# Alaska Village Electric Cooperative

**Shaktoolik Wind Construction**

**95% Design Documents**

**AEA Grant #: 2195463**

**July 7, 2011**

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# Executive Summary

The Shaktoolik Wind Construction project involves the construction of a two 100kW wind turbine (200 kW total generation capacity) power project in the community of Shaktoolik, Alaska on the South end of the old village runway. Activities are currently underway and the majority of project work is expected to be completed during 2011. Project activities are centered on the installation of three project components:

1. Two Northwind 100 (100 kW) wind turbines
2. New Automated Switchgear
3. New Secondary Load Controls

Construction of the project is scheduled to begin during the summer 2011 season. Turbine installations will be completed during the summer of 2011 and associated integration activities are expected to be completed by the close of the year. Construction activities will be completed by Alaska Village Electric Cooperative (AVEC) through existing construction management contracts and electrical integration activities will be completed by internal cooperative resources.

Cost estimates have been outlined in the existing grant agreement between AVEC and the Alaska Energy Authority (AEA). Total project costs are budgeted at $3,023,000 and are based on the following contributions:

| | |
|---|---|
| Alaska Energy Authority | $ 2,465,664 |
| Alaska Village Electric Cooperative (Project Match) | $ 262,296 |
| Alaska Village Electric Cooperative (Additional Contribution) | $ 295,040 |
| **Total Project Costs** | **$ 3,023,000** |

Of the total project costs, $2,465,664 have been allocated to construction activities and $230,972 has been allocated to final design activities.

Wind conditions at the project site have been estimated at 6.38 m/s (at 30 M hub height) through the combination of recorded MET tower data. The completed project is expected to run at a 27.5% capacity factor (90% availability) which will create a high penetration wind/diesel system once the project is fully complete. Average wind penetration level for the project is estimated to be 56% (90% turbine availability) based on an average load for Shaktoolik at 98 kW (max village load of 181 kW and estimated minimum load of 60 kW. Through the scope of work under this project, the installation is expected to displace approximately 48,342 gallons of diesel fuel annually.

Completed geotechnical analysis indicates that the project site maintains some of the best soil conditions within community. The project site is located on the community's abandoned air strip and, as a result of prior use, contains large volumes of structurally sound and well compacted fill material to support the tower's loading requirements. Geotech analysis has not revealed any conditions that the project team is not intimately familiar with through the execution of similar scopes of work in similar locations across the Norton Sound region. Foundation designs for the installed wind turbines have been designed with consideration of soil conditions at the project site and document a poured in place spread footing. AVEC has utilized a similar foundation design at the cooperative's wind turbine installation in Gambell, but the design is most similar to the turbine foundations installed in Unalakleet.

All wind generated electricity from the project will be managed through Secondary Load Controlling equipment installed at the Shaktoolik powerhouse facilities. Integration equipment installed as part of this project consists of automated switchgear, a secondary load controller, and resistive heat load equipment. All necessary secondary heat loads associated with the project have not been fully determined at this time, but AVEC intends to utilize a resistive dump load boiler (hot water heater) as the primary load controlling piece of equipment. Additional heat loads are expected to be installed and will be determined during the process of developing final integration designs. Heat generated from the excess energy will be utilized primarily at the community powerhouse; however, AVEC is in the process of determining other uses for the thermal energy generated by the project at locations elsewhere in the community. These other uses may include the implementation of dispatchable heating equipment in various community buildings locations in Shaktoolik.

Major equipment (wind turbines) is covered under a two year manufacturer warranty and AVEC will service the new generation equipment in accordance with established procedures for AVEC's existing wind energy systems. The Shaktoolik project will be the $11^{th}$ wind-diesel installation the cooperative has undertaken. Installed equipment and operational procedures will be consistent with AVEC's existing fleet-wide components and practices.

## Schedule and Budget Overview

Project activities for the Shaktoolik Wind Construction project are currently underway. As of December 2009, wind turbines for the project have been procured and will be delivered to the project site along with all other construction materials and equipment with the first barge shipment to Shaktoolik in 2011. Construction of the project will begin during the summer 2011 season. Construction activities for the wind farm and distribution line are expected to be completed by fall 2011 and integration work is expected to be concluded by the end of 2011. An updated version of the project master schedule is included as an attachment to this document.

The total project costs for the wind power/intertie project are estimated to be $3,023,000 and the current project design of two turbines and the associated controls has been budgeted for as follows:

| | |
|---|---|
| Total Wind Project Costs | $ 1,750,000 |
| Total Integration/Control Costs | $ 1,273,000 |
| **Total Project Costs** | **$ 3,023,000** |

Consistent with AVEC's/AEA's grant agreement, a project budget is included below:

| BUDGET SUMMARY | TOTAL GRANT BUDGET |
|---|---|
| **BY TASK OR MILESTONE** | |
| Milestone 1 | $ 255,500 |
| Milestone 2 | $ 2,740,732 |
| Milestone 3 | $ 26,768 |
| **TOTAL** | **$ 3,023,000** |
| **BY BUDGET CATEGORIES** | |
| Direct Labor and Benefits | $ 442,688 |
| Travel | $ 1,453,870 |
| Equipment | $ 488,482 |
| Contractural Services | $ 70,600 |
| Construction Services | $ 50,000 |
| Supplies | $ 271,700 |
| Other Direct Costs | $ 245,660 |
| **TOTAL** | **$ 3,023,000** |
| **BY FUND SOURCES** | |
| Grant Funds (90%) | $ 2,465,664 |
| Grantee Match – Cash (10%) | $ 262,296 |
| Other Contributions | $ 295,040 |
| **TOTAL** | **$ 3,023,000** |

# Electrical System Overview

AVEC expects the installed Northwind 100 wind turbines to produce approximately 56% of the electricity consumed in Shaktoolik today (based on 90% turbine availability). The wind turbines should supply almost 480,230 kWh of electrical energy annually, including excess energy used to heat water. The completed project will possess one of the highest penetration levels of the wind-diesel systems currently maintained by the cooperative and, as a result, will require load management equipment to efficiently manage energy supplies. Final integration designs are in progress and AVEC intends to utilize a secondary load controller, a dump load water heater, and resistive air heaters as the primary energy management tools.

The wind turbines will interconnect with the existing diesel power plant in Shaktoolik. Secondary load control will dispatch the installed water heater (along with additional load management equipment that may be installed) as required to use excess wind energy while allowing the diesel generators to continue running at efficient/programmed levels. The wind-generated electrical energy will be delivered using a slightly extended electrical distribution grid also included as part of this project.

The goal of this project is to reduce the cost of energy within the community and this will be accomplished through the displacement of diesel generation/heating fuels.

**Constraints**

Electricity generated from the project is subjected to the constraints of physical abilities to transmit the energy to where it is needed when it is produced (or stored for a use at a later date) and the total energy demands across the community. Neither constraint is expected to present significant challenge and will be considered with the development of final integration designs.

**Wind Resource Documentation**

Detailed information regarding the wind resource is included in the attached “Shaktoolik, Alaska Wind Power Report.”

**Annual Electric Load Data**

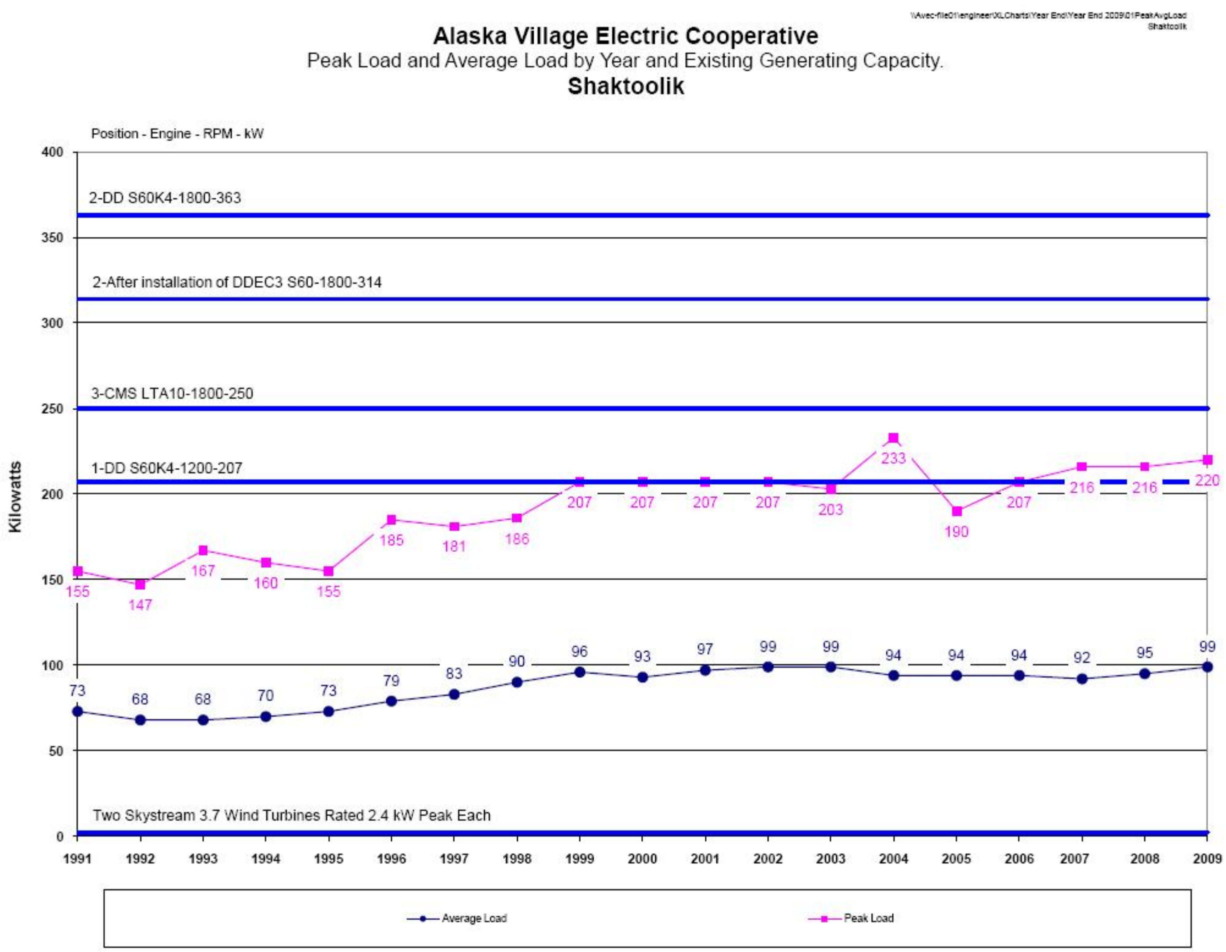
To evaluate Skahtoolik’s load profile, historic generation data was synthesized using the Alaska village load calculator spreadsheet developed by the AEA. The results were then adjusted slightly to match actual data recorded in Shaktoolik documented by AVEC in the cooperative’s annual power generation report. The result is a load profile with 98 kW average load, 181 kW peak load, and 60 kW minimum load. Seasonal, daily and Map profiles of Shaktoolik’s load can be found in the attached Shaktoolik, Alaska Wind Power Report.

AVEC is currently in the process of installing digital data loggers at all of their generation facilities across the cooperative’s network. Data loggers are expected to be installed in Shaktoolik in 2011. Data captured through these devices will be recorded at 15 minute resolution and will be utilized to further evaluate design and operational considerations for the new wind-diesel system.

**Load Projection**

The community of Shaktoolik has experienced steady growth in monthly kWh consumption that is consistent with AVEC's system wide averages. Consumption/Generation in Shaktoolik has increased by approximately 35% since 1991 (1.7% annual average). It is expected that the load in Shaktoolik will continue to grow throughout the duration of the project's lifespan at a rate that is comparable to AVEC system wide averages. Over the same period (1992-2009), consumption has grown by 27% (1.36% annual average) across AVEC's entire network.

Information involving trends regarding average monthly consumption Shaktoolik can be found in the chart below.



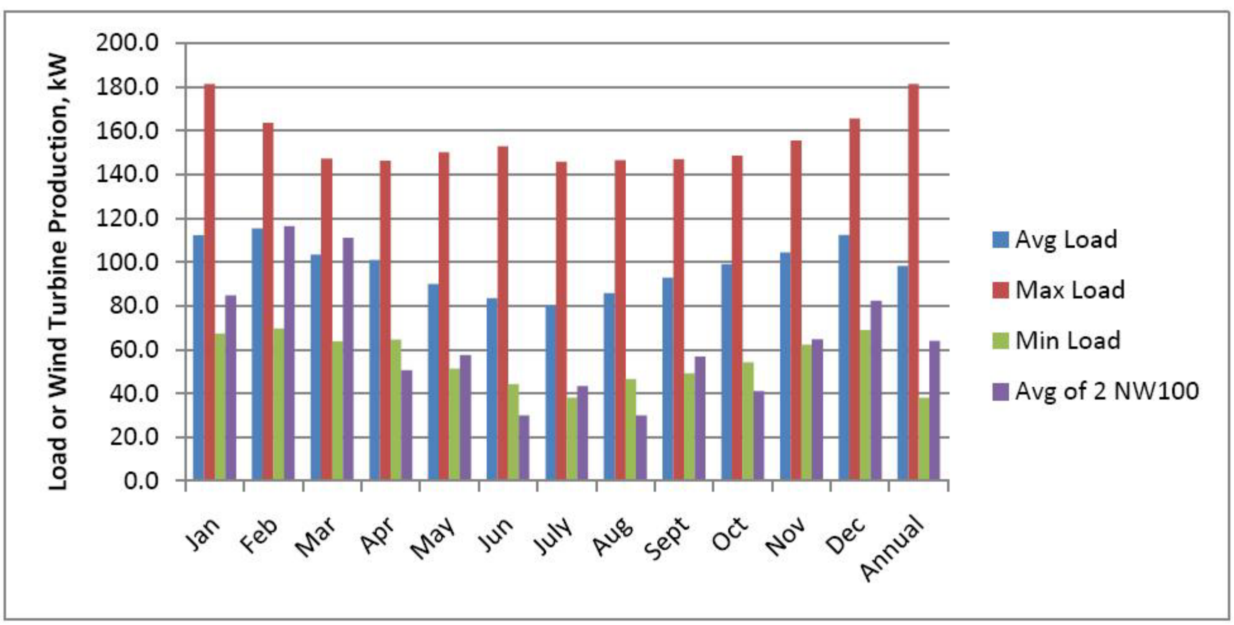
## Performance Modeling

**Operational Modeling**

The relatively high penetration level of the completed wind-diesel system (estimated at 55.8% wind penetration – 90% turbine availability) in comparison to existing AVEC managed wind-diesel systems will result in excess wind generated energy. Due to existing AVEC established operating procedures and consumption patterns in the community, there will be periods when the amount of wind generated electricity on the Shaktoolik electrical system exceeds current demand. This excess energy will be managed through the use of secondary load controlling equipment.

Excess energy will be utilized at the Shaktoolik powerhouse through an installed dump load water heater that is connected into existing heat loops within the facility. Excess energy supplies have been factored into economic modeling and estimates indicate that 20% of energy produced by the wind farm will be utilized for thermal applications.

Anticipated wind production also correlates well to periods of high demand within the community. This also contributes to a more stable electrical system. More information about anticipated monthly energy contributions from generation resources in the community can be found in the attached Shaktoolik, Alaska Wind Power Report. A summary chart of expected wind penetration on the system can be found below:



**Updated Economic Modeling**

Utilizing AEA REF grant assumptions, a revised economic analysis for the project was also completed. The results of this analysis and the assumptions utilized are noted below.

| Results | |
|---|---|
| NPV Benefits | $2,446,546 |
| NPV Capital Costs | $2,120,841 |
| B/C Ratio | 1.15 |
| NPV Net Benefit | $325,706 |

The AEA analysis was based on the following assumptions:

| Performance | Unit | Value |
|---|---|---|
| Displaced Electricity | kWh per year | 480,230 |
| Displaced Electricity | total lifetime kWh | 9,604,600 |
| Displaced Petroleum Fuel | gallons per year | 40,159 |
| Displaced Petroleum Fuel | total lifetime gallons | 803,186 |
| Displaced Natural Gas | mmBtu per year | - |
| Displaced Natural Gas | total lifetime mmBtu | - |
| Avoided CO2 | tonnes per year | 408 |
| Avoided CO2 | total lifetime tonnes | 8,155 |
| | | |
| **Proposed System** | **Unit** | **Value** |
| Capital Costs | $ | $ 3,023,000 |
| Project Start | year | 2011 |
| Project Life | years | 20 |
| Displaced Electric | kWh per year | 480,230 |
| Displaced Heat | gallons displaced per year | 5,360 |
| Displaced Transportation | gallons displaced per year | - |
| Renewable Generation O&M | $ per kWh | $ 0.022 |
| | | |
| **Base System** | **Unit** | **Value** |
| Diesel Generator O&M | $ per kWh | $ 0.020 |
| Diesel Generation Efficiency | kWh per gallon | 13.80 |
| | | |
| **Parameters** | **Unit** | **Value** |
| Heating Fuel Premium | $ per gallon | $ 0.50 |
| Transportation Fuel Premium | $ per gallon | $ 1.00 |
| Discount Rate | % per year | 3% |
| Crude Oil | $ per barrel | $ 110.00 |
| Natural Gas | $ per mmBtu | EIA |

# Civil Design

AVEC has spent significant resources evaluating potential project sites for the wind project within the community of Shaktoolik.  Final civil designs document the project installation site for two turbines.  The installation site is located on the community's abandoned air strip on the Northern edge of the village. The installed turbines will be placed approximately 680' apart and are referenced as site "T-1" and "T-2" in the attached diagrams/reports.  At this time, FAA permits for both turbines have also been obtained for construction for this site along with several other project related permits. Civil works associated with the project also include the installation of new electrical distribution lines between the project site and the Shaktoolik power house.

No significant site access construction will be necessary due to the project's placement on developed lands at the old airstrip.  Lease agreements for the project site have already been executed between AVEC and the land owner (Shaktoolik Native Corporation).

A site plan for the project is included as an attachment to this document.

**Geotechnical Evaluation**
Significant subsurface investigation has been completed at the project site since it was first examined by the Alaska Department of Transportation in 1980.

Shaktoolik is located about 10 miles east of Cape Denbigh and 35 miles north of Unalakleet on Alaska's coast with Norton Sound. Shaktoolik lies within the Norton Bay Lowland, an extension of Yukon Kuskokwim Lowlands in the Bering Shelf Physiographic Province. Near the coast, the lowland is characterized by a series of low beach ridges marked by lines of thaw lakes. Wind-blown silt covers much of the area. Permafrost underlies most of the lowland and surface drainage is generally poor. Meandering streams with extremely low gradients are typical.

