages.

The primary benefit to the participants of the IPG was the ability of the BESS to instantly contribute to system stability following the loss of a major transmission line or generator. The BESS could also provide spinning reserves that would, potentially, allow generation units to be run at lower levels or shut down entirely, resulting in significant savings.

Sizing the BESS

In the early 90's, the State of Alaska was also involved in a new DOE clean coal technology power plant being built next to GVEA's existing coal fired power plant in Healy. This power plant, when combined with the Northern Intertie, would allow the secure import of 140 MW into the Fairbanks area. The existing transmission line between Healy and Fairbanks can handle 100 MW securely so the sizing of the BESS was arrived at by assuming the Northern Intertie would trip under a 140 MW import scenario and that for the system to stay secure the BESS would have to supply 40 MW. Combustion turbines can then be brought on line within 15 minutes, so the amount of time that the BESS would have to supply energy was determined to be 15 minutes. At the end of 15 minutes the BESS would be backed off by the generation that was now on line. A conservative 4 MW/minute ramp down rate was selected for the BESS to give adequate time for the turbines to respond. GVEA was extremely interested in the 40 MW size due to the number of power supply outages we are exposed to. Since GVEA imports a large portion of its power from Anchorage over the Intertie, any loss of generation in Anchorage or faults on the Intertie are considered power supply outages. The chart on the next page shows that GVEA experienced 111 power supply outages between 1994 and 1997. For each outage a MW demand was determined and the number of outages with the same demand are grouped together and shown as a frequency bar. The cumulative total number of outages is shown as a percentage by the line (cumulative %). By sizing the BESS at 40 MW it can be seen from this chart that approximately 74% of the power supply related outages, that GVEA experienced during the period 1994-1997, would have been eliminated.



BESS SPECIFICATION

After the BESS was selected as the preferred option, the IPG selected Power Engineers to write a technical specification for the BESS. Stan Sostrom with Power Engineers started from an old EPRI specification and modified it based on the experience of the BESS owned by Puerto Rico Electric Power Authority (PREPA) in San Juan, Puerto Rico, input from Abbas Akhil with Sandia National Laboratories, Phil Symons with Symons/EECI, Black & Veatch and GVEA.

The final specification required that the vendor provide a turnkey BESS. GVEA chose not to specify a particular battery type or dictate the type of power conversion equipment that could be proposed. The specification was written as a performance based specification. The vendor would be responsible for finding the right partners for the various subsystems, finding a battery manufacturer, coordinating building demolition and construction, and guaranteeing that the installation would work. The specification required that the vendor guarantee for twenty years that the BESS could supply 40MW for 15 minutes, with a 4MW/min ramp down after the 15 minute mark. The BESS is required to be capable of operating in all four quadrants (i.e., full power circle) and to provide continuous, infinitely adjustable, control of real and reactive power over the entire operating range. The specification also required that the BESS be able to operate in an automatic mode as GVEA does not plan to man the facility.

GVEA required the BESS to provide rated output for the following power system characteristics:

- Nominal voltage = 138kV (1.0 pu)
- Normal sustained voltage = 0.90 pu (min) and 1.1 pu (max)
- Normal frequency = 60 Hz with normal deviation of +/- 0.1 Hz
- Sustained frequency range = 59.0 Hz (min) and 60.5 Hz (max)

GVEA also required the BESS to operate, without damage, under the following emergency conditions:

- Emergency 5-minute voltage swings = 0.60 pu (min) and 1.15 pu (max)
- Switching Transient = 1.4 pu for 1 cycle
- Emergency Frequency Swings = 50 Hz (min) and 65 Hz (max)

GVEA asked that the BESS be able to operate in seven distinct modes; VAR support, spinning reserve, power system stabilizer, automatic scheduling, scheduled load increases, automatic generation control (AGC), and charging. These operating modes are described below.

- VAR Support: This mode requires that the BESS provide voltage support for the power system under steady state and emergency operating conditions.

- Spinning Reserve: This mode requires that the BESS respond to remote generation trips in the Railbelt system. Spinning reserve mode will initiate at a system frequency of 59.8 Hz with the BESS loading to full output at 59.4 Hz if system frequency continues to drop. Spinning reserve has the highest priority of all modes and will interrupt any other mode the BESS is operating under.

- Power System Stabilizer: The control for the BESS will include a power system stabilizer to effectively damp power system oscillations.

- Automatic Scheduling: This mode is used to provide instantaneous system support in the event of a breaker trip on either a transmission line or a local generator. The BESS has fifteen independently triggered inputs which will be tied remotely to the trip circuits of breakers.