Locally, the village of Shaktoolik occupies a low, narrow spit with the Tagoomenik River to the east and Norton Sound to the west. The Tagoomenik River joins the Shaktoolik River near the proposed wind turbine site, about 2 miles from the Shaktoolik River's outlet into Norton Sound. The spit is generally composed of washed sand and gravel beach deposits and is about 10 to 15 feet above sea level. Undisturbed areas near the proposed wind turbine site are generally covered with tundra vegetation, and grasses are noted in some areas, including near the beach on the west side of the spit.

The subsurface soil conditions observed at the proposed wind turbine locations consist primarily of sand with gravel beach deposits. At turbine location T-2, a granular fill pad from the old runway embankment was observed to a depth of about 4.5 feet, and was underlain by sand with gravel to exploration depth, 11.5 feet deep.

Thermal conditions at the proposed wind turbine site differed at the two turbine locations. At turbine location T-1, surface thaw had extended 1 to 3 feet deep, underlain by frozen ground to exploration depths, 5 to 9 feet deep. Visible ice was observed in the test pits, between 5 and 10 percent as clear and white crystals.

Unfrozen conditions were observed beneath a seasonally frozen layer 6 feet deep in test pit G10-SKK-1 at turbine location T-2. There was no visible ice observed in frozen soil in G10-SKK-1. Ground water was not observed in the test pit G10-SKK-1 during the exploration.

A complete geotechnical report for the project is included as an attachment to this document.

**Foundation Design**

AVEC will utilize a pre-cast foundation design for the project. The foundation is constructed in Seattle and will be barged to Shaktoolik for installation. The pre-cast foundation will be placed, tensioned, and installed in a non-permafrost location identified in the project sitemaps.

A complete set of foundation drawings (95% level) is included as an attachment to this document.

**Distribution Design**

AVEC will install new distribution lines for the project providing a 3-Phase electrical connection between the wind project and existing power plant facility in Shaktoolik. The installed line will run west from the turbines along the old apron access road to its junction with the main road. The line would then be routed along the west side of the main road. The line would be attached to approximately eleven 40-foot tall poles. Each pole, approximately 12 inches in diameter at the base and approximately 40 feet tall, would be placed in a hole approximately 4-5 feet deep. Typically, two guy wires would support each utility pole. Final designs for the distribution line are currently being developed.

A map indicating routing for this new line is included as an attachment to this document.

## Electrical Design

The Shaktoolik project involves the installation of 2 Northwind 100B wind turbines (200 KW total generation capacity for the project), new automated switchgear, Secondary Load Controller (SLC), new secondary electric loads, and a wind dispatch control module. The installed turbines will be located on the northern edge of Shaktoolik, approximately 1 mile from AVEC's existing power plant. The wind installation will be electrically connected into existing 3 Phase service and the energy produced from the system will be utilized across AVEC's existing distribution network in the community. Communications with the installed turbines will be managed through an installed wireless system that links the wind generators with new controls located in the Shaktoolik powerhouse. All integration activities associated with the wind installation will be completed within the existing butler building.

Final design activities are in progress and AVEC anticipates having all aspects of the wind energy system commissioned and fully operational by the end of 2011. Remaining integration activities are being executed internally by AVEC Operations and Engineering staff and equipment suppliers (Northern Power). AVEC is currently designing a SLC module internally (AVEC has procured this equipment from outside vendors in the past) which will be utilized for the Shaktoolik project. The design for the particular piece of equipment will be almost identical to other SLC's designed for other AVEC wind-diesel applications (Mekoryuk, Quinhagak, and Emmonak as examples). The project will utilize a Wind Turbine Dispatch Controller, designed and constructed by AVEC, that will ultimately by integrated with the SLC. Almost identical to AVEC's wind-diesel system under construction in Emmonak, the Shaktoolik installation will also utilize a dump load water heater to manage excess wind energy supplies and maintain overall system stability. This equipment is consistent with the fleet components that are found throughout the cooperative's network of wind-diesel systems.

Additional dump load heating equipment will be considered as necessary as AVEC gains operational experience with the new system. Due to relatively high penetration levels of Shaktoolik's wind system, the completed project is expected to provide significant contributions towards heating loads. This operational situation will be considered during the development of final designs.

The major integration components of Shaktoolik's wind-diesel system consist of (equipment to be installed through the scope of this project in italic):

- *Two (2) Northwind 100B wind turbines*
- *Wireless communication system (for installed wind turbines)*
- *SmartView SCADA System*
- *Northern Power Wind Turbine Dispatch Controller (WTDC)*
- *AVEC Secondary Load Controller (SLC)*
- *Secondary Electric Load Equipment (dump load water heater and potentially additional resistive air heaters)*
- *Kohler Automated Switchgear*
- Three diesel-powered generator sets
    - 207 kW
    - 175 kW

- 250 kW
- *Kohler Supervisory Diesel Controller (PLC)*

Energy production estimates for the Shaktoolik wind system indicate that it should have an approximate 27.5% capacity factor which would result in average wind penetration level of 56% based on the reported average load of 98 kW (2009 data). It is expected that the penetration level of the completed wind system will result in operational situations when the energy output of the wind turbines exceeds the load in community. In situations when wind energy production exceeds current electricity demand within the community (along with total dump load capacity in the connected hot water heaters/heat loop) wind production is curtailed by shutting down wind turbines as necessary to maintain system stability. In Shaktoolik, it is also expected that these procedures will need to be fine tuned once the cooperative gains operational experience with this particular system. Decisions regarding the operation schedules for the Shaktoolik turbines along with the potential necessity for additional electric dump load equipment will be made through operational experience after the system is fully functional. AVEC anticipates the completion of all on-going integration activities for the Shaktoolik project during 2011.

One way AVEC has accommodated excess wind energy without shutting down wind turbines in the past has been accomplished through the utilization of a Secondary Load Controller (SLC). AVEC has utilized this equipment at Selawik, Kasigluk and Toksook Bay with SLC's supplied by Sustainable Automation. This is currently being completed at Chevak, Hooper Bay, and Gambell with SLC's supplied by Northern Power as well. Similar to AVEC's wind-diesel system in Quinhagak (and the one under construction in Emmonak), the cooperative will also utilize a SLC in Shaktoolik that is being designed, constructed, and installed through the AVEC's internal Operations and Engineering departments in lieu of procuring a SLC supplied by an outside vendor as AVEC has done in the past. The existing SLC's at Selawik, Kasigluk, and Toksook Bay, and soon to be installed SLC's in Chevak, Hooper Bay, and Gambell, all energize and de-energize resistive elements in a conventional water heater. At Shaktoolik, AVEC has decided to utilize a single dump load hot water heater (and potentially incorporate resistive air heaters if deemed necessary through operational experience) as load management equipment. As excess wind energy enters the electrical system, resistive elements within the water heater are turned on/off to balance overall energy flows and system parameters. The overall system design is almost identical to the systems AVEC is currently completing in Quinhagak and Emmonak.

Primarily, the purpose of Shaktoolik's SLC and resistive energy management equipment is to absorb excess energy generated by the wind turbines during periods of low village loads as well as to allow for maintaining some load on the diesels at all times. This will maintain overall system stability and reliability during periods of fluctuating wind. There is also an indication that through the extremely fast on/off switching of elements in the dump load hot water heater, the SLC will counter the rapid changes in the output of the wind turbines to improve overall power quality. It is expected that the AVEC designed SLC switching cabinet-dump load combinations will perform better than the systems previously supplied Sustainable Automation or Northern Power SLC switching cabinet-water heater combinations due to tighter and more integrated engineering elements.

Similar in design to the dump load water heaters that AVEC has utilized in the past, the installed dump load water heater in Shaktoolik will have a total capacity above the total generation capacity of the wind system including all resistive steps. This design element will allow the boiler to accept additional energy supplies from the wind farm and on-line diesel generators if deemed prudent by operational set points and specific system settings. During the fabrication of the new SLC, the final size of the individual resistance steps (along with total resistive capacity) in the water heater will be documented. The water heater consists of “off the shelf” technology and will be manufactured by Caloritech. Water heated though this system will be connected into the existing heat loop within the Shaktoolik power plant and utilized to offset the cooperative’s heating costs/operational cost at the facility.

AVEC’s internally developed SLC is also being designed to incorporate the future functionality of dispatchable tertiary electric heating loads located across the community. It is anticipated that these tertiary systems (either hydronic or forced air) would be installed in public facilities (school, city offices, village corporation) and be utilized to supplement existing diesel fired heating systems in these facilities. The applicability and/or necessity of tertiary load management equipment and controls will be determined by AVEC once operational history/data is obtained from the newly installed wind system. Nonetheless, all integration equipment associated with the installation in Shaktoolik will be limited initially to the power house until AVEC gathers some operational experience with the new system.

Once all integration work at Shaktoolik is complete, wind generated electricity will be managed through the utilization of the SLC. The primary function of the SLC will be to manage general generation parameters and set points established by the overarching diesel control system (PLC) which monitors village load conditions and diesel generation. The supervisory PLC controller also places generators on/off-line as required to meet system demands while sending appropriate signals to the SLC about the ability to turn wind generators on and off and where to direct wind generated electricity on the system (towards village electrical demand or towards heating loads). In Shaktoolik, as in all of AVEC’s automated village power systems, set points for individual generators are established in the PLC programming to regulate generator run times in order to:

1) Ensure that adequate generation capacity is on-line to meet current and anticipated system demands
2) Maximize diesel fuel efficiency
3) Provide individual generators within each village system relatively consistent run time
4) Maintain proper operation temperatures in the village power house

Across AVEC’s network of isolated generation facilities, established generation set points vary widely depending on the make, model, and age of individual generators along with the overall system configuration in each village. Nonetheless, AVEC generally establishes set point parameters that allow individual generator sets to operate between 25% and 100% of their rated capacity. For example, in the case of a 200 kW diesel generator, an installed AVEC PLC would allow this particular generator to operate between 50 kW and 200 kW. Additionally, as a general operational rule, AVEC systems will not allow any generator to run below 50 kW of output at any given time, so the minimum set point of this particular set (or any generator below 200 kW max output) would be limited to 50 kW. AVEC’s general PLC programming guidelines will be followed in Shaktoolik which will essentially create three operational scenarios with the completed wind-diesel system:

1) **Diesel Only Operation:** When the wind turbines are offline, the generation system will function under normal demand control. When the system-wide demand exceeds 90% of the rated capacity generators currently on-line for more than 2 minutes, the PLC will automatically bring an additional (the most appropriately sized) generator on-line. Once the second generator is brought on-line and if demand drops below 80% of the generation capacity of either individual generator for a period of more than 5 minutes, one of the generators will be taken off-line.

2) **Low Penetration Wind-Diesel Operation** (system load greater 2x total wind project output): When conditions are such that the combined wind energy output is less than half the current total system demand, the power plant will function essentially as it does under diesel-only operation. In this mode, the PLC communicates with the WTDC to determine if/when turbines are allowed to run. Once this determination has been made, the installed SLC directs wind turbine energy supplies towards overall system demands (effectively reducing load on operating diesel generator sets) and/or diverts power to dump load heat elements as necessary to address quick shifts in power quality due to wind variations. This functionality provides overall system stability and keeps generators running within established parameters.

3) **Medium/High Penetration Wind-Diesel Operation** (system load is less than 2X total wind project output): When the conditions are such that the combined wind turbine output is providing more than half of the total system demand, the SLC will control resistive heating elements in the installed dump load elements to ensure that generators are run above their minimum operating capacity. Thus, the SLC functions as an active load management device by diverting wind generated electricity towards the fulfillment of general system demands and/or resistance heating elements as necessary to maintain proper load management, overall system stability, and optimum efficiencies. Should temperatures in the dump load water heater rise above acceptable levels, warm air is vented from the facility to ensure that adequate heat load capacity is available. Should diesel generation demands drop below minimum loading set points through the loss of the SLC (or inability of the SLC to send excess energy to resistive elements), the PLC signals the WTDC to shutdown turbines as necessary to maintain system stability. As necessary, the SLC also controls the air heaters to deliver heat sufficient enough to maintain adequate loading capacity on operating diesel-generators. It is anticipated that under this operational scenario, some level of wind generated electricity would be diverted to resistive elements at all times.

AVEC also anticipates having the WTDC module installed and commissioned in the Shaktoolik plant prior to the installation of the SLC. During this interim (period between WTDC commissioning and SLC commissioning), AVEC will run installed turbines conservatively through the use of the WTDC to manage wind generated electricity supplies. Under this temporary operational scenario, varying set point parameters will be tested and established to prevent wind generated energy supplies from overpowering the electrical system. These parameters will essentially limit the project to low instantaneous penetration levels until the SLC is installed later this year. AVEC anticipates the SLC to be installed concurrently with the installation of new, automated switchgear at the facility.

**Communication Integration Plan**

Reliable communications is essential to the monitoring, control and trouble shooting of the wind system installed in Shaktoolik. Northern Power's web based Smart View SCADA System is the medium for providing this necessary information and control of the Shaktoolik wind system. AVEC will install a wireless communication system between the wind turbines and the Shaktoolik power plant to monitor energy production and system performance along with general turbine control. A decision was made to install a wireless system in lieu of the "hard wired" fiber optic cable system previously used at AVEC's existing installations at Toksook Bay, Kasigluk, Savoonga, Hooper Bay and Gambell. The wireless system will be identical to what is currently being deployed in Mekoryuk, Quinhagak and Emmonak and consists of standardized AVEC fleet components.

Hardware for the communication system at Shaktoolik will consist of a L-Com Global Connectivity Hyperlink Wireless 900 MHZ Professional 8 dBi High Performance Omni Antenna Model HG908U-PRO at each wind turbine and at the power plant. This antenna is attached to a fiberglass support beam secured to the W36 main beam of each wind tower foundation with the top of the antenna 11' 2- 5/32" above the top of the wind tower foundation and located to the right side of the steel service mast.

AVEC Operations is expected to specify B & B Electronics LMR 400 cabling with an outside diameter of .405" and protected it with 2" liquid tight flex from the antenna to the spare conduit routed into the interior of the wind tower with the final designs. Inside the tower, AVEC Operations will utilize a new Hoffman cabinet mounted to the side of the Down Tower Junction Box. Included in this cabinet will be a 900 MHZ Wireless Ethernet Bridge. Both the bridge and the Ethernet switch utilize a 120 V power supply.
At the Shaktoolik power house, AVEC will utilize the same antenna as in Quinhagak and Mekoryuk. The antenna cable will then be routed to a Hergo Brand 24" x 14" x 18" Communications Cabinet located in the Butler building. This Communications Cabinet will house the proposed Ethernet Bridge and the proposed Ethernet switch and is also supplied with 120 V power.

Through this system, communications between the installed turbines and the Shaktoolik power house will be managed through the utilization of Northern Power's SmartView Monitoring System which provides a data logging and diagnostic interface required to provide remote support for the Northwind 100. The SmartView platform provides a user-friendly, real-time monitoring, control, and reporting platform. The SmartView platform allows access to turbine control features, and reporting for wind turbine owners, remote monitoring services from the Northern Power Network Operations Center (NOC).

The SmartView platform is based on a web-based HMI, but is currently being retooled to operate on AVEC's internal Intranet. Ultimately, AVEC will assume all monitoring responsibilities for their fleet of Northwind turbines, but will continue to utilize Northern Power's monitoring services for the Emmonak installation throughout the turbine warranty period (two years post-commissioning). Up to this time, Northern Power will provide web-based access so the 24/7 staffed NOC based in Vermont can provide support and turbine monitoring services to make sure the fleet is up and running and producing power at its optimum output. This configuration ensures that when a fault does occur, the system can get back on-line with the least amount of downtime. It is anticipated that the project will be operational through the use of the WTDC prior to AVEC assuming full monitoring responsibilities.

| General SmartView Specifications: | |
|---|---|
| Form | Browser based real time human-machine interface (HMI). |
| Distribution | Via the Internet or an organization's Intranet, allowing authorized personnel access to the system. |
| Access | Available on the web for public viewing or can be configured to operate within a network's firewall. |
| Information Included: | Energy production, wind speed, capacity factor, turbine availability, estimated cost savings, and historical data. |

Once integration activities are completed and the SmartView system retooling is complete, AVEC will continue to utilize a modified version of the existing SmartView platform for system management and control.

## Mechanical Design

Due to the relatively high penetration level of the completed wind installation in Shaktoolik, the new wind system is expected to provide thermal energy contributions. AVEC will install load management equipment to manage this thermal energy/excess wind energy generated through the completed project. These particular integration components are included within the scope of this project to:

- Ensure a high level of system stability
- Fully utilize all wind generated energy
- Incorporate integration components that will allow for relatively seamless project expansion in the future

Mechanical equipment installed through the scope of work in this project includes an electric dump load water heater and will be managed through the installed Secondary Load Controller and overarching power plant PLC. The installed water heater will be physically located in the Butler building and piped into an existing heat recovery system within the Shaktoolik power plant. An additional pump will be added during the installation of this equipment, but all other existing mechanical equipment will be unchanged. A mechanical drawing of the Shaktoolik power house that documents existing equipment, radiators, pumps, and controls is included as an attachment to this document.

The existing heat recovery system at the Shaktoolik plant is piped directly to existing generator sets to capture heat/facilitate cooling during the generation process. At this time, the existing heat loop is located entirely within the generation facility, however, the potential expansion of the system to additional buildings within the community will be considered during the generation of final designs. Due to the relatively high expected thermal contributions of the installed wind system, it is also expected that some operational procedures regarding heat utilization will need to be adjusted once the completed wind project is operational and the cooperative gains operational experience with the system.

The installed electric water heater will be sized well above any expected instantaneous power contributions from the installed wind system and comfortably within the overall mechanical system heat limitations. The water heater will be manufactured by Caloritech (CCI Thermal Technologies) with standard “off the shelf” technology that is consistent with existing fleet wide components utilized by the cooperative.

## Operations Planning

Once the Shaktoolik project is commissioned, AVEC will incorporate the new wind-diesel system into the cooperative's existing operational and maintenance programs that are in place across the utility's network of generation facilities. The project will be operated in a manner that will provide the greatest level of fuel savings possible.

Currently, AVEC employs numerous individuals that have received factory direct training regarding the installation, operation, and regular maintenance procedures of the turbines that will be installed in Shaktoolik. AVEC has sent participants to Northern Power's Level I and Level II wind technician trainings since 2005. These trainings occur at various times throughout the year. In anticipation of this particular project, AVEC sent a local resident from Emmonak to the turbine training in 2009 to make sure that there will be at least one individual with an understanding of the installed generators in the community.

Once the project is commissioned, AVEC will follow the regular annual maintenance procedures outlined in Operation and Maintenance manuals supplied by Northern Power. These practices are consistent with the procedures that are implemented at all existing wind-diesel facilities maintained by AVEC. The completed project will be incorporated in the cooperative's over-all depreciation schedules, maintained, and operated consistent with all other generation assets that are managed by the cooperative. The project presents no challenges or necessary changes to existing business practices maintained by AVEC.

The installed turbines are covered under a two year manufacturer's warranty which includes all parts and labor associated with repairs under this break-in period. Once this period expires, AVEC will maintain responsibility for performing any necessary repair or maintenance work. This procedure is identical to all other wind-diesel systems managed by the cooperative including those funded through AEA's Renewable Energy Fund program.

Should the project be expanded at a later date (additional installed turbines), AVEC will re-evaluate the potential availability of thermal/excess energy supplies and determine if enough will be produced to justify generating a thermal sales agreement and appropriate transmission infrastructure for these energy supplies.

Attached to this document are complete warranty terms for the procured Northwind turbines included as part of the executed sales agreement.

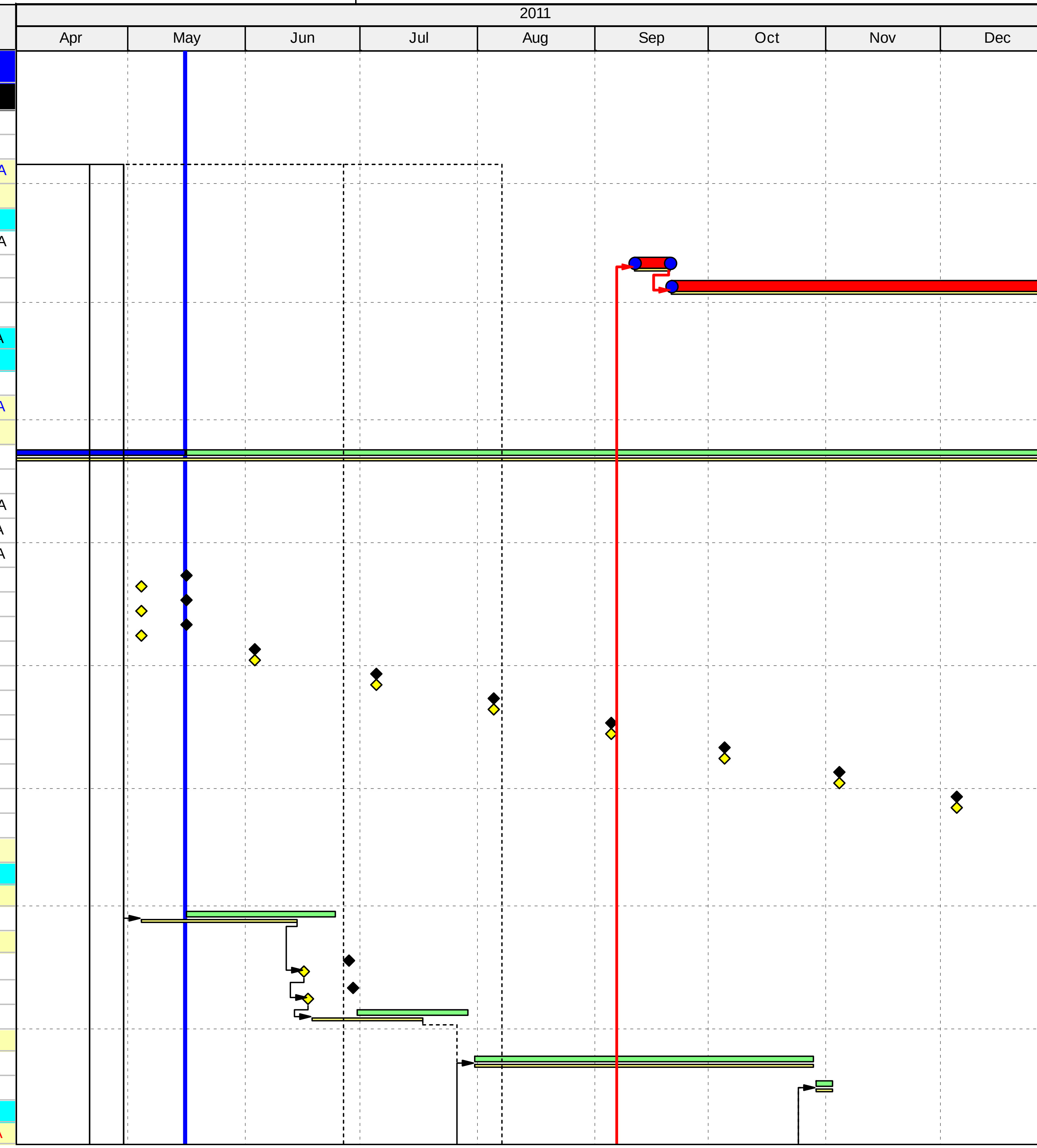
## Attachments

1. Updated Project Master Schedule
2. Electrical System Diagrams (15 sheets)
    a. Ground Grid Installation Diagram – 1 Sheet
    b. Shaktoolik Plant Plans – 4 Sheets
    c. Shaktoolik Control Module Foundation – 2 Sheets
    d. Shaktoolik 480V Sectionalizing Diagram – 1 Sheet
    e. Power Plant Wireway Diagrams – 3 Sheets

AVEC Scheduler
Sean Robbins
srobbins@avec.org; 351-4752



| Activity ID | Respons Departm | Activity Name | At mpletion | Activity % complete | Start | Finish |
|---|---|---|---|---|---|---|
| **SHKT Shaktoolik** | | | 2215d | | 01-Jan-06 A | 08-Feb-12 |
| **Shaktoolik Install Two Wind Turbines** | | | 2215d | | 01-Jan-06 A | 08-Feb-12 |
| SHKT.WND.1730 | A.MM | Stop Work Issued | 0d | 100% | 16-Jun-10 A | |
| SHKT.WND.1720 | A.MM | Resume Work (Based on FAA Permit Approval) | 0d | 100% | 01-Sep-10 A | |
| **Conceptual Design Report** | | | 260d | | 01-Jan-07 A | 31-Dec-07 A |
| **Site Control (WO 9724631)** | | | 2215d | | 01-Jan-06 A | 08-Feb-12 |
| **Replat and Record** | | | 2073d | | 17-May-06 A | 01-Feb-12 |
| SHKT.WND.1010 | A.MM | Conveyed to AVEC | 0d | 100% | 17-May-06 A | 17-May-06 A |
| SHKT.WND.1020 | S.SO | Replat and Record After Construction | 10d | 0% | 11-Sep-11 | 20-Sep-11 |
| SHKT.WND.1380 | A.MM | DNR Approve Draft Plat | 120d | 0% | 21-Sep-11 | 18-Jan-12 |
| SHKT.WND.1390 | A.MM | Record Replat and Quit Claim | 14d | 0% | 19-Jan-12 | 01-Feb-12 |
| **Convey to AVEC** | | | 1607d | | 01-Jan-06 A | 09-Jun-10 A |
| **Convey Back** | | | 5d | | 02-Feb-12 | 08-Feb-12 |
| SHKT.WND.1040 | A.MM | Convey Back to City | 5d | 0% | 02-Feb-12 | 08-Feb-12 |
| **Permitting (WO 9724631)** | | | 106d | | 17-May-10 A | 01-Sep-10 A |
| **Funding (AEA)** | | | 913d | | 01-Jul-09 A | 05-Jan-12 |
| SHKT.WND.1060 | A.AW | AEA Project 2195463 | 908d | 74.78% | 01-Jul-09 A | 30-Dec-11 |
| SHKT.WND.1950 | A.MM | Funding Agreement Signed | 0d | 100% | 16-Apr-10 A | |
| SHKT.WND.1940 | A.MM | Progress Report #1: Inception through October 31, 2010 | 0d | 100% | | 08-Nov-10 A |
| SHKT.WND.2080 | A.MM | 65% Design Review | 0d | 100% | | 31-Jan-11 A |
| SHKT.WND.1960 | A.MM | Progress Report #2: November 2010-January 2011 | 0d | 100% | | 01-Feb-11 A |
| SHKT.WND.1970 | A.MM | Monthly Progress Report: February 2011 | 0d | 0% | | 16-May-11 |
| SHKT.WND.1980 | A.MM | Monthly Progress Report: March 2011 | 0d | 0% | | 16-May-11 |
| SHKT.WND.1990 | A.MM | Monthly Progress Report: April 2011 | 0d | 0% | | 16-May-11 |
| SHKT.WND.2000 | A.MM | Monthly Progress Report: May 2011 | 0d | 0% | | 03-Jun-11* |
| SHKT.WND.2010 | A.MM | Monthly Progress Report: June 2011 | 0d | 0% | | 05-Jul-11* |
| SHKT.WND.2020 | A.MM | Monthly Progress Report: July 2011 | 0d | 0% | | 05-Aug-11* |
| SHKT.WND.2030 | A.MM | Monthly Progress Report: August 2011 | 0d | 0% | | 05-Sep-11* |
| SHKT.WND.2040 | A.MM | Monthly Progress Report: September 2011 | 0d | 0% | | 05-Oct-11* |
| SHKT.WND.2050 | A.MM | Monthly Progress Report: October 2011 | 0d | 0% | | 04-Nov-11* |
| SHKT.WND.2060 | A.MM | Monthly Progress Report: November 2011 | 0d | 0% | | 05-Dec-11* |
| SHKT.WND.2070 | A.MM | Monthly Progress Report: December 2011 | 0d | 0% | | 05-Jan-12* |
| **System** | | | 560d | | 20-Apr-10 A | 02-Nov-11 |
| **Power Plant 480v Conversion (WO TBD)** | | | 171d | | 16-May-11 | 02-Nov-11 |
| **Engineering and Design** | | | 30d | | 16-May-11 | 24-Jun-11 |
| SHKT.WND.1550 | AEN | Design 480V Conversion (Greg?) | 30d | 0% | 16-May-11 | 24-Jun-11 |
| **Materials** | | | 32d | | 28-Jun-11 | 29-Jul-11 |
| SHKT.WND.1560 | AEN | Generate 480V Conversion Staking Sheet | 0d | 0% | 28-Jun-11 | |
| SHKT.WND.1570 | AOP | Commit 480V Conversion Staking Sheet and Generate Ticket | 0d | 0% | 29-Jun-11 | |
| SHKT.WND.1580 | APR | Procure 480V Conversion Materials | 30d | 0% | 30-Jun-11 | 29-Jul-11 |
| **Installation** | | | 95d | | 31-Jul-11 | 02-Nov-11 |
| SHKT.WND.1590 | AOP | Convert Plant to 480V | 90d | 0% | 31-Jul-11 | 28-Oct-11 |
| SHKT.WND.1660 | AOP | Commission New Plant Configuration | 5d | 0% | 29-Oct-11 | 02-Nov-11 |
| **New Automated Switchgear (WO 9724621)** | | | 528d | | 17-May-10 A | 28-Oct-11 |
| **Engineering and Design** | | | 26d | | 18-Mar-11 A | 25-Apr-11 A |




Remaining Level of Effort
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Baseline Miles...
Milestone

# AVEC Project Schedule

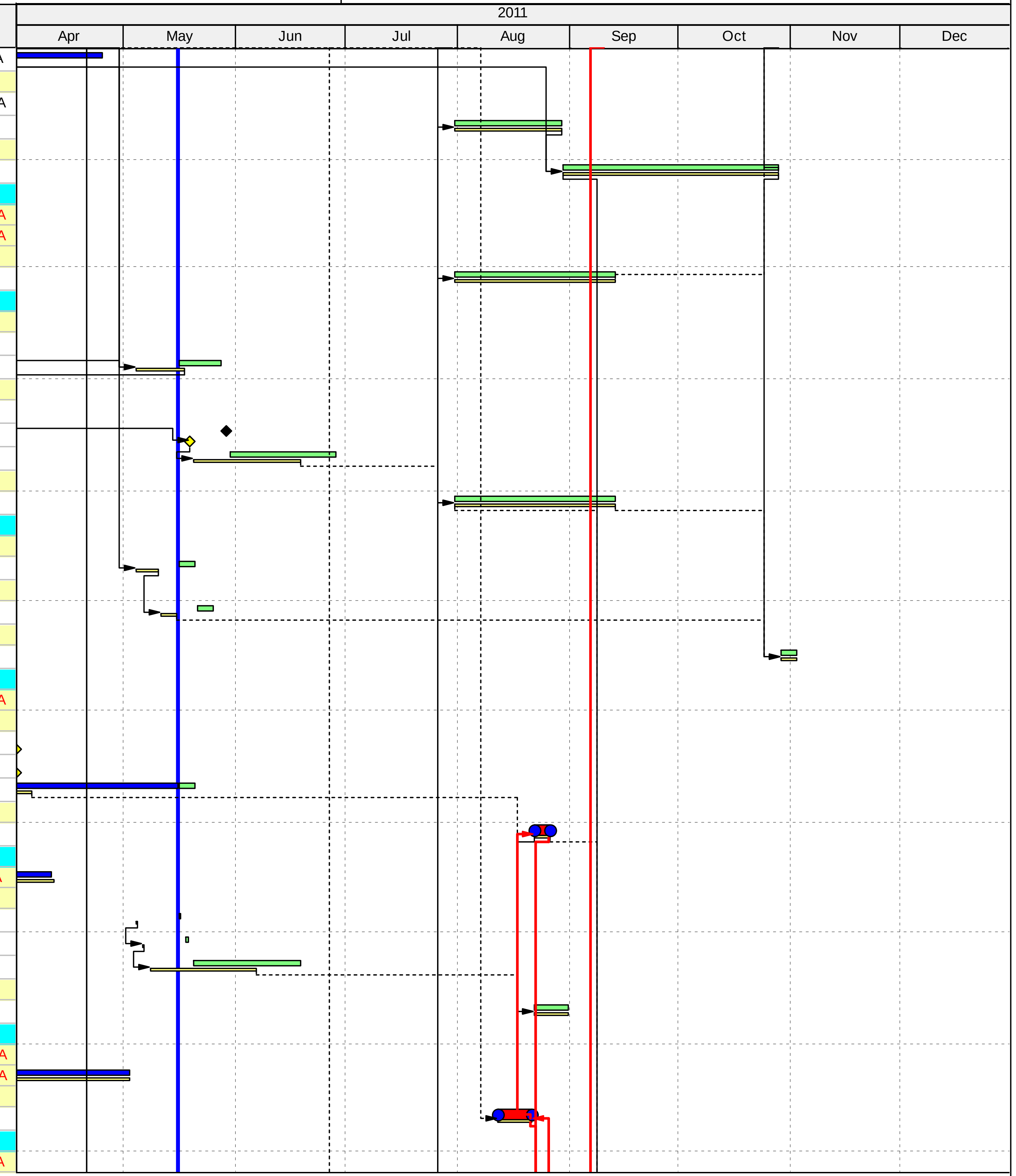
By Village and Project

Data Date: 16-May-11

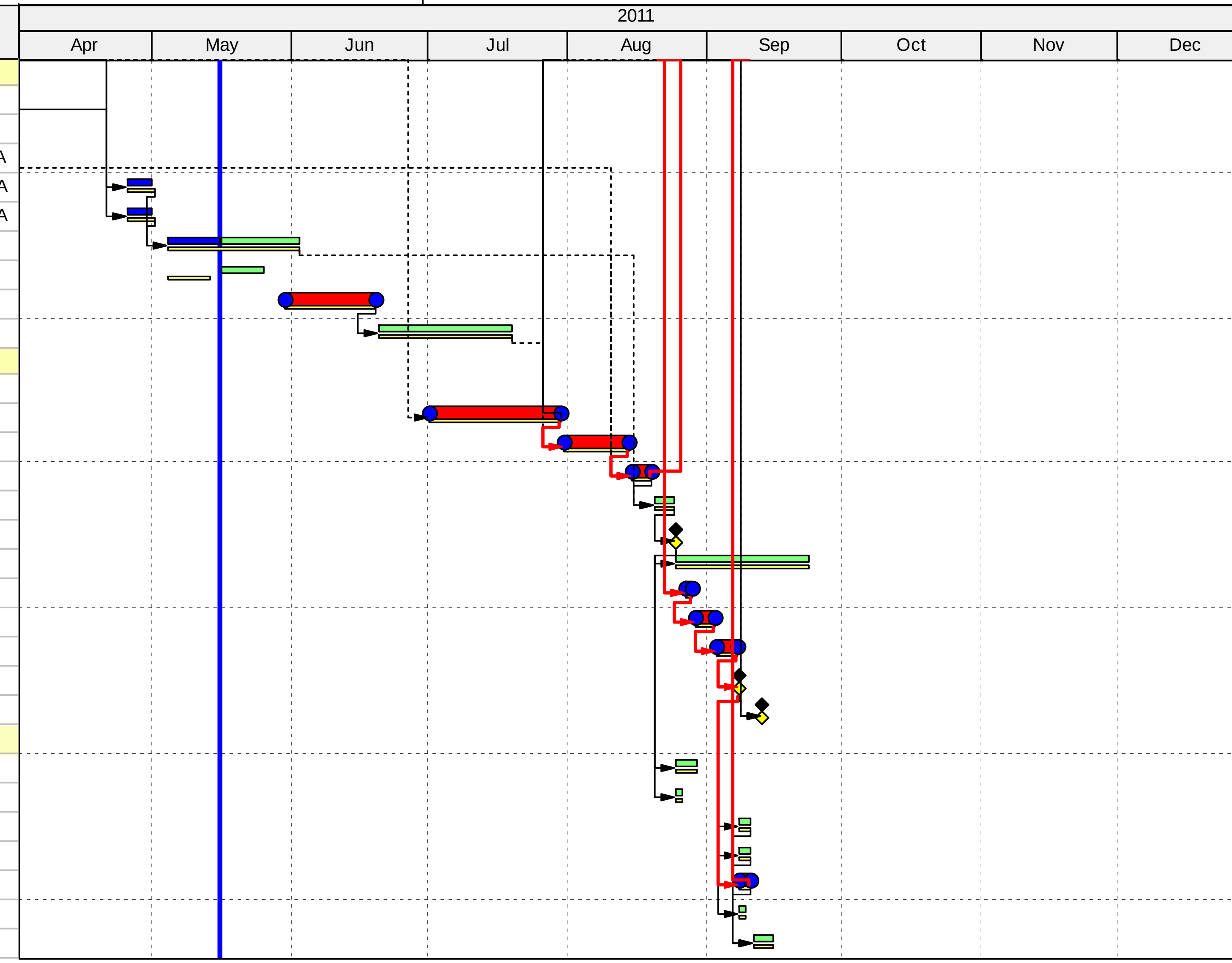
AVEC Scheduler
Sean Robbins
srobbins@avec.org; 351-4752