- Scheduled Load Increases: This mode will be initiated and terminated by SCADA and puts the BESS in a frequency and voltage regulation mode to allow it to respond to the addition of large motor loads.

- Automatic Generation Control: This mode requires the BESS to be capable of operating by Automatic Generation Control (AGC) similar to that of rotating machinery.

- Charging: This mode allows the SCADA dispatcher to control how fast (selectable MW rate) the BESS will be charged and when the charging will start after a BESS discharge event.

The specification also reflected the tremendous amount of effort that was put into warranty and guarantees. The following warranties and guarantees were included in the specification.

- Construction Warranty: A standard 12 month construction warranty that covers quality of workmanship issues.

- Availability Guarantee: Since the BESS is critical to the stable and economic operation of the system, it must be available for use to the maximum extent possible. An 18 month availability guarantee period was implemented where the ownership and operation transfer to Golden Valley, but the maintenance responsibility stays with the vendor. If the BESS fails to meet the required availability, the 18 month period is extended until 18 consecutive months, at the required availability, is achieved.

- Capacity Guarantee: Each BESS proposal was evaluated over a 20 year life span. To accomplish this it was necessary to determine how many, if any, complete change-outs of the battery would be required. Each vendor was required to provide battery life information based on the operating descriptions and outage data contained in the specification and to guarantee that with a bond for 75% of the total battery replacement cost.

The specification was issued as a RFP in November of 1999 with the goal to have the BESS construction completed at approximately the same time as the Northern Intertie transmission line. Proposals were received in February of 2000 but during the evaluation process it became clear that the Northern Intertie would be delayed over environmental permitting issues. GVEA decided to delay the BESS selection process until it became clear when the permitting issues would be resolved.

EVALUATION PROCESS

Within the BESS specification were areas that requested information necessary for GVEA to perform a meaningful evaluation. The power conversion system (PCS) and supporting subsystems were important but for GVEA the biggest unknown was the battery. Battery replacement costs, battery life and battery maintenance issues were critical and needed to be identified and evaluated properly. The specification required the vendors to supply the following information.

- Battery Replacement: This identified the number of cells that would be permanently retired from service and need replacement during the twenty-year period. The vendors were asked to supply this in the form, number of cells/year.

- Maintenance Hours: This identified the manhours needed to maintain the facility including, but not limited to, battery and auxiliary systems, AC and DC station service, HVAC, building, PCS and auxiliary systems, cooling system, controls, protection and monitoring equipment calibration, and transformers. The vendors were asked to supply this in the form of manhours/year.

- Total Energy In: This identified all net electric energy input into the system. It would include all charging energy, transformer load losses, PCS losses, battery losses, station service and auxiliary systems loads. This information was to take into account the effects of battery aging and replacement, maintenance procedures and testing requirements. The vendors were asked to provide this in the form of MWh/year.

- Self-discharge Losses: This identified the sum of battery system losses in MWh that occur due to battery self-discharge, and included the replacement batteries in storage as well as spare modules on float charge. The vendors were asked to provide this in the form of MWh/year.

- Charging Efficiency: Charging efficiency was defined as the net difference between the MWh/MVARh delivered to the GVEA 138kV system and the MWh required from the GVEA system to recharge the batteries. This included the transformer load losses, PCS and battery losses, but excluded the station service and auxiliary systems. The information supplied was to take into account the effects of battery aging and replacement for the specified 20-year life of the BESS. The vendors were asked to provide this in the form of percent/year.

- Reduced Capacity Time: For the purposes of the life-cycle evaluation, a day is defined as a calendar day or any portion thereof that the BESS is at reduced capacity due to the battery, portion of the battery, or any other system device being out of service for maintenance or replacement. The vendors were asked to identify the number of days for each of the following categories.

Days of full capacity	100% (Days/year)
Days of reduced capacity	75-99% (Days/year)
Days of reduced capacity	50-74% (Days/year)
Days of reduced capacity	0-49% (Days/year)

- Efficient use of Building Space: The BESS is being built in an existing 120' X 500' building. A credit for the purposes of the Life-Cycle Evaluation was applied to useable space designated solely for GVEA use.

Anticipated Cycling Loads

To assist the vendors in sizing the battery and to help GVEA in evaluating each proposal, the following anticipated cycling loads were included in the specification for use in the Life-Cycle evaluation calculations.

- Three (3) full duty discharges per year. Each event will consist of a ramp up from 0 to 40 MW within a few cycles, a continuous output of 40MW for 15 minutes and a ramp down of 4MW per minute to zero. Each event will have a total net energy discharge of 13.3 MWh.