| Activity ID | Respons Departm | Activity Name | At Completion | Activity % Complete | Start | Finish |
|---|---|---|---|---|---|---|
| SHKT.WND.1890 | AEN | Engineer Switchgear Install (Adam) | 26d | 100% | 18-Mar-11 A | 25-Apr-11 A |
| **Materials** | | | 468d | | 17-May-10 A | 29-Aug-11 |
| SHKT.WND.1090 | APR | Procure Switchgear (PO103401, ticket 4372) | 134d | 100% | 17-May-10 A | 29-Sep-10 A |
| SHKT.WND.1900 | S.SO | Ship Switchgear to Shaktoolik | 30d | 0% | 31-Jul-11 | 29-Aug-11 |
| **Installation** | | | 60d | | 30-Aug-11 | 28-Oct-11 |
| SHKT.WND.1120 | AOP | Retrofit new switchgear into existing Butler building | 60d | 0% | 30-Aug-11 | 28-Oct-11 |
| **Switching Cabinet (WO 9724621)** | | | 225d | | 01-Feb-11 A | 13-Sep-11 |
| **Engineering and Design** | | | 18d | | 01-Feb-11 A | 25-Feb-11 A |
| **Materials** | | | 0d | | 25-Feb-11 A | 25-Feb-11 A |
| **Installation** | | | 45d | | 31-Jul-11 | 13-Sep-11 |
| SHKT.WND.1510 | AOP | Install Switching Cabinet | 45d | 0% | 31-Jul-11 | 13-Sep-11 |
| **Secondary Load (WO 9724631)** | | | 319d | | 29-Oct-10 A | 13-Sep-11 |
| **Engineering and Design** | | | 151d | | 29-Oct-10 A | 27-May-11 |
| SHKT.WND.1260 | A.BT | Ops Decide SLC Configuration (w/ Heat Recovery?) | 0d | 100% | 29-Oct-10 A | |
| SHKT.WND.1170 | AEN | Design Secondary Load System (Adam) | 10d | 0% | 16-May-11 | 27-May-11 |
| **Materials** | | | 242d | | 29-Oct-10 A | 28-Jun-11 |
| SHKT.WND.1520 | A.BT | Generate Secondary Load Staking Sheet | 0d | 100% | 29-Oct-10 A | |
| SHKT.WND.1530 | AOP | Commit Secondary Load Staking Sheet and Generate Ticket | 0d | 0% | 29-May-11 | |
| SHKT.WND.1540 | APR | Procure Secondary Load Materials | 30d | 0% | 30-May-11 | 28-Jun-11 |
| **Installation** | | | 45d | | 31-Jul-11 | 13-Sep-11 |
| SHKT.WND.1240 | AOP | Install Secondary Loads in/on Butler Building | 45d | 0% | 31-Jul-11 | 13-Sep-11 |
| **AVEC Dispatch Controller (WO 9724621)** | | | 171d | | 16-May-11 | 02-Nov-11 |
| **Engineering and Design** | | | 5d | | 16-May-11 | 20-May-11 |
| SHKT.WND.1640 | A.BT | Design Dispatch Controller (Installation Details) | 5d | 0% | 16-May-11 | 20-May-11 |
| **Materials** | | | 5d | | 21-May-11 | 25-May-11 |
| SHKT.WND.1650 | APR | Procure Dispatch Controller | 5d | 0% | 21-May-11 | 25-May-11 |
| **Installation** | | | 5d | | 29-Oct-11 | 02-Nov-11 |
| SHKT.WND.1320 | A.BT | Commission Wind Control and Secondary Load System | 5d | 0% | 29-Oct-11 | 02-Nov-11 |
| **Wireless Turbine Controls (WO 9724621)** | | | 159d | | 21-Mar-11 A | 26-Aug-11 |
| **Engineering and Design** | | | 4d | | 21-Mar-11 A | 25-Mar-11 A |
| **Materials** | | | 54d | | 28-Mar-11 A | 20-May-11 |
| SHKT.WND.1610 | A.BT | Generate Wireless Staking Sheet | 0d | 100% | 28-Mar-11 A | |
| SHKT.WND.1620 | AOP | Commit Wireless Staking Sheet and Generate Ticket | 0d | 100% | 28-Mar-11 A | |
| SHKT.WND.1330 | APR | Procure Wireless Communications Materials (off-the-shelf) | 50d | 0% | 01-Apr-11 A | 20-May-11 |
| **Installation** | | | 5d | | 22-Aug-11 | 26-Aug-11 |
| SHKT.WND.1340 | AOP | Install Wireless Communications | 5d | 0% | 22-Aug-11 | 26-Aug-11 |
| **Satellite Communications (WO 9724633)** | | | 153d | | 01-Apr-11 A | 31-Aug-11 |
| **Engineering and Design** | | | 10d | | 01-Apr-11 A | 11-Apr-11 A |
| **Materials** | | | 34d | | 16-May-11 | 18-Jun-11 |
| SHKT.WND.2130 | AEN | Generate Starband Staking Sheet | 1d | 0% | 16-May-11 | 16-May-11 |
| SHKT.WND.2140 | AOP | Commit Starband Staking Sheet | 1d | 0% | 18-May-11 | 18-May-11 |
| SHKT.WND.2150 | APR | Procure Starband Materials | 30d | 0% | 20-May-11 | 18-Jun-11 |
| **Installation** | | | 10d | | 22-Aug-11 | 31-Aug-11 |
| SHKT.WND.2160 | AOP | Install Starband System | 10d | 0% | 22-Aug-11 | 31-Aug-11 |
| **Distribution to Turbines (WO 9714661)** | | | 487d | | 20-Apr-10 A | 21-Aug-11 |
| **Engineering and Design** | | | 25d | | 20-Apr-10 A | 25-May-10 A |
| **Materials** | | | 349d | | 17-May-10 A | 02-May-11 A |
| **Installation** | | | 10d | | 12-Aug-11 | 21-Aug-11 |
| SHKT.WND.1110 | AOP | Finish Installing Lines to Turbine Site | 10d | 0% | 12-Aug-11 | 21-Aug-11 |
| **Wind Turbine (WO 9724631)** | | | 504d | | 06-May-10 A | 23-Sep-11 |
| **Engineering and Design** | | | 308d | | 06-May-10 A | 11-Mar-11 A |



| Activity ID | Respons Departm | Activity Name | At Completion | Activity % Complete | Start | Finish |
|---|---|---|---|---|---|---|
| **Materials** | | | 365d | | 19-Jul-10 A | 19-Jul-11 |
| SHKT.WND.1830 | NPS | Ship Blade from CA to VT for Coating | 4d | 100% | 19-Jul-10 A | 23-Jul-10 A |
| SHKT.WND.1860 | NPS | Coat Blades | 1d | 100% | 26-Jul-10 A | 26-Jul-10 A |
| SHKT.WND.1150 | S.GM | Ship Towers from Chevak (37m) | 17d | 100% | 07-Sep-10 A | 24-Sep-10 A |
| SHKT.WND.1160 | NPS | Transport Nacelles from VT to Seattle (20 ft containers) | 6d | 100% | 25-Apr-11 A | 01-May-11 A |
| SHKT.WND.1760 | NPS | Transport Blades from VT to Seattle (40 ft container) | 6d | 100% | 25-Apr-11 A | 01-May-11 A |
| SHKT.WND.1750 | S.SO | Ship Turbine Components from Seattle to Shaktoolik | 30d | 40% | 04-May-11 A | 02-Jun-11 |
| SHKT.WND.1220 | S.SO | STG Procure Tower Foundation Materials | 10d | 0% | 16-May-11* | 25-May-11 |
| SHKT.WND.2100 | S.SO | Concrete Tech Precast Bases in Seattle | 21d | 0% | 30-May-11* | 19-Jun-11 |
| SHKT.WND.2110 | S.SO | Ship Precast Bases from Seattle to Shaktoolik | 30d | 0% | 20-Jun-11 | 19-Jul-11 |
| **Installation** | | | 211d | | 25-Feb-11 A | 23-Sep-11 |
| SHKT.WND.2090 | S.SO | Shane Oyster Replaced Gary Matthews as STG PM | 0d | 100% | 25-Feb-11 A | |
| SHKT.WND.1230 | S.SO | STG Mobilize Eqpt from Multiple Locations, Western Alaska | 30d | 0% | 01-Jul-11* | 30-Jul-11 |
| SHKT.WND.1910 | S.SO | Set Precast Turbine Foundations | 15d | 0% | 31-Jul-11 | 14-Aug-11 |
| SHKT.WND.1190 | S.SO | Erect Towers | 5d | 0% | 15-Aug-11 | 19-Aug-11 |
| SHKT.WND.1200 | S.SO | Install Nacelle and Blades | 5d | 0% | 20-Aug-11 | 24-Aug-11 |
| SHKT.WND.1130 | NPS | Turbines Commissioned to Operate | 0d | 0% | 25-Aug-11 | |
| SHKT.WND.1600 | S.SO | STG Demobilize | 30d | 0% | 25-Aug-11 | 23-Sep-11 |
| SHKT.WND.1410 | NPS | NPS Commission SmartView Package | 2d | 0% | 27-Aug-11 | 28-Aug-11 |
| SHKT.WND.1420 | AOP | Provide Information for SCADA Screens | 5d | 0% | 29-Aug-11 | 02-Sep-11 |
| SHKT.WND.1430 | AOP | Install SCADA Equipment | 5d | 0% | 03-Sep-11 | 07-Sep-11 |
| SHKT.WND.1440 | NPS | Overall Turbine System Commissioning | 0d | 0% | 08-Sep-11 | |
| SHKT.WND.1350 | AOP | Turbine Should be Available to Generate Power | 0d | 0% | 13-Sep-11 | |
| **As-Builting (WO 9724631)** | | | 22d | | 25-Aug-11 | 15-Sep-11 |
| SHKT.WND.1400 | S.SO | Provide Turbine As-Built Info | 5d | 0% | 25-Aug-11 | 29-Aug-11 |
| SHKT.WND.1460 | AOP | Inventory Excess Materials for STG Backhauling | 2d | 0% | 25-Aug-11 | 26-Aug-11 |
| SHKT.WND.1140 | A.BT | Document System Logic | 3d | 0% | 08-Sep-11 | 10-Sep-11 |
| SHKT.WND.1360 | AOP | Survey and Document As-Built Conditions, Red Lines | 3d | 0% | 08-Sep-11 | 10-Sep-11 |
| SHKT.WND.1300 | AEN | Engineer Inspect | 3d | 0% | 08-Sep-11 | 10-Sep-11 |
| SHKT.WND.1450 | AOP | Inventory Excess Materials | 2d | 0% | 08-Sep-11 | 09-Sep-11 |
| SHKT.WND.1370 | AEN | Incorporate Red Line and As-Buit Data into Drawings | 5d | 0% | 11-Sep-11 | 15-Sep-11 |

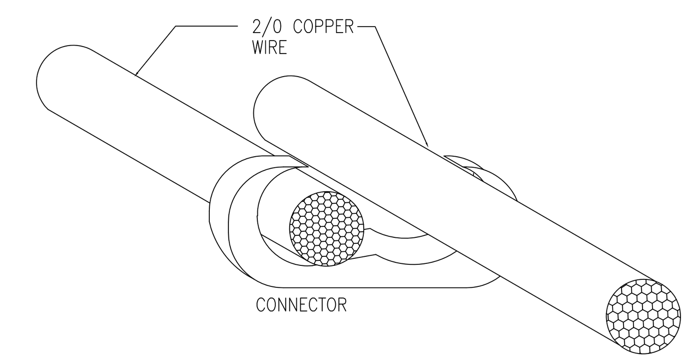


| ITEM | PART NUMBER | DESCRIPTION |
|---|---|---|
| 1 | AVEC STOCK# 594-0325 | 2/0 BARE, COPPER WIRE, STRANDED |
| 2 | AVEC STOCK# 594-0028 | 5/8" X 8'-0" COPPER GROUND ROD |
| 3 | BURNDY YGHC26C26 | 2/0 COMPRESSION GROUND TAP |
| 4 | AVEC 594-0312 | 5/8" X 2/0-250 MCM GROUND ROD CLAMP |
| 5 | McMASTER-CARR P/N 6542K64<br>McMASTER-CARR P/N 6542K74 | 98-1/2' HOSE BAND<br>10 HOSE BAND BUCKLES |
| 6 | AVEC 594-0011 | 1/2"-2/0 BRASS GROUNDING LUG |

## LEGEND

- - - - COPPER WIRE BURIED 15" - 20" BELOW GRADE

——— COPPER WIRE ABOVE GRADE




(3) 2/0 BARE STRANDED COPPER TO 2/0 BARE STRANDED COPPER COMPRESSION GROUND TAP

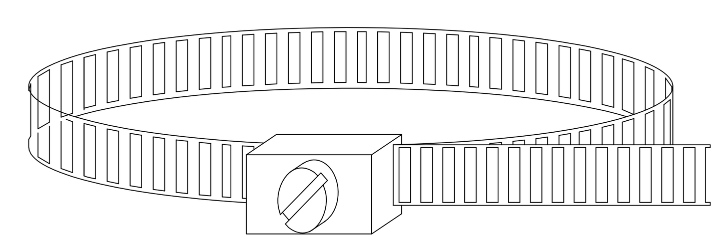
BURNDY YGHC 26C26
USE BURNDY Y39 COMPRESSION TOOL W/U997 DIE

(8) 3/0 BARE STRANDED COPPER TO 2/0 BARE STRANDED COPPER COMPRESSION GROUND TAP

BURNDY YGHC 29C26 (AVEC STOCK # 594-0338)

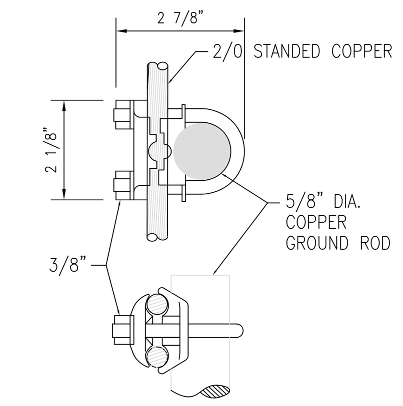
(9) 3/0 BARE STRANDED COPPER TO 3/0 BARE STRANDED COPPER COMPRESSION GROUND TAP

BURNDY YGHC 29C29 (AVEC STOCK # 594-0320)



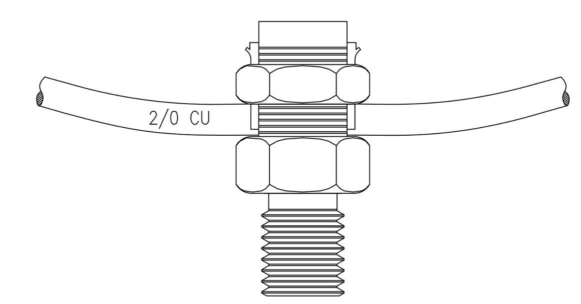
(5) HOSE BAND & HOSE BAND BUCKLES

McMASTER-CARR P/N 6542K84 98-1/2' HOSE BAND
McMASTER-CARR P/N 6542K94 50 HOSE BAND BUCKLES



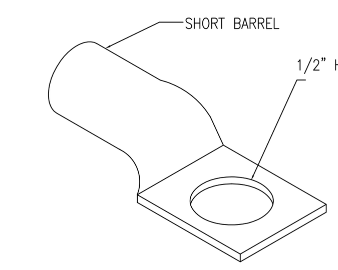

(4) 5/8" - 2/0 GROUND ROD CLAMP

BURNDY GP 6429 (AVEC STOCK # 594-0312)



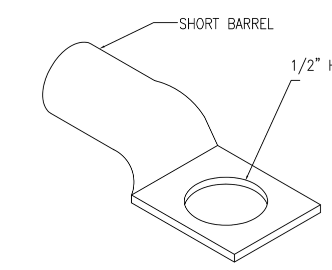

(6) 1/2" - 3/0 BRASS GROUNDING LUG

AVEC STOCK # 594-0011



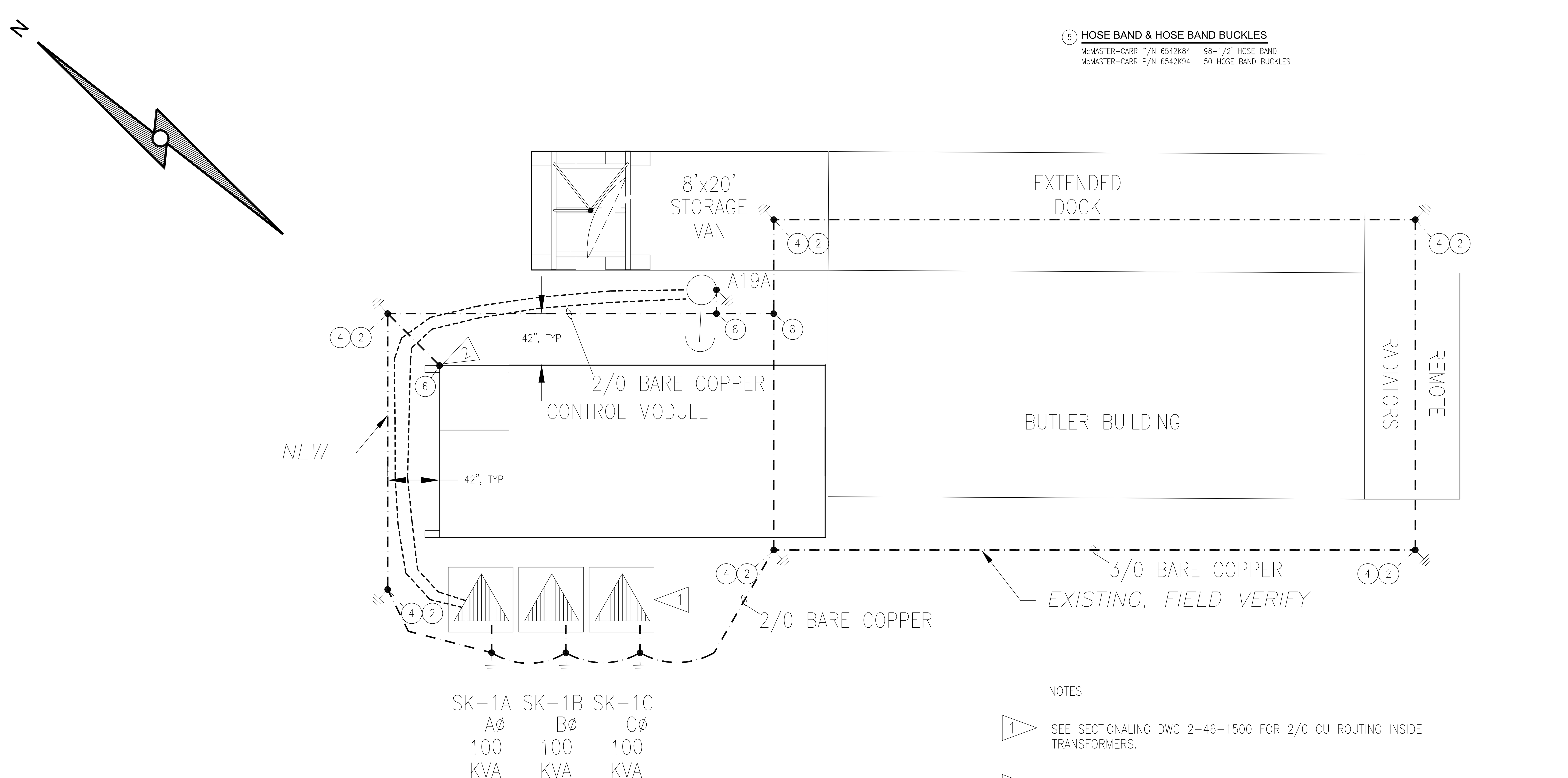

(7) 3/0 STRANDED BONDING TO EQUIPMENT, BUILDING OR ENCLOSURE

BURNDY YA27-L BOX (AVEC STOCK # 600-0736)
USE BURNDY Y39 COMPRESSION TOOL W/427 RT DIE
ONE CRIMP PER CONNECTOR
OR
T&B 54165, USE DIE # 50