- Fifteen (15) partial discharges per year. Each event will consist of a ramp up from 0 to 25 MW within a few cycles, a continuous output of 25MW for 5 minutes and a ramp down of 4MW per minute to zero. Each event will have a total net energy discharge of 3.4 MWh

- Five (5) partial discharges per year from a reduced state of charge. This event will consist of a ramp up from 0 to 25 MW within a few cycles, a continuous output of 25MW for 5 minutes and a ramp down of 4MW per minute to zero. This event will have a total net energy discharge of 3.4 MWh. The battery charge prior to the start of the event will be at 85% of total charge.

Major Evaluation Areas

The evaluation process was complex and covered a number of major areas. Personnel from purchasing, operations, power supply, dispatch, engineering, accounting as well as our consultant were involved in the process. The major areas evaluated were:

- Life Cycle Cost Calculation
- Warranties and Guarantees
- Operational Considerations
- Overall Design
- Risk
- Commercial and Contractual
- Flexibility of the Proposed Design
- Corporate Pro-activeness
- Other
- Exit Strategy.

For the life cycle cost calculation a net present value method was used to bring the identified costs (O&M as well as initial) and benefits back to 2000 dollars over the twenty year life of the project. Sensitivity analysis was applied to the life cycle cost calculations using different loan rates, inflation rates, cell replacement costs, and discount rates. The life cycle cost evaluations were surprisingly close even though the battery technologies and PCS modularity were totally different.

The warranties and guarantee evaluation had subcategories that included the battery warranty, which was weighted the heaviest, as well as equipment warranties and the 18 month availability guarantee. Both of these were evaluated equally.

Operational considerations had a number of subcategories and evaluated the vendors implementation of the operation modes (spinning reserve, VAR support, etc), the short term ratings of the equipment, any initial capacity increase that was built into the BESS and ease of maintenance for the batteries, PCS and other equipment. Operational considerations also included the flexibility of the recharging mode, how user friendly the operator interface would be, ease with which drawings are interpreted and the availability of replacement parts.

The area of overall design evaluated the efficient use of the building, how completely the vendor complied with the modeling for system studies requirement, the detail of the PTI PSS/E BESS model that was to be provided, software issues, standardization of equipment (PLC's, equipment and protocols), flexibility of the station service configuration and the design of the buss, battery connection and overall configuration.

Risk evaluated the type of battery failure and the likely hood of a total vs a partial failure. Risk also looked at spare parts availability, converter transformer availability, the likelihood of PCS or transformer failure, the ability to use GVEA's mobile substation in the event of a transformer failure.

The area of commercial and contractual evaluation the commercial terms and conditions, arbitration, the choice of subcontractors, the milestone payment schedule and the project schedule.

Design flexibility evaluated how flexible the converter was in converting to a different battery technology, mixing battery types, and converting the BESS to just a SVC.

Corporate proactiveness looked at the likelihood of being able to develop a win-win relationship, how difficult it was to communicate ideas and communicate with the project people. We also evaluated the location of the support personnel (how fast can they get to Alaska) and the long term stability of the support team.

The Other area was a grab bag that evaluated the testing plans for completeness, the training that was offered, site security, remote access security and another catch all category called green stuff which evaluated battery disposal, how preexisting building conditions were handled, noise, and other hazards.

The final area looked at a GVEA exit strategy if the BESS was to become too costly or failed completely. We looked at the possibility of redeploying the equipment for use throughout our system or reselling the equipment. We also looked at how the building could be reused.

These major areas were weighted and assigned points, with the points adding to 100.

When the Northern Intertie environmental hurdles were cleared in March 2001, ABB, with their partners ABB Industrie (Switzerland) and Saft (France), were notified that they were the vendor of choice. After four months of contract negotiation the contract was signed on October, 2001.

BESS DETAILS

The BESS is comprised of the Power Converter System (PCS), battery and converter transformers. The BESS is being installed in a existing 500'x120' building. Layout for the BESS is shown on the last page.

PCS Details

The PCS interfaces the battery to the AC system using standard ABB medium voltage three level 2-phase modules utilizing Integrated Gate-Commutated Thyristors (IGCT). Maximum sustained output out of the PCS is 46 MVA. The PCS is water cooled utilizing a SwedeWater fine water/raw water system. The fine water system can flow over 400 gallons a minute of 100% dimineralized water and uses a heat exchanger in the raw water (glycol) side to dissipate heat. The raw water side has external cooling towers for heat dissipation. The primary control of the PCS will be handled by ABB's programmable high-speed controller (PHSC) with local system control and interface to GVEA's SCADA system handled by redundant ABB micro SCADA systems.