(10) 2/0 STRANDED BONDING TO EQUIPMENT, BUILDING OR ENCLOSURE

BURNDY YA26-L BOX
USE BURNDY Y39 COMPRESSION TOOL W/427 RT DIE
ONE CRIMP PER CONNECTOR
OR
T&B 54165, USE DIE # 50




NOTES:

1. SEE SECTIONALING DWG 2-46-1500 FOR 2/0 CU ROUTING INSIDE TRANSFORMERS.
2. ENSURE GROUND LUG IS INSTALLED IN A LOCATION OUT OF THE MAIN TRAFFIC AREA TO PREVENT DAMAGE TO THE LUG OR TO THE COPPER WIRE.
3. GROUND RODS DRIVEN SO THAT CLAMP IS 15-20" BELOW GRADE. ALL BELOW GRADE COPPER WIRE BURIED TO A DEPTH OF 15-20"

## COPPER GROUND GRID LAYOUT PLAN VIEW

N.T.S.

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|

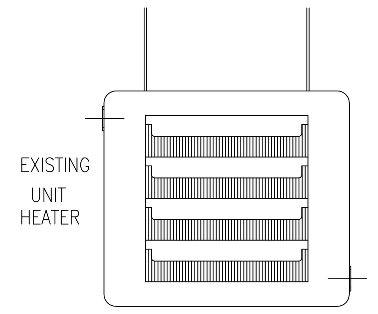
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE

*SHAKTOOLIK GROUND GRID INSTALLATION*

| | |
|---|---|
| WORK ORDER No. 9724621 | |
| BY AAC | FF # |
| ENGR. AAC | CAD# |
| VILLAGE SHAKTOOLIK | |
| SCALE NONE | DATE 5/4/10 · SHEET 1 OF 1 |
| NO. 2-46-1534 | REV. |

\Avec-file01\engineer\Eng Main\Village\Shaktoolik\Drawings\AEA_FUNDED\2-46-1534.dwg, 7/6/2011 8:03:30 AM, Adobe PDF



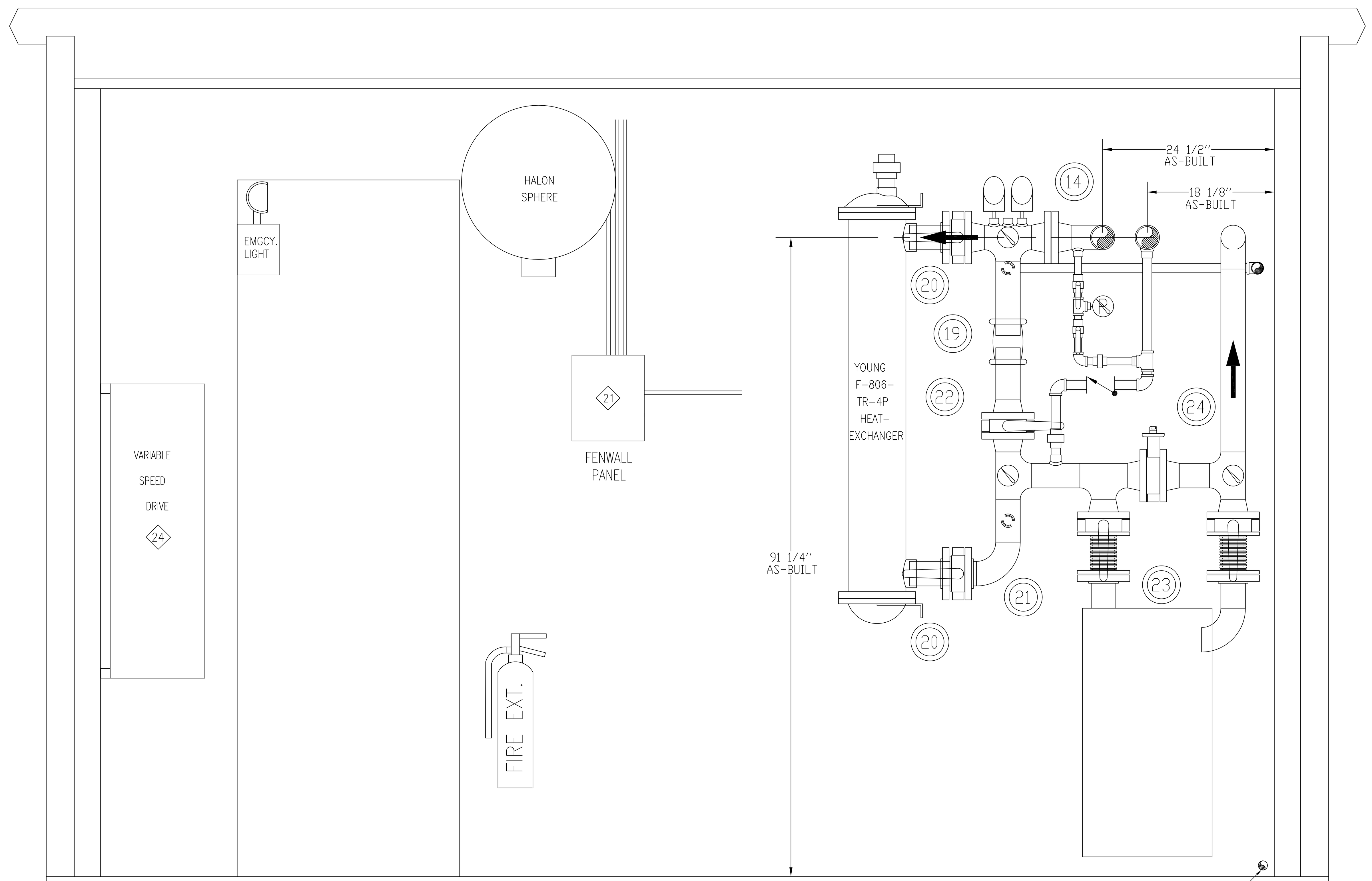

NOTES:

4. AS-BUILD (REDLINE) THIS DRAWING FOR ACTUAL LOCATION, SIZE, MAKE AND MODEL OF EQUIPMENT. ADD EQUIPMENT NOT SHOWN. DIMENSIONS OF EQUIPMENT AND DISTANCES TO A FRONT AND SIDE WALL ARE REQUIRED FOR AN ACCURATE AS-BUILT. RETURN THE CORRECTED COPY OF THIS DRAWING TO THE ANCHORAGE ENGINEERING OFFICE.

8. SEE DRAWING 1-46-1200, SHEET 2 FOR THE ELECTRICAL EQUIPMENT LIST.

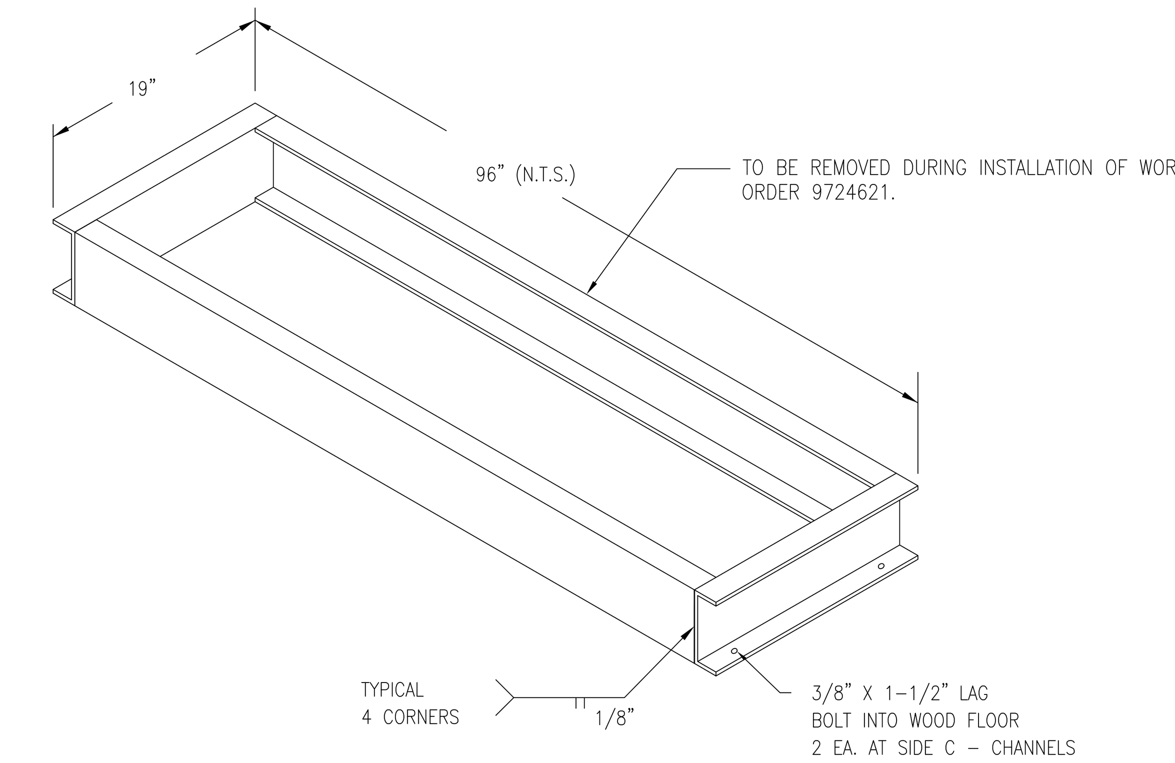
9. SEE DRAWING 1-46-1200, SHEET 1 FOR THE ELECTRICAL SYSTEMS LEGEND, THE MECHANICAL LEGEND, THE CABLE SCHEDULE, AND THE WIREWAY MATERIAL SCHEDULE.

16. SEE DRAWING 3-46-6400, SHEET 4, ELEVATION A-A FOR BUTLER BUILDING BACK WALL INTERIOR VIEW.



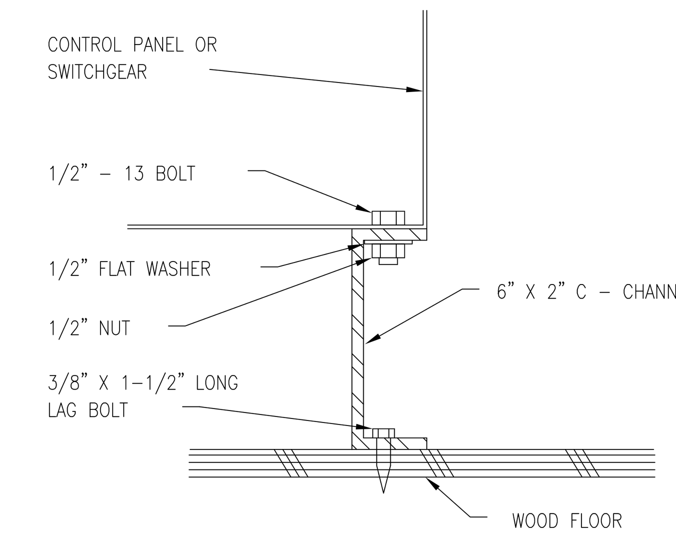

ELEVATION H (FACING DAYTANK ROOM)

SCALE: 1" = 1'-0"



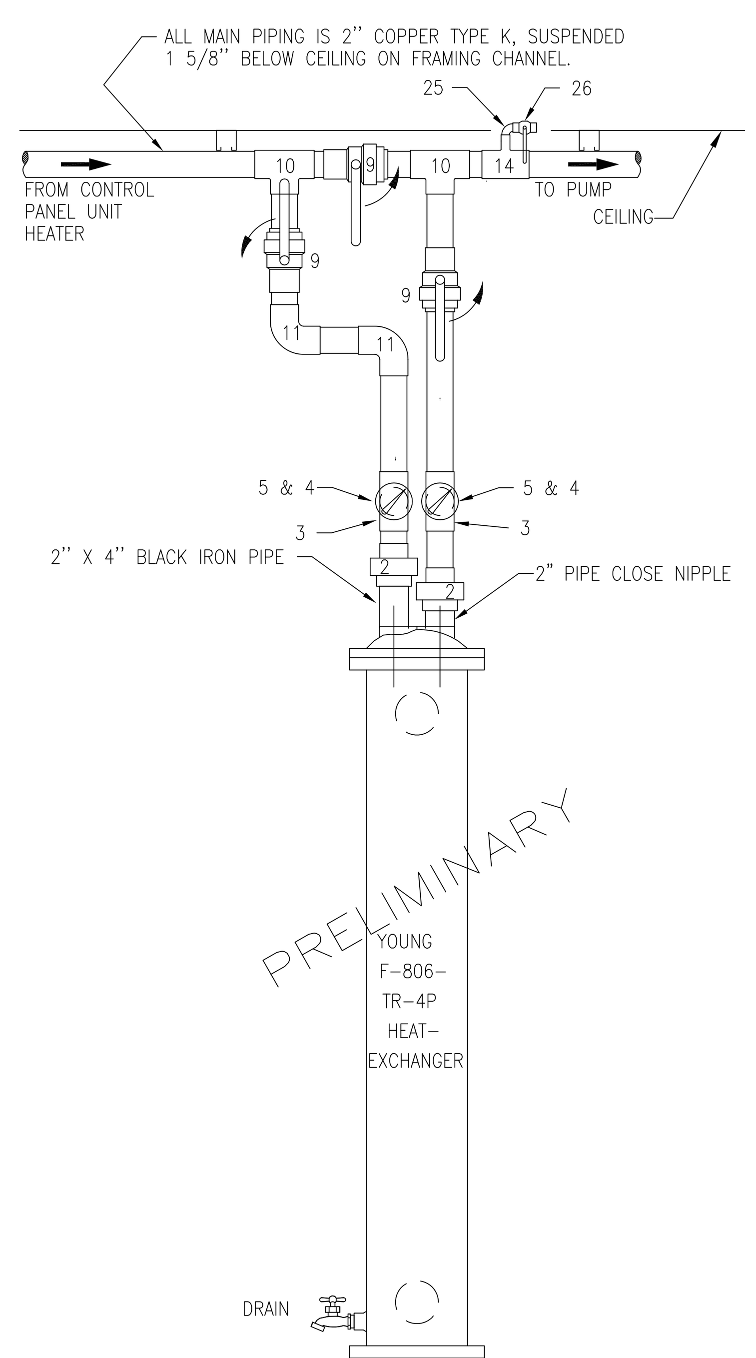

6" C - CHANNEL PANEL BASE (D)

SCALE: 1" = 1'-0"



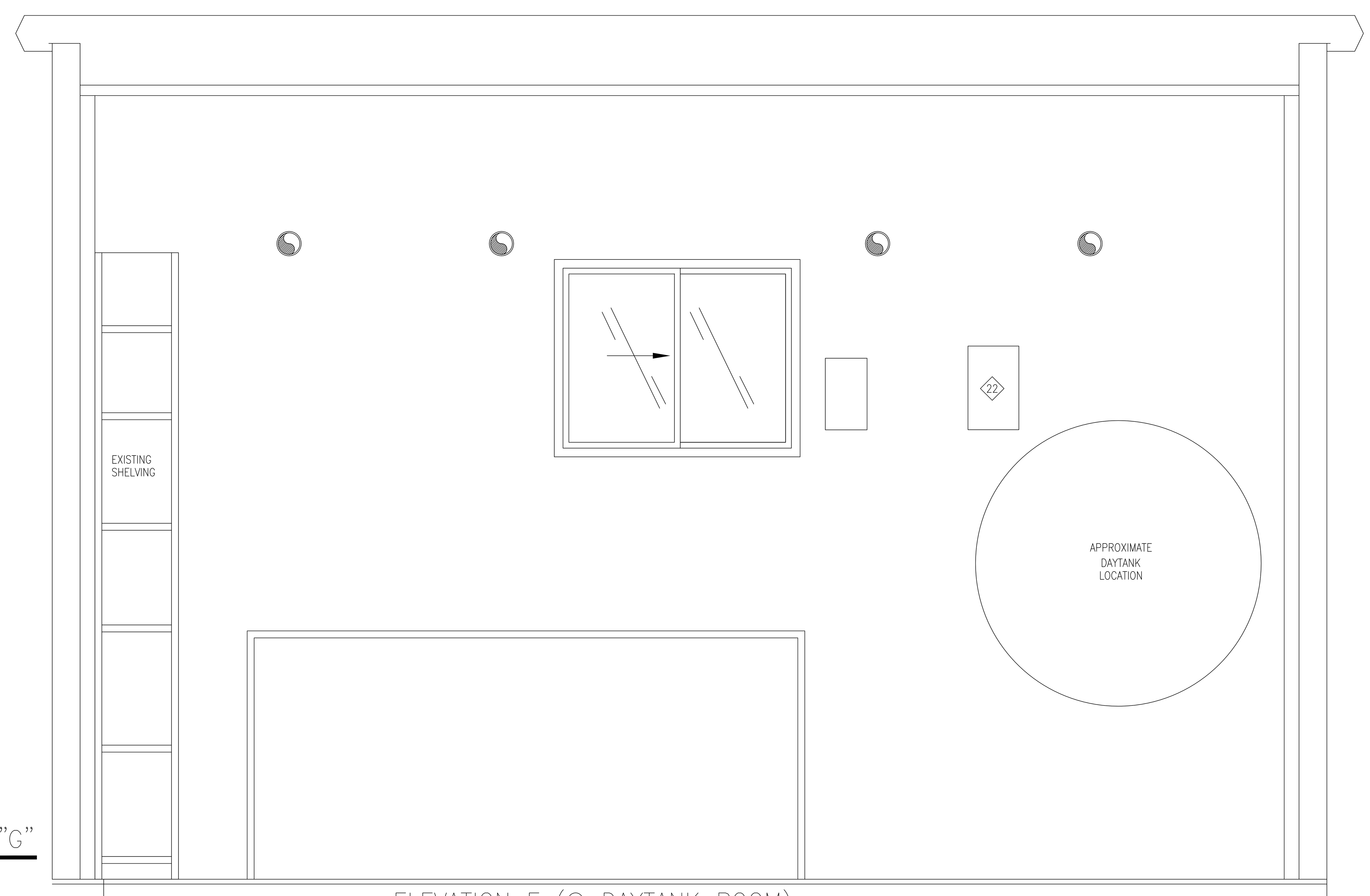

CONNECTION DETAIL (E)