Battery Details

The battery GVEA choose to install consists of four strings (expandable to eight) connected in parallel with each string containing 3,440 cells arranged in 10 cell modules. Each cell is a Saft type SBH920 liquid filled Ni-Cad . This is a high performance, 920 amphour, pocket plate Ni-Cad that can with stand repeated deep discharges with little effect on battery life. Each cell is 16” high x 21” long x 8” wide and weighs 159 #’s. There will be a total of 13,760 cells installed and 10 spare modules (100 cells) on site for maintenance purposes.

The strings are connected to a +/- 2500 volt bus. This bus is sized to handle the 12,000 amps output from the battery as the cell voltage approaches 1.0 Volts at the end of a 40 MW discharge. Nominal float voltage for the battery is 1.4 V/cell or 4,816 Volts at the buss. The recharging voltage is limited to 1.45V/cell or 4,988 Volts at the buss.

The 10 cell modules are arranged in a racking system that is 5 tiers high and built for a seismic zone 3. Modules will be built at the Saft factory in Sweden and shipped with the electrolyte installed. This also means that the only electrical connection that needs to be done on site is the one between each module. Each module will have enough room to contain all the electrolyte from the cells in the event of a catastrophic failure. Modules and cells will be assigned a unique number to enable tracking of each component throughout the life of the facility.

Each module will be tied to the battery monitoring system (BMS). At each module a Philadelphia Scientific Sentry Unit will monitor the module voltage, electrolyte level in one cell, temperature in one cell and the presence of any liquids in the bottom of the module. Each Sentry Unit will relay its information to a single Sergeant Module dedicated to each string. The Sergeant module will collect data from each Sentry Unit and then send the information to BMS supervisory computer. The Sergeant module will also monitor string current and ambient temperature.

Data sampling of all points occurs every 30 seconds. Storage of the data depends on the mode the battery is operating in. For example, if the battery is being discharged, the data will be stored every 30 seconds, if the battery is in a recharge mode the data will be stored every 2 minutes and finally if the battery is on float the data will be stored hourly. Given the number of discharge and recharge events that will occur each year it is estimated that there will be over 1.5 billion data points stored each year.

Battery Maintenance

If a module exhibits a problem, the module will be changed out by GVEA crews. Saft personnel will be on site once a year to tear each module apart and identify the problem cells.

An industrial warehouse fork truck complete with an in-floor wire guide system will be used to remove/install modules and carry the pallet tank units (PTU) containing water. As the fork truck enters the aisle the wire guide system is acquired and the operator loses steering control (left/right). The operator still has control of forward/backward and up/down. The fork truck is a Raymond EASi Swing-Reach operator up truck which was specifically chosen to operate in the narrow (5’10”) aisle.

The primary maintenance function is anticipated to be watering of the cells. Considerable thought was put into the water system and how to streamline the maintenance procedures to insure that a string is down for the minimum time. The water system starts with an industrial water deionizer water processing station that will service one of two PTU’s. To facilitate the watering of the individual cells a self contained filling system will be installed on each module and connected in a way that allows the simultaneous filling of two modules (20 cells) in a single operation. Due to the expected yearly cycles (discharge/charge) the BESS will experience it is anticipated that ½ of the electrolyte reserve will be consumed every two year. GVEA will replenish this reserve at the end of each two year cycle.

Battery Resizing

As we entered into contract negotiations with ABB it became clear, from a system standpoint, that GVEA would not need 40 MW from the BESS. The 40 MW number had been developed assuming that a new power plant, HCCP, in Healy would be on line by the time the BESS and the second transmission line were constructed. With HCCP on line the amount of secure power that could be imported into Fairbanks, from Healy, over the two transmission lines was 140 MW. If the new transmission line tripped, the old transmission line can handle 100 MW securely and the BESS would be expected to pick up the rest. With no clear indication as to when HCCP would be brought on line, GVEA decided to delay purchasing two battery strings. This reduced the guaranteed output of the BESS to 26.67 MW. This is a significant reduction but if you refer back to the Power Supply Outages graph you can see that we should still be able to eliminate 68% of the power supply outages experienced by our members.

As we started to explore the ramifications of battery strings being added at a later date, it became obvious that the guarantees would have to be tweaked. Saft developed a per string capacity guarantee that took into account the effective age of each string. It was determined that the effective age would be either the calendar age of the string (in years) or a number calculated by taking the number of cycle equivalents each string has been subjected to and dividing by 10. Whichever number is greater will be considered the effective age of that string. Each time the BESS discharges, the energy per string will be measured and the cycle equivalent determined by the following table.