SCALE: 3" = 1'-0"




HYDRONIC CONNECTIONS TO HEAT EXCHANGER "G"

SCALE: 1" = 1'-0"




ELEVATION F (@ DAYTANK ROOM)

SCALE: 1" = 1'-0"

## HYDRONIC FITTINGS LEGEND

| ITEM # | DESCRIPTION |
|---|---|
| 1 | 2-1/2" X 2" REDUCING BUSHING, BLACK IRON |
| 2 | 2" COPPER CUP X STEEL FPT DIELECTRIC UNION |
| 3 | TEE, 2" X 2" X 3/4", COPPER MUE W-40106 |
| 4 | 3/4" FTG X 1/2" FPT CU. REDUCER, MUE W-1547 |
| 5 | THERMOMETER, 3" FACE, 2-1/2" STEM LENGTH, 1/2" CONNECTION SIZE TRERICE B8320205 |
| 6 | 2" FTG X 3/4" C REDUCER, MUE W-1362 |
| 7 | 3/4" FTG X M COPPER ADAPTER, MUE W-1446 |
| 8 | AUTOMATIC AIR ELIMINATOR, 3/4" MPT, HOF #79 |
| 9 | 2" BALL VALVE, SOLDER ENDS, BRONZE, NBO S-580-Y |
| 10 | 2" COPPER TEE, MUE W-40102 |
| 11 | 2" COPPER ELBOW, MUE W-2086 |
| 12 | 2" X 1 1/2" BLACK IRON BUSHING |
| 13 | FLOW METER, LUBE/COOLANT, 0 TO 40 GPM, 2" PORT SIZE, FOR 32 SSU FLUID, OIL & DUST TIGHT LEFT-TO-RIGHT FLOW, UFM OK40G-16-32S-ONR |
| 14 | TEE, 2" X 2" X 1/2", COPPER, MUE W-40107 |
| 15 | 1/2" FTG X 1/4" FPT FLUSH BUSHING, MUE A-7813 |
| 16 | PRESSURE GAGE, 0 TO 30 PSI, 1/4" BACK CONNECTION, 3-1/2" FACE, MMC 4000K72 |
| 17 | PUMP W/ 1 1/2" FLANGE ADAPTERS & 1 1/2" X 4" PIPE NIPPLES, GRF UP 43-75F, 1-SPEED, 1/6 HP |
| 18 | 2" BLACK IRON, 90° STREET ELBOW |
| 19 | HOSE BIB DRAIN, BRASS 3/4" MPT, HMD 2002 |
| 20 | 2" SPRING-TYPE CHECK VALVE, WITH 1/16" HOLE DRILLED IN FLAP, NBO S-480 |
| 21 | 2" FTG X 3/4" COPPER CUP REDUCER, MUE W-1362 |
| 22 | 3/4" C X MPT ADAPTER, COPPER, MUE W-1146 |
| 23 | 30 PSI PRESSURE RELIEF VALVE, 3/4" FPT, WATTS NO. 174A SERIES |
| 24 | 2" CAST IRON Y-TYPE STRAINER, 1-1/4" BLOW-DOWN MMC 4417K26 |
| 25 | 1/2" FTG X FTG 90° COPPER ELBOW, MUE W-2626 |
| 26 | 1/2" BALL VALVE, BRONZE, SOLDER ENDS, NBO S-580-Y |
| 27 | 3/4" BRONZE BALL VALVE, SOLDER ENDS, NBO S-580-Y |
| 28 | 3/4" COPPER CUP X STEEL FPT DIELECTRIC UNION |
| 29 | 3/4" BALL VALVE, BRONZE THREADED ENDS, NBO T-580-Y |
| 30 | 3/4" TEE, THREADED, 150 PSI, BLACK IRON |
| 31 | 3/4" 90° ELBOW, THREADED 150 PSI, BLACK IRON |
| 32 | HAND PUMP, PISTON-TYPE, 3/4" FPT, BLACKMER BLPA525 |
| 33 | 3/4" BLACK IRON UNION, THREADED |
| 34 | AQ. 3/4" MPT X #12 HOSE FITTING, 4412-12-12S |
| 35 | AQ FC300-12 BLUE HOSE, 5/8" |
| 36 | 1" X 3/4" BLACK IRON BUSHING |
| 37 | STRAINER FOOT VALVE, 1" CONNECTION, MMC 5436K21 |
| 38 | 3/4" CHECK VALVE, BRONZE, NBO T-413 |
| 39 | 2" BLACK IRON 90° ELBOW |
| 40 | 2" CAP, MUE W-7014 |
| 41 | 1 1/2" X 3/4" BLACK IRON BUSHING |
| 42 | 2" X 22"-LONG STAINLESS STEEL FLEX HOSE, DOUBLE BRAIDED, MALE NPT ENDS |
| 43 | 3/4" COPPER ELBOW, SOLDER ENDS, MUE W-1634 |

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 3 | 6/7/11 | AAC AAC | MODIFIED FOR CONTROL MODULE |
| 2 | 3/30/11 | AAC AAC | ADDED NOTE TO CHANNEL PANEL BASE DETAIL |
| 1 | 8/15/01 | ALA SJP | 480V CONV., UPGRADE VSD (46G032) |

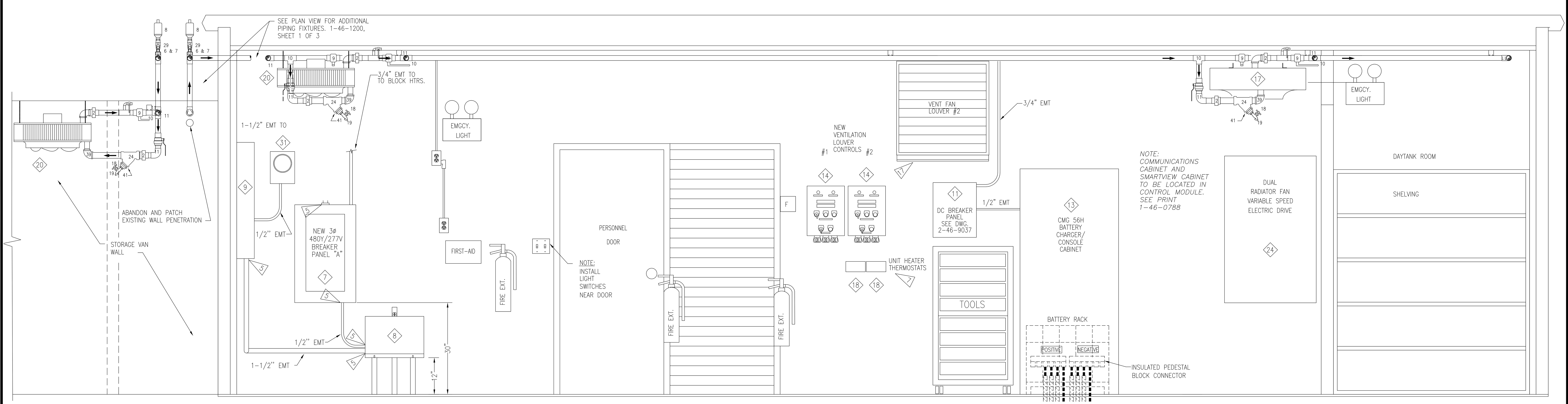
AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE
SHAKTOOLIK PLANT PLANS
ELEVATION, DETAIL & LEGEND

WORK ORDER No.

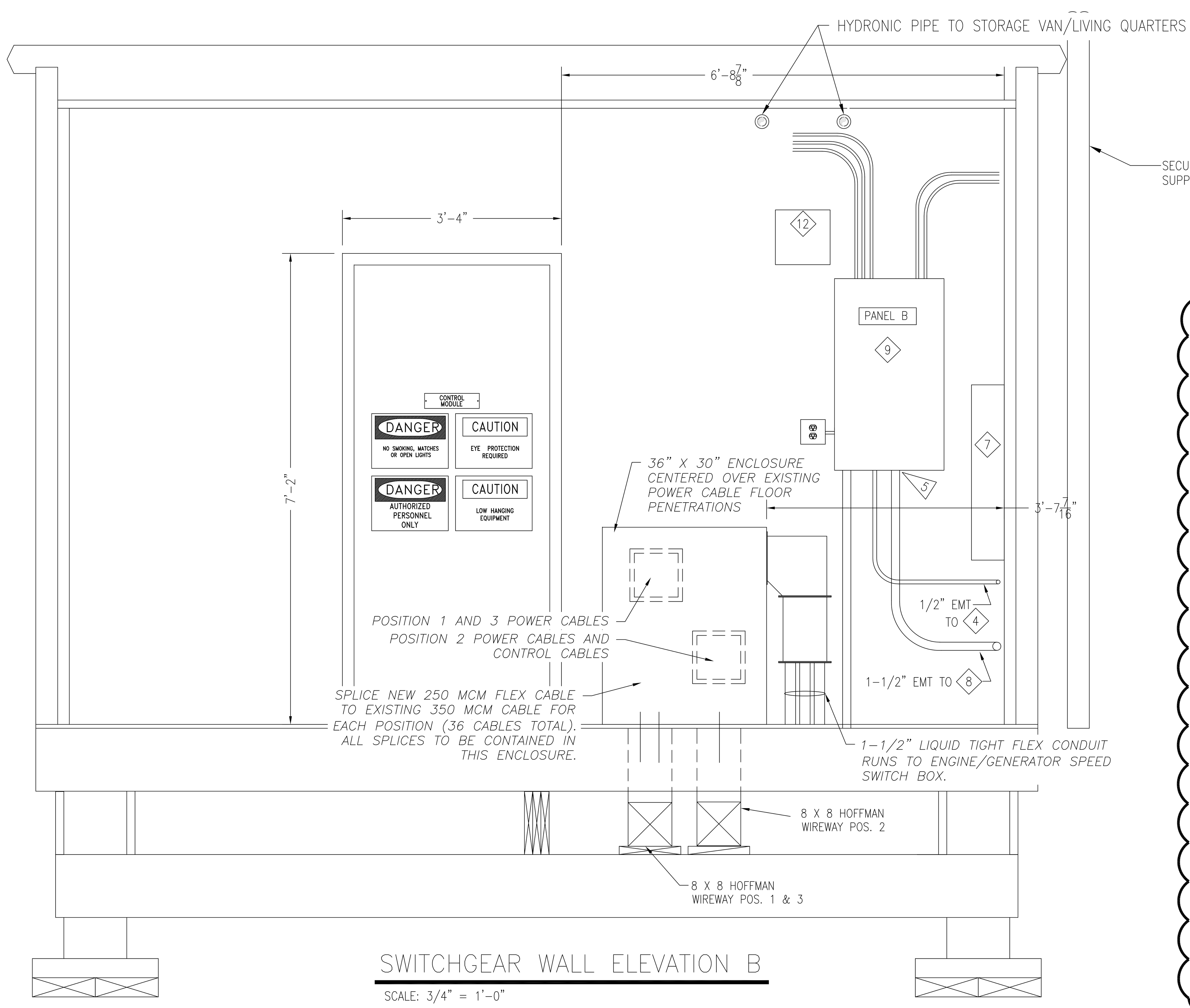
BY R. MONAHAN | FF #
ENGR. D.R.BIEGEL | CAD# B46GP030
VILLAGE SHAKTOOLIK
SCALE AS NOTED | DATE 5/11/94 | SHEET 3 OF 4
NO. 1-46-1200 | REV. 3

\\Avec-file01\engineer\Eng Main\Village\Shaktoolik\Drawings\B46GP030.dwg, 7/6/2011 7:59:32 AM, Adobe PDF



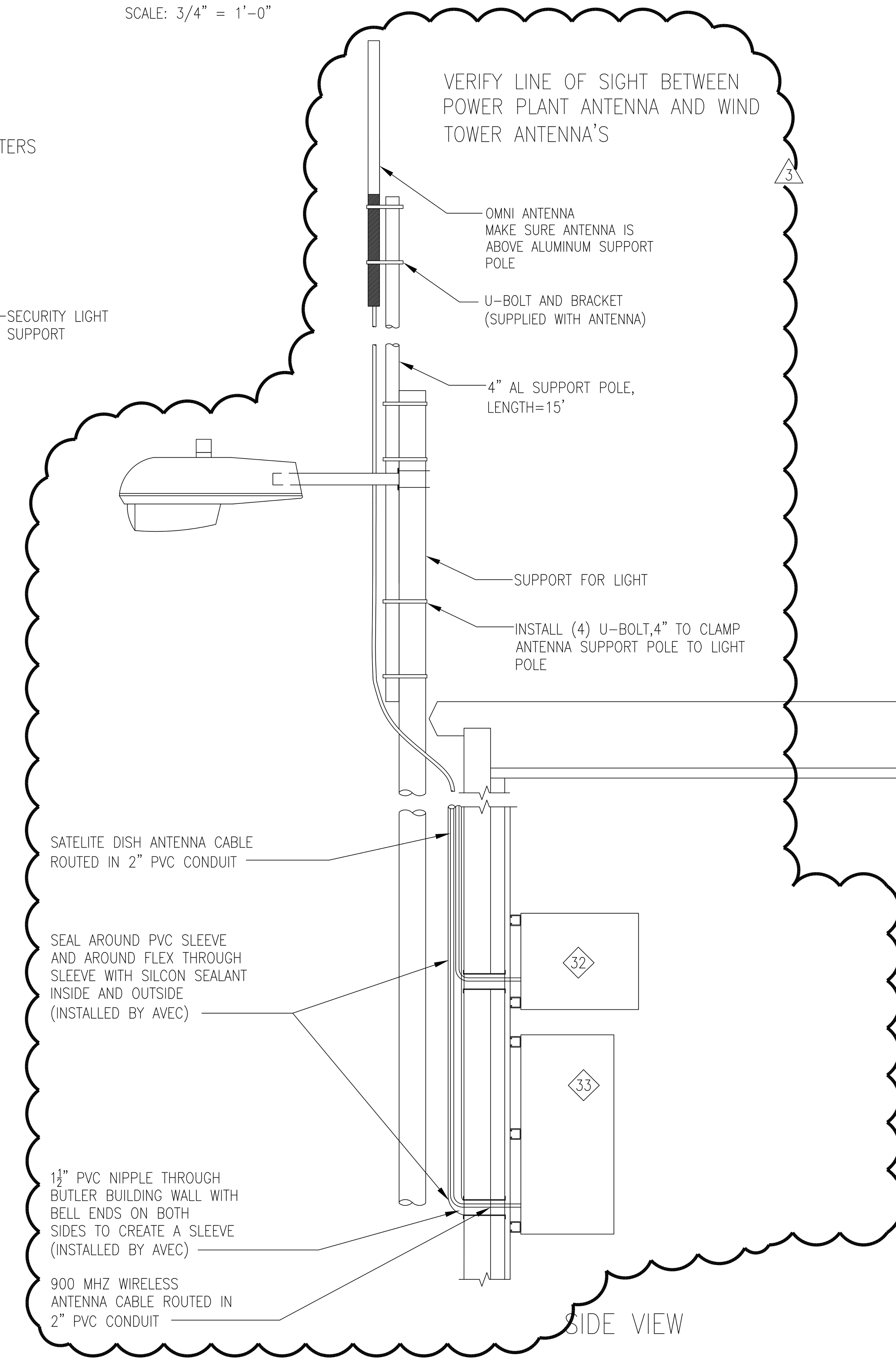

FRONT WALL ELEVATION A

SCALE: 3/4" = 1'-0"




SWITCHGEAR WALL ELEVATION B

SCALE: 3/4" = 1'-0"




COMMUNICATIONS ELEVATION

SCALE: 3/4" = 1'-0"

## NOTES

1. USE 2-HOLE STACKING COMPRESSION LUGS WITH HARDWARE, TORQUED TO 45 FT-LBS. ON BOTH ENDS OF GENERATION BUS TO SWITCHGEAR BUS JUMPER CABLES.
4. AS-BUILD (REDLINE) THIS DRAWING FOR ACTUAL LOCATION, SIZE, MAKE AND MODEL OF EQUIPMENT. ADD EQUIPMENT NOT SHOWN. DIMENSIONS OF EQUIPMENT AND DISTANCES TO A FRONT AND SIDE WALL ARE REQUIRED FOR AN ACCURATE AS-BUILT. RETURN THE CORRECTED COPY OF THIS DRAWING TO THE ANCHORAGE ENGINEERING OFFICE.
5. PROVIDE SPECIAL CONDUIT END BONDING FOR ALL CIRCUITS ABOVE 200 VOLTS AND AS INDICATED. SEE SPECIFIC NOTE ON DWG. 2-46-1400.
6. TOTALIZING METER CT'S: 300:5 WITH RF = 4.0. SEE DRAWING 2-46-1500.
7. VERIFY AND AS-BUILD AS REQUIRED.
9. SEE DRAWING 1-46-1200, SHEET 1 FOR THE ELECTRICAL SYSTEMS LEGEND, THE MECHANICAL LEGEND, THE CABLE SCHEDULE, AND THE WIREWAY MATERIAL SCHEDULE.
10. BLOWN FUSE INDICATORS AND TEST SWITCH. SEE DWG. 2-00-9048, SHEETS 2 & 3.
11. UPGRADE FUSING, GROUNDING, AND OTHER MODIFICATIONS IN SWITCHGEAR PER W.O. 46G032. SEE FIELD NOTES AND DWG. 2-46-1500.
12. UPGRADE CONTROL PANEL SECTIONS PER W.O. 46G032, 46G034 SEE SPECIFIC CONTROL PANEL DRAWINGS.
13. UPGRADE STATION SERVICE WIRING PER PLANT 480V CONVERSION (W.O. 46G032). SEE DRAWING 2-46-1400 FOR DETAILS.
14. SEE DRAWINGS 2-46-1500 AND 2-00-1501 FOR TOTALIZING METER WIRING DETAILS.
15. ALL RELATED PHASE AND NEUTRAL CONDUCTORS MUST BE RUN TOGETHER THROUGH THE SAME METAL RACEWAY.
17. DRIP SHIELD. IF NOT PRESENT, CONTACT AVEC O&M OR ENGINEERING TO HAVE ONE SENT TO THE SITE.

## ELECTRICAL EQUIPMENT LIST

1.
2.
3.
4.
5. TOTALIZING METER, ABB "ALPHA PLUS" ELECTRONIC, Q3202000, FORM 9S, 277-VOLT, CLASS 20, AVEC STOCK 107-0369. METER BASE: 13-JAW, SELF-CLOSING SOCKET, MILBANK UC7237-XL, AVEC STOCK 594-0134.
6. STATION SERVICE METER, CLASS 200, FORM 16S, SOCKET-TYPE, 277-VOLT, 4-WIRE, 7-TERMINAL, ABB "ALPHA PLUS" ELECTRONIC WATTHOUR DEMAND METER, ABB QC3302000, TA 30, TV 120, KH 21.6, AVEC STOCK 107-0368. METER BASE, 200A, 7-JAW, CAW U207, AVEC STOCK 594-0136. SEE ALSO DWG. 2-46-1400.
7. BREAKER PANEL "A", 3ø 480Y/277-VOLT, 18-POSITION, SQD NF BREAKER PANEL, 100-AMP MAIN, MH32 BOX, NC32S FRONT, EDB BRANCH BREAKERS. SEE ALSO DWG. 2-46-1400.
8. STATION SERVICE TRANSFORMER, 9KVA, 480V PRIMARY, 208Y/120-VOLT SECONDARY, SQD 9T2F, AVEC STOCK 107-0342. SEE ALSO DWG. 2-46-1400.
9. BREAKER PANEL "B", 3ø 208Y/120-VOLT, 42-POSITION, SQD NQOD BREAKER PANEL, 100-AMP MAIN, MH35 BOX, QOB BRANCH BREAKERS. SEE ALSO DWG. 2-46-1400.
10. (7) BREAKER PANEL "C", 1ø 120/208V, 24 POSITION CUTLER-HAMMER, CAT # ??, 100A MAIN, WITH CLASS CTL, TYPE CH BREAKERS. SEE ALSO DRAWING 2-46-1400.
11. DC BREAKER PANEL, (16) 1-POLE POSITIONS, SQD QO16L125, RATED 48VDC (OR 120/240VAC), 14.25"W X 17.92"H. SEE ALSO DWG. 2-46-9037.
12. LOW COOLANT LEVEL TERMINAL STRIP JUNCTION BOX, 10"W X 10"H X 6"D, CONTINUOUS HINGE, HOFFMAN A-10106CH, AVEC STOCK 553-4951. SEE ALSO DWG. 2-46-9037.
13. NIFE BATTERY BANK, H411, 24V, 20-CELL.
14. VENTILATION SYSTEM CONTROL PANEL. SEE DRAWING 3-14-6024.
15. VENTILATION INTAKE HOOD, SEE DRAWING 3-14-6024.
16. VENTILATION FAN MOTOR, 3/4 & 1/4 HP, 1725 & 1140 RPM, 2-SPEED, 200V, 3ø, 3.00 & 1.90 AMPS, S.F. 1.25, INSULATION CLASS B, DRIPPROOF TYPE, CODE K, BALL BEARINGS, RESILIENT BASE, GE 5K47SG1116, AVEC STOCK 553-3415. FOR VENTILATION FAN AND OTHER RELATED PARTS, SEE DWG. 3-14-6024.
17. UNIT HEATER, DUNHAM-BUSH MODEL C400G.
18. UNIT HEATER THERMOSTAT, HONEYWELL T6054A1005A. AVEC STOCK 553-4394.
19. TYPICAL PLANT LIGHT FIXTURE, FOR ALL FUTURE INSTALLATIONS, FLOURESCENT, HIGH-EFFICIENCY, GOOD LOW TEMP. STARTING, 120VAC, 48"-LONG, 2-LAMP, LITHONIA AF248H0120. LAMPS: 40-WATT, HIGH-OUTPUT, LONG-LIFE, LITHONIA F48T12CWHO, AVEC STOCK 552-0414.
20. UNIT HEATER, TRANE UHPA-102P-4A-BAD
21. FIRE SUPPRESSION SYSTEM CONTROL PANEL, FENWALL, SEE DWGS. 2-46-2004 AND 2-00-2002, E-1 & E-2.
22. DAYTANK PUMP CONTROLS, SEE 3-00-1010
23. ENGINE-RUNNING RELAY JUNCTION BOX, SEE DRAWING 2-00-9042.
24. DUAL RADIATOR FAN MOTOR VARIABLE SPEED DRIVE, 480V INPUT, 5HP (OR 2HP) 3ø 0-460V, 0-60HZ OUTPUT, TOSHIBA. SEE DRAWING 2-00-1082.
25. RADIATOR FAN MOTOR, 2 HP, 3ø, 230-460V, 1200 RPM, HIGH-EFFICIENCY, TEFC, 184T FRAME, WITH 100,000 HR BEARINGS, ARCTIC LUBRICATION, AND 45-WATT INTERNAL STRIP HEATER (NOT USED), AVEC STOCK 553-4223.
26. HYDRONIC SYSTEM HEAT EXCHANGER, 3" PORTS SHELL SIDE, 2" PORTS TUBE SIDE, 4-PASS, CAPACITY FACTOR 210 BTU/MIN.°F @ 140 GPM FLOW IN SHELL, YOUNG HF-806-TR-4P, SEE DWG. 3-46-6400.
27. POSITION 1 GAUGE PANEL & SPEED SWITCH BOX, MURPHY 10-POSITION PANEL, HOFFMAN 12"X12" BOX, GAC SS681 SPEED SWITCH. SEE DRAWING 3-46-5500.
28. POSITION 2 GAUGE PANEL & SPEED SWITCH BOX, MURPHY 10-POSITION PANEL, HOFFMAN 12"X12" BOX, GAC SS681 SPEED SWITCH. SEE DRAWING 3-00-6500.
29. POSITION 3 GAUGE PANEL & SPEED SWITCH BOX, MURPHY 10-POSITION PANEL, HOFFMAN 12"X12" BOX, GAC SS681 SPEED SWITCH. SEE DRAWING 3-00-6500, SHEET 3.
30. SWITCH FOR ENGINE BLOCK HOT COOLANT CIRCULATING PUMP, FRACTIONAL HORSEPOWER STARTER, 1-POLE, 120VAC, WITH PILOT LIGHT, SQD CLASS 2510, TYPE FG-1P, AVEC STOCK 553-4239. USE AN A .86 THERMAL UNIT, AVEC STOCK 553-4439.
31. HEAT RECOVERY PUMPS METER, FORM 12S, 208VAC, 3-WIRE, NETWORK, CLASS 200, 5-TERMINAL WATTHOUR METER, ABB Q5302000 (AVEC STOCK # 107-0377). METER BASE: 125A, 4-JAW, MILBANK U7487-RL WITH 5TH TERMINAL (MILBANK 5T8K1) INSTALLED.
32. HERGO COMMUNICATIONS CABINET. 24"X14"X18" # 554104001
33. SMARTVIEW CABINET 24"X30"X14" (3)

VERIFICATION OF ELECTRICAL CLEARANCES NOT INCLUDED IN NANA/COLT ENG. SCOPE OF WORK. NANA/COLT ENGINEERING, LLC HAS NOT CONFIRMED THE ACCURACY OF RECORD INFORMATION PRESENTED ON THIS DRAWING.

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 3 | 04/06/11 | SK / MT | REVISED SECURITY LIGHT LOCATION, ADDED SMARTVIEW |
| 2 | 2/25/11 | TVM / TVM | SAT COM TO WIND |
| 1 | 8/13/01 | ALA / SJP | 480V CONV. ET., AL. (46G032, 46G034) |

AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE
SHAKTOOLIK PLANT PLANS
INTERIOR ELEVATIONS
AFTER KOHLER SWITCHGEAR
INSTALLATION

| | |
|---|---|
| WORK ORDER No. | |
| BY R. MONAHAN | FF # |
| ENGR. D.R.BIEGEL | CAD# B46GP020 |
| VILLAGE SHAKTOOLIK | |
| SCALE 3/4"=1'0" | DATE 5/11/94 |
| SHEET 2 OF 4 | |
| NO. 1-46-1200 | REV. 4 |

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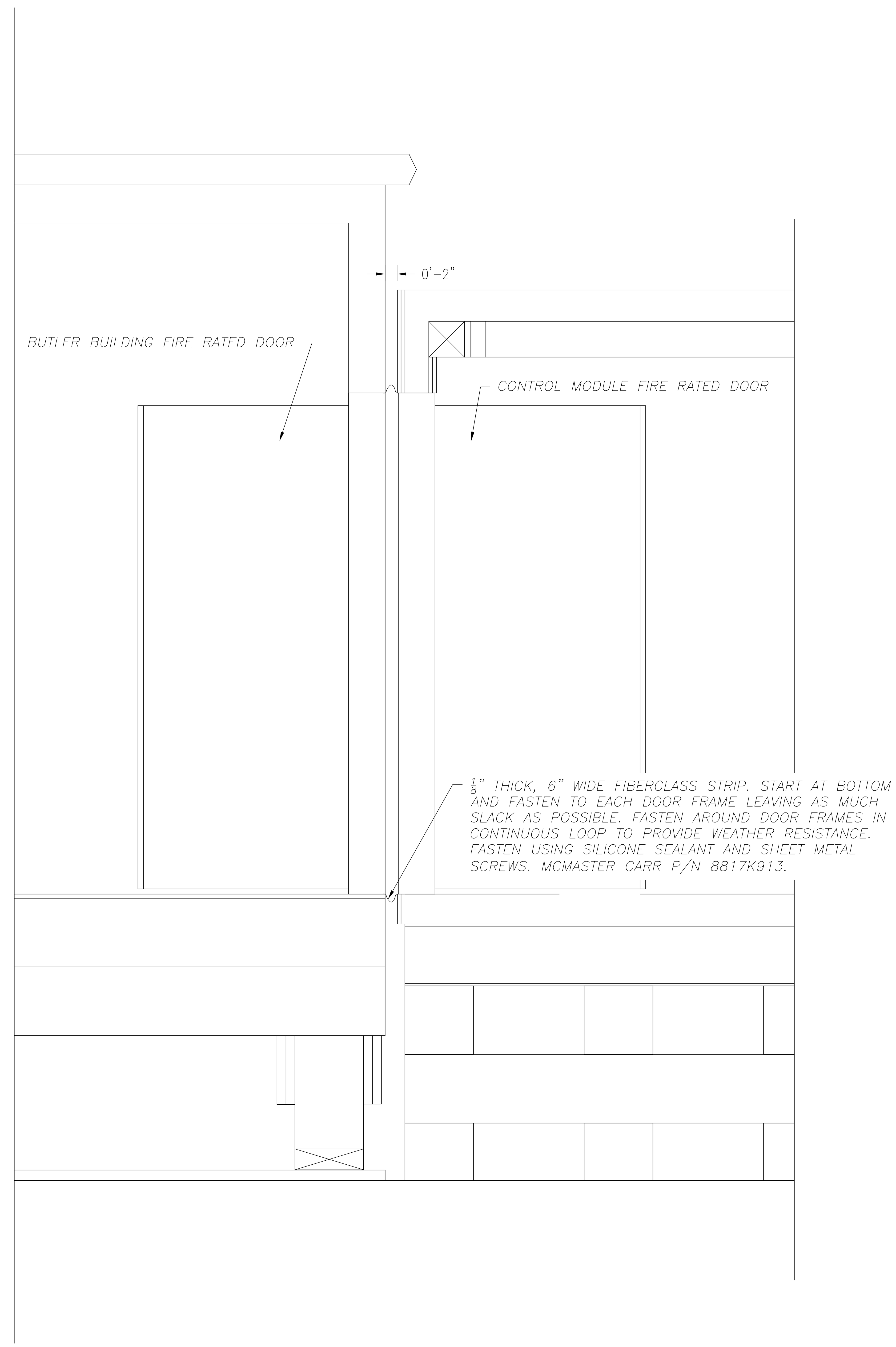



# INTERFACE BETWEEN BUTLER BUILDING AND CONTROL MODULE

SCALE: 1" = 1'

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|

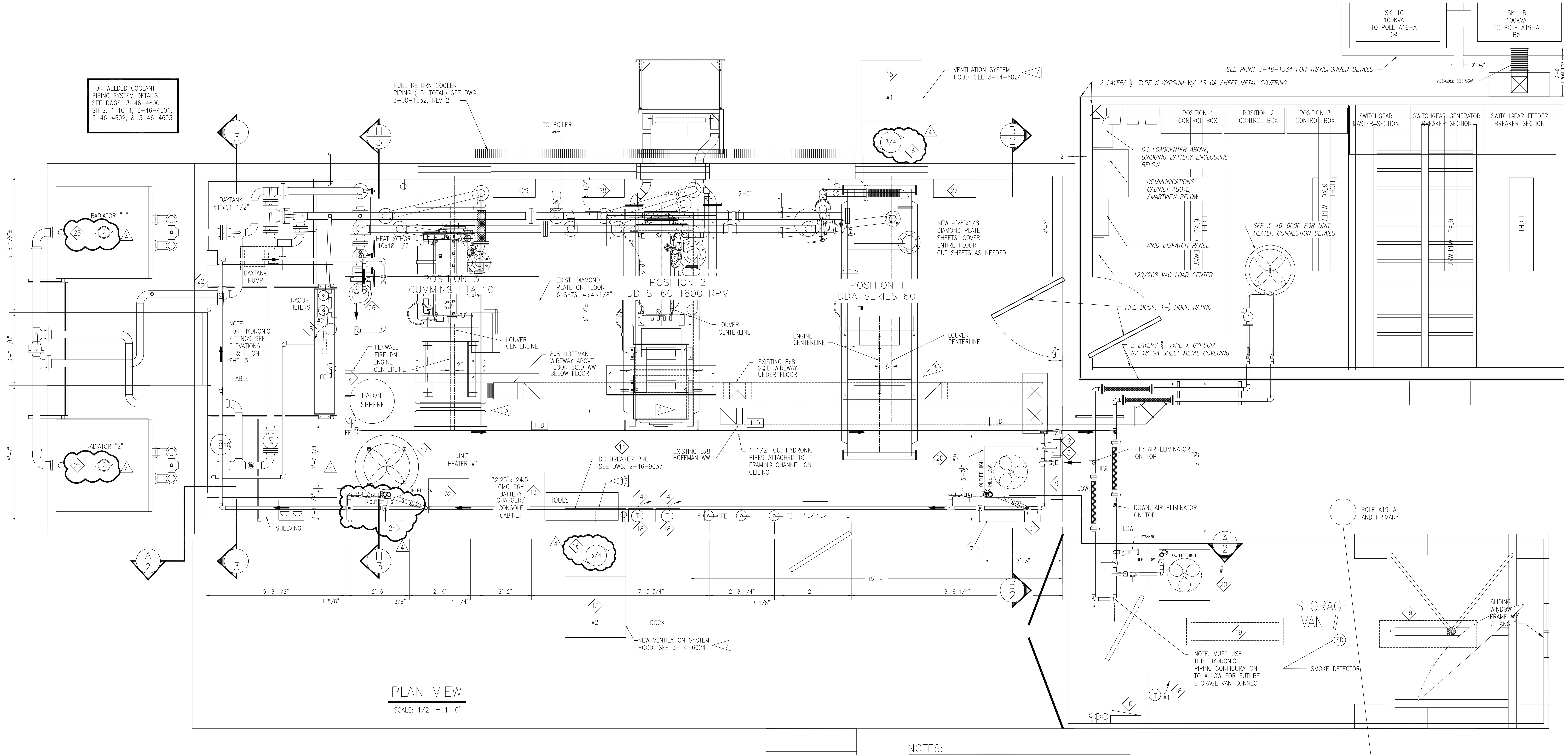
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE

*SHAKTOOLIK PLANT PLANS*
*INTERIOR ELEVATIONS*
*AFTER KOHLER SWITCHGEAR*
*INSTALLATION*

WORK ORDER No.

| | | |
|---|---|---|
| BY AAC | FF # | |
| ENGR. AAC | CAD# 1-46-1200 | |
| VILLAGE SHAKTOOLIK | | |
| SCALE 1"=1'0" | DATE 6/2/11 | SHEET 4 OF 4 |
| NO. 1-46-1200 | | REV. 0 |




## ELECTRICAL SYSTEMS LEGEND

- REFER TO INDICATED NOTE
- ELECTRICAL EQUIPMENT SCHEDULE
- W.P. INDICATES WEATHERPROOF
- E. EMERGENCY LIGHT
- P.C. PHOTOCELL
- BRANCH CIRCUIT PANEL
- TERMINAL CABINET
- TRANSFORMER
- 3-PHASE MOTOR, W/H.P. INDICATED
- 1-PHASE MOTOR, W/H.P. INDICATED
- BRANCH CIRCUIT--EXPOSED
- BRANCH CIRCUIT--UNDER FLOOR
- 3 WIRES IN 1/2" CONDUIT
- 350 MCM 4 WIRES, 350 MCM EACH
- FLEX CONDUIT (L.T.=LIQUID TIGHT)
- UNDERFLOOR WIREWAY
- MOTOR STARTER
- DISCONNECT SWITCH
- COMBO MOTOR STARTER-DISCONNECT
- CONDUIT/PIPE UP
- CONDUIT/PIPE DOWN
- CONDUIT/PIPE CAPPED OR PLUGGED
- HPS FLUORESCENT FIXTURE
- J JUNCTION BOX
- DUPLEX OUTLET
- HIGH PRESSURE SODIUM FIXTURE
- SPECIAL PURPOSE OUTLET
- S SINGLE POLE SWITCH
- $S_2$ DOUBLE POLE SWITCH
- $S_P$ SWITCH W/PILOT LIGHT
- T THERMOSTAT
- D MAGNETIC DOOR HOLDER
- F MANUAL FIRE PULL STATION
- FP FIRE ALARM PANEL
- HD HEAT DETECTOR
- ID IONIZATION DETECTOR
- F FIRE HORN OR SIREN
- $F_S$ FUEL LEVEL HORN OR SIREN
- M KW METER
- $M_T$ TOTALIZING KWH METER
- TC THERMOCOUPLE
- OIL PRESSURE SWITCH