BESS Output (MWh/string)	Cycle Equivalent
Over 2.8	1.2
2.10 -2.80	1.0
1.40 – 2.10	0.75
1.05 – 1.40	0.55
0.70 – 1.05	0.30
0.35 – 0.70	0.10
< 0.35	0.00

Once the effective age in years has been calculated, the table below is used to determine the approximate capacity (MW) for each string. These minimum string 15-minute rates are guaranteed by Saft.

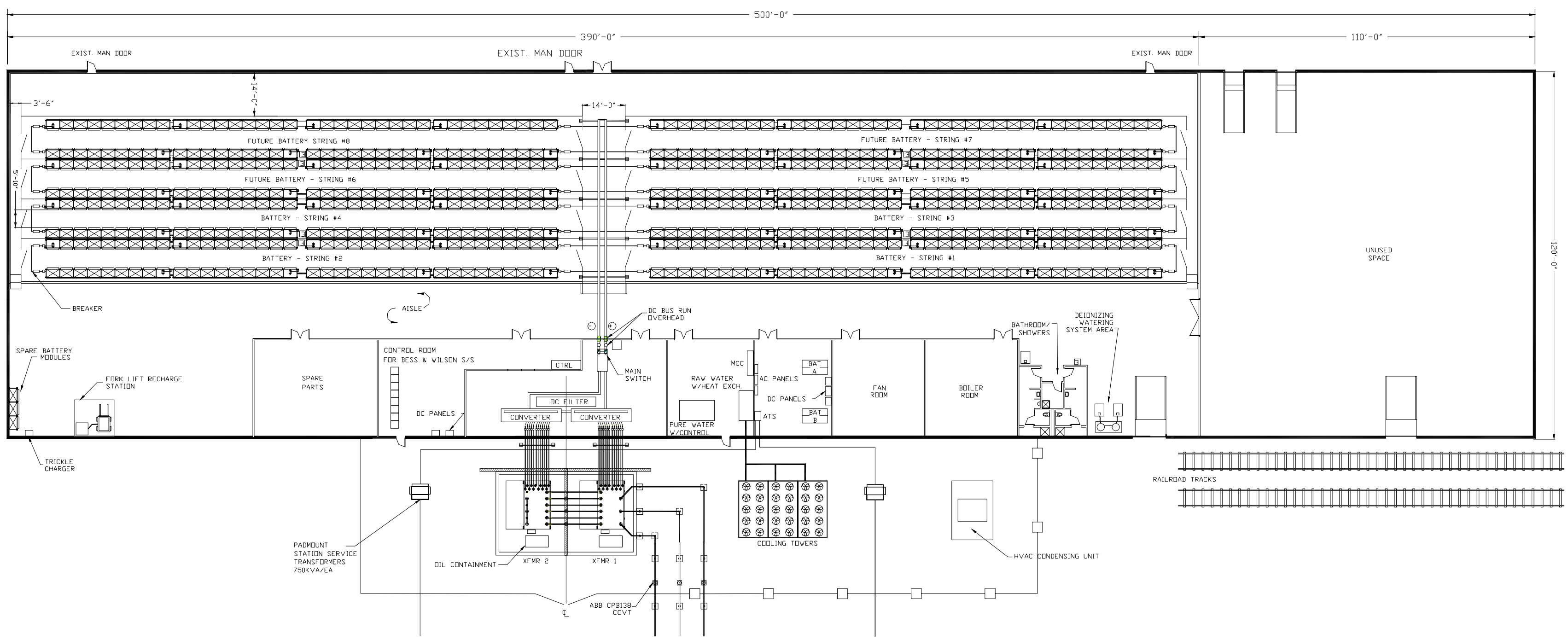
Effective String Age and MW Guarantee

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
MW	6.67	6.67	6.67	6.67	6.67	6.67	6.43	6.19	5.95	5.71	5.48	5.24	5.00

PROJECT SCHEDULE

The demolition of the building started in January with existing electrical, plumbing and mechanical systems being removed. The walls, floor and ceiling are being cleaned, prepped and painted. A new HVAC system is being installed, the existing fire system upgraded and new lighting will be installed. The exterior of the building will be patched and painted. Interior walls for the PCS, SwedeWater system, control room, air handling and boiler will start in May 2002. PCS equipment will start arriving in October 2002 with battery modules arriving in late in 2002.

Project Start	10/30/01
30% Design Review Complete	12/15/01
90% Design Review Complete	3/22/02
Construction and Installation Complete	4/25/03
BESS Start Up with two battery strings	7/11/03
Begin 18 month Availability test	7/30/03
Final Documentation & Training complete	7/31/03
All four battery Strings installed	12/19/03
Provisional Acceptance Certificate	1/30/04



GVEA BESS LAYOUT (30% Design)