## MECHANICAL LEGEND

- N.O. NORMALLY OPEN VALVE
- N.C. NORMALLY CLOSED VALVE
- OPEN BALL VALVE
- CLOSED BALL VALVE
- COPPER TEE
- COPPER 90° ELBOW
- RISE IN PIPING
- TEE DOWN
- UNION OR DIELECTRIC UNION
- 90° ELBOW POINTING PERPENDICULAR TO VIEW
- TEE POINTING PERPENDICULAR TO VIEW
- GATE VALVE
- CHECK VALVE
- THERMOMETER

## CABLE SCHEDULE:

1. POS. 1 GENERATOR FEEDER: 4 RUNS 350KCM CU PER PHASE AND NEUTRAL, #3/0 BARE CU GROUND, ROUTED IN 8" X 8" WIREWAY UNDER FLOOR.
2. POS. 2 GENERATOR FEEDER: 4 RUNS 350KCM CU PER PHASE AND NEUTRAL, #3/0 BARE CU GROUND, ROUTED IN 8" X 8" WIREWAY UNDER FLOOR.
3. POS. 3 GENERATOR FEEDER: 4 RUNS 350KCM CU PER PHASE AND NEUTRAL, #3/0 BARE CU GROUND, ROUTED IN 8" X 8" WIREWAY UNDER FLOOR.
4. 
5. FEEDER BREAKER #1 DISTRIBUTION FEEDER: 2 RUNS 250KCM CU XHHW PER PHASE AND NEUTRAL, #2/0 BARE CU GROUND, ROUTED TO TRANSFORMER IN 3" METAL FLEX CONDUIT.
6. FEEDER BREAKER #2 DISTRIBUTION FEEDER: 2 RUNS 350KCM CU XHHW PER PHASE AND NEUTRAL, #2/0 BARE CU GROUND, ROUTED TO TRANSFORMER IN 3" LTMF CONDUIT.
7. FEEDER BREAKER #3 DISTRIBUTION FEEDER: 2 RUNS 250KCM CU XHHW PER PHASE AND NEUTRAL, #2/0 BARE CU GROUND, ROUTED TO TRANSFORMER IN 3" METAL FLEX CONDUIT.

## NOTES:

1. 
2. UPGRADE EXISTING PAD TRANSFORMERS AS PER PLANT 480VOLT CONVERSION (W/O 46G032). UPGRADE 15KV CONNECTIONS TO INCLUDE EMERGENCY BYPASS JUMPERS. VERIFY TRANSFORMER GROUNDING INCLUDES #2/0 BC LOOP TO BUTLER BUILDING GROUND GRID. COMPLETE TRANSFORMER GROUNDING PER DWGS. 2-46-1500, 2-00-1008 & 2-00-1504.
3. RECONNECT GENERATOR LEADS FOR 480/277V CONVERSION PER W.O. 46G032. SEE DWG. 2-46-1500.
4. AS-BUILD (REDLINE) THIS DRAWING FOR ACTUAL LOCATION, SIZE, MAKE AND MODEL OF EQUIPMENT. ADD EQUIPMENT NOT SHOWN. DIMENSIONS OF EQUIPMENT AND DISTANCES TO A FRONT AND SIDE WALL ARE REQUIRED FOR AN ACCURATE AS-BUILT. RETURN THE CORRECTED COPY OF THIS DRAWING TO THE ANCHORAGE ENGINEERING OFFICE.
5. PROVIDE SPECIAL CONDUIT END BONDING FOR ALL CIRCUITS ABOVE 200 VOLTS AND AS INDICATED. SEE SPECIFIC NOTE ON DWG. 2-46-1400.
6. TOTALIZING METER CT'S: 500:5 WITH RF = 4.0. SEE DRAWING 2-46-1500.
7. VERIFY AND AS-BUILD AS REQUIRED.
8. SEE DRAWING 1-46-1200, SHEET 2 FOR THE ELECTRICAL EQUIPMENT LIST.
9. SEE DRAWING 1-46-1200, SHEET 1 FOR THE ELECTRICAL SYSTEMS LEGEND, THE MECHANICAL LEGEND, THE CABLE SCHEDULE, AND THE WIREWAY MATERIAL SCHEDULE.
10. 
11. 
12. 
13. UPGRADE STATION SERVICE WIRING PER PLANT 480V CONVERSION (W.O. 46G032). SEE DRAWING 2-46-1400 FOR DETAILS.
14. SEE DRAWINGS 2-46-1500 AND 2-46-1511 FOR TOTALIZING METER WIRING DETAILS.
15. ALL RELATED PHASE AND NEUTRAL CONDUCTORS MUST BE RUN TOGETHER THROUGH THE SAME METAL RACEWAY.
16. SEE DRAWING 3-46-6400, SHEET 4, ELEVATION A-A FOR BUTLER BUILDING BACK WALL INTERIOR VIEW.
17. DRIP SHIELD. IF NOT PRESENT, CONTACT AVEC O&M OR ENGINEERING TO HAVE ONE SENT TO THE SITE.

GRAPHIC SCALE
2' 0 1' 2' 4' 8'
( IN FEET )
1 inch= 2' FT.

## REVISIONS

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 9 | 6/7/11 | AAC/AAC | ADDED CONTROL MODULE |
| 8 | 4/26/11 | AAC/AAC | CHANGED POS 2 LABEL TO "DD S-60 1800 RPM" |
| 7 | 3/23/11 | AAC/AAC | ADDED KOHLER SWITCHGEAR |
| 6 | 2/25/11 | TVM/TVM | ADDED COM CABINET AND DISH |
| 5 | 9-12-07 | AAC/AAC | CHANGE POS 2 TO DD S-60, HCI504 |
| 4 | 8/13/01 | ALA/SJP | 480V CONV. ET., AL. (46G032, 46G034) |
| 3 | 7/18/94 | RM/DRB | REVISED HYDRONICS |
| 2 | 5/11/94 | RM/DRB | NEW CAD DRAWING, ADDED ENG. POS. 1 |

AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE
SHAKTOOLIK PLANT PLANS
BUTLER BUILDING PLAN VIEW
AFTER KOHLER SWITCHGEAR
INSTALLATION

| | | | |
|---|---|---|---|
| WORK ORDER No. | | | |
| BY R. MONAHAN | | FF # | |
| ENGR. D.R.BIEGEL | | CAD# B46GP000 | |
| VILLAGE SHAKTOOLIK | | | |
| SCALE 1/2"=1'-0" | DATE 5/11/94 | SHEET 1 OF 4 | |
| NO. 1-46-1200 | | REV. 9 | |

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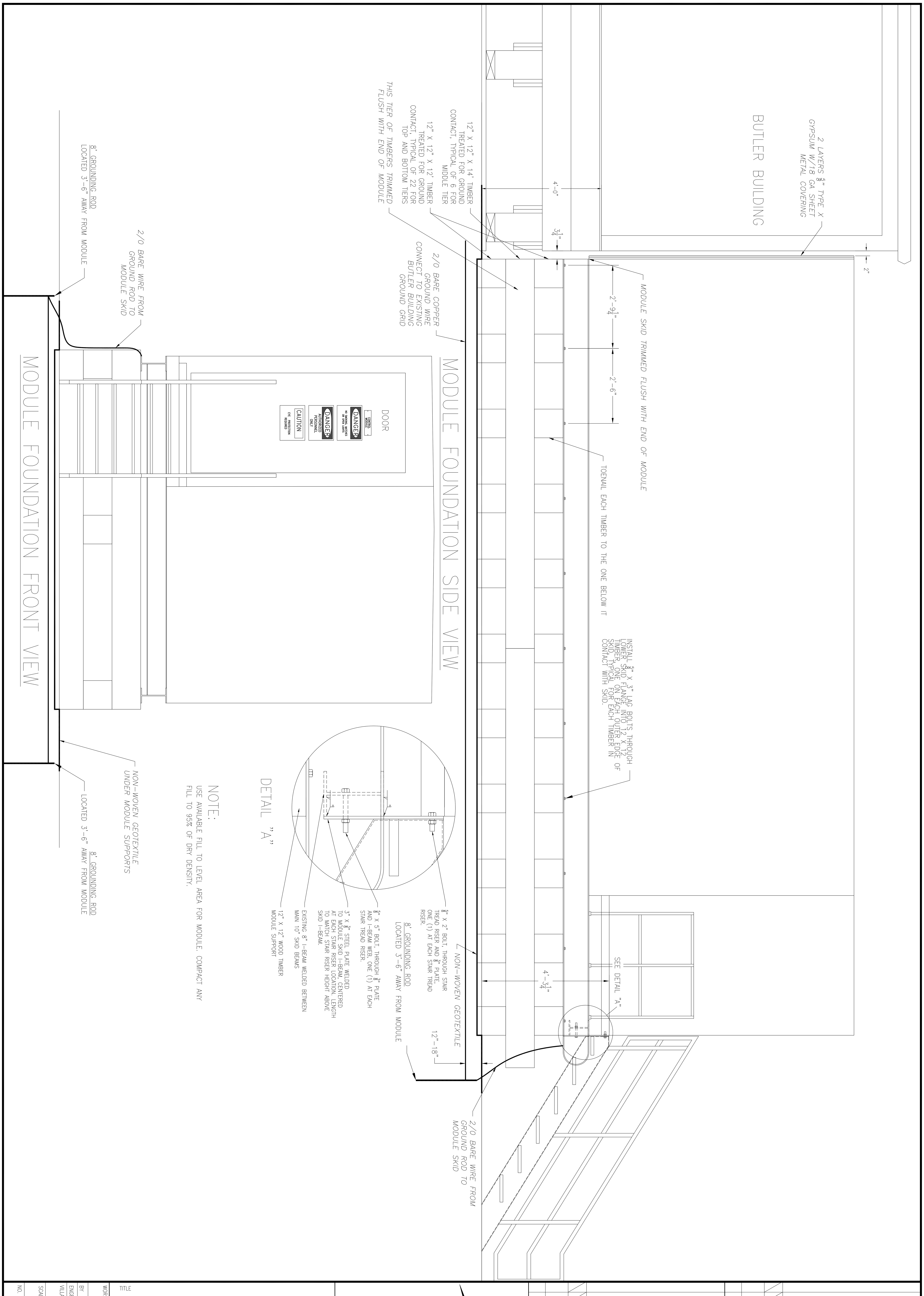


| | |
|---|---|
| NO. | 1-46-0988 |
| REV. | |
| SCALE | 1=16 |
| DATE | 5/13/11 |
| SHEET | 1 OF 2 |
| VILLAGE | SHAKTOOLIK |
| ENGR. | AAC |
| CAD # | 1-46-0988 |
| BY | AAC |
| FF # | |
| WORK ORDER No. | 9724621 |

TITLE

**SHAKTOOLIK CONTROL MODULE FOUNDATION**

AVEC

ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| | | | |

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| | | | |

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BOCA PREFABRICATED STAIRWAY
MANUFACTURED BY ENGINEERED STEEL PRODUCTS
AVEC NON-STOCK #341104022

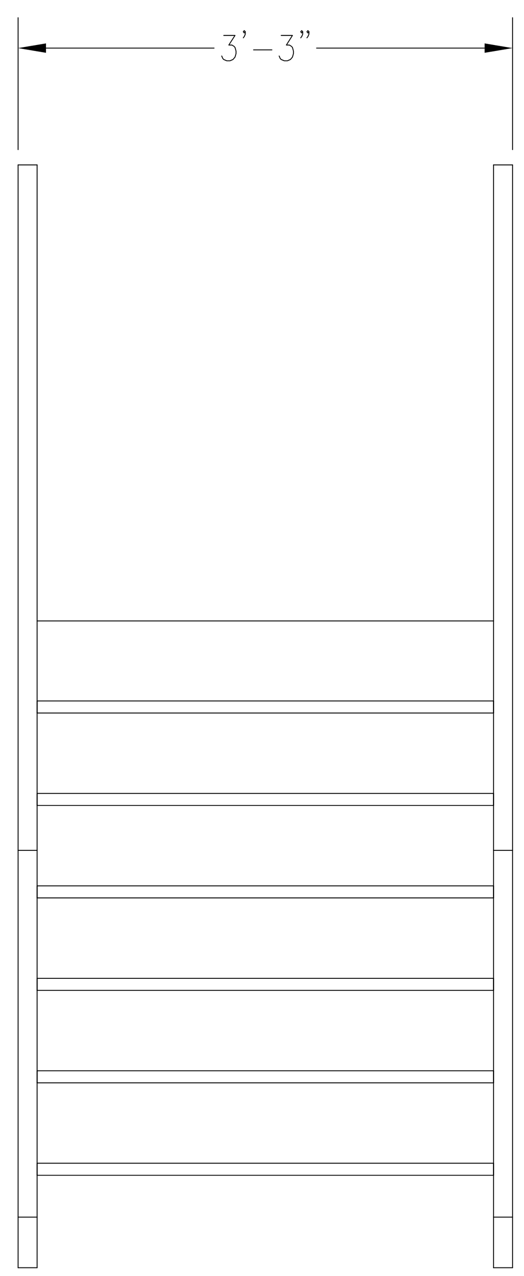
1. GALVANIZED FINISH

2. HEAVY DUTY STEEL BAR GRATING STAIR TREADS, 7/11 RISE/RUN

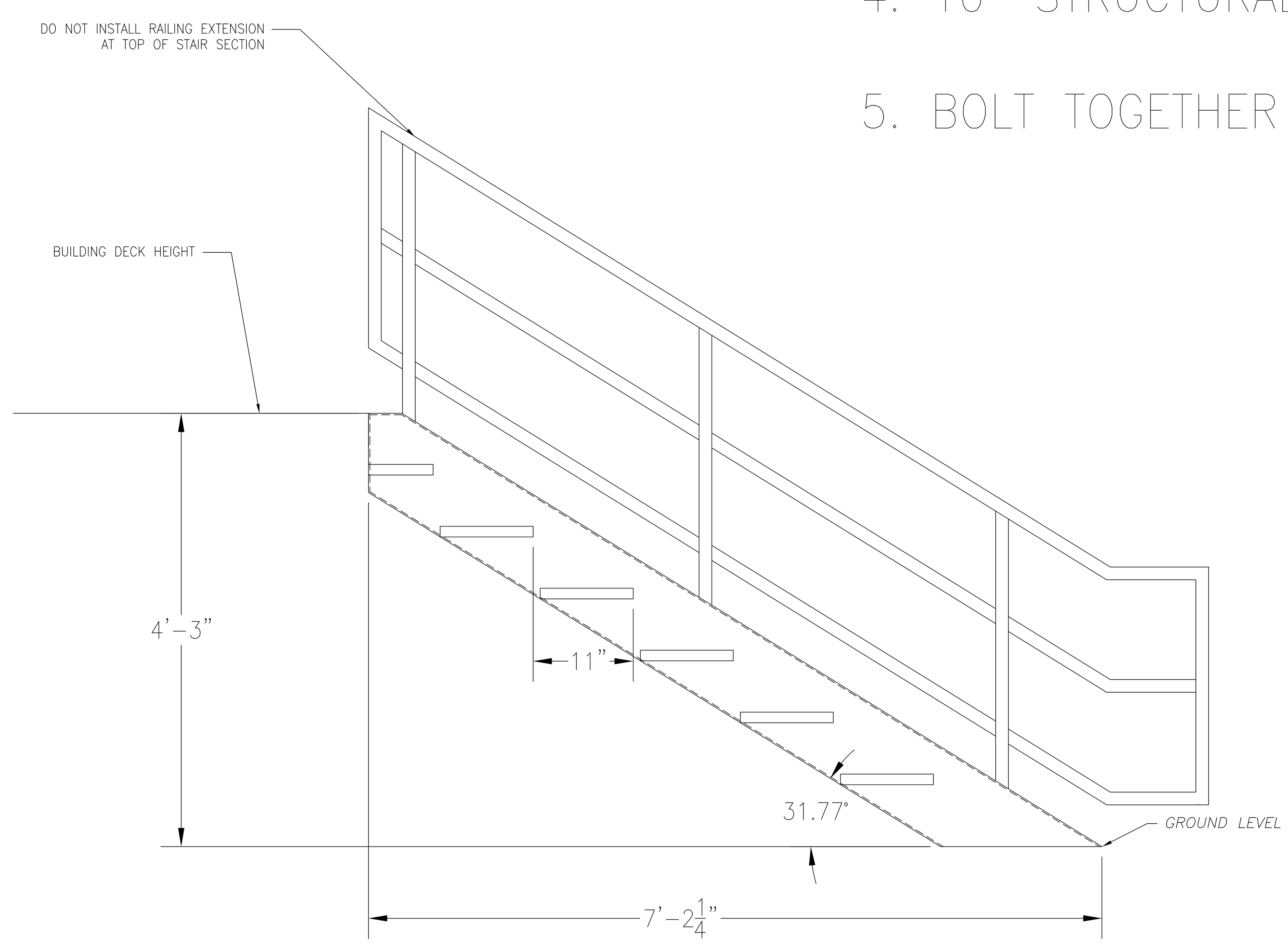
3. 1-1/2" SQUARE TUBING RAILS, 42" HEIGHT

4. 10" STRUCTURAL STEEL CHANNEL STRINGERS

5. BOLT TOGETHER ASSEMBLY




FRONT VIEW




SIDE VIEW

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 1 | 6/14/10 | AAC AAC | MODIFIED STAIRS TO QUOTE PROVIDED BY FS INDUSTRIES |

ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE
**SHAKTOOLIK CONTROL MODULE STAIRWAY**

WORK ORDER No. 9724621
BY AAC | FF #
ENGR. AAC | CAD# 1-46-0988
VILLAGE SHAKTOOLIK
SCALE 1" = 1' | DATE 5/18/11 | SHEET 2 OF 2
NO. 1-46-0988 | REV. 0

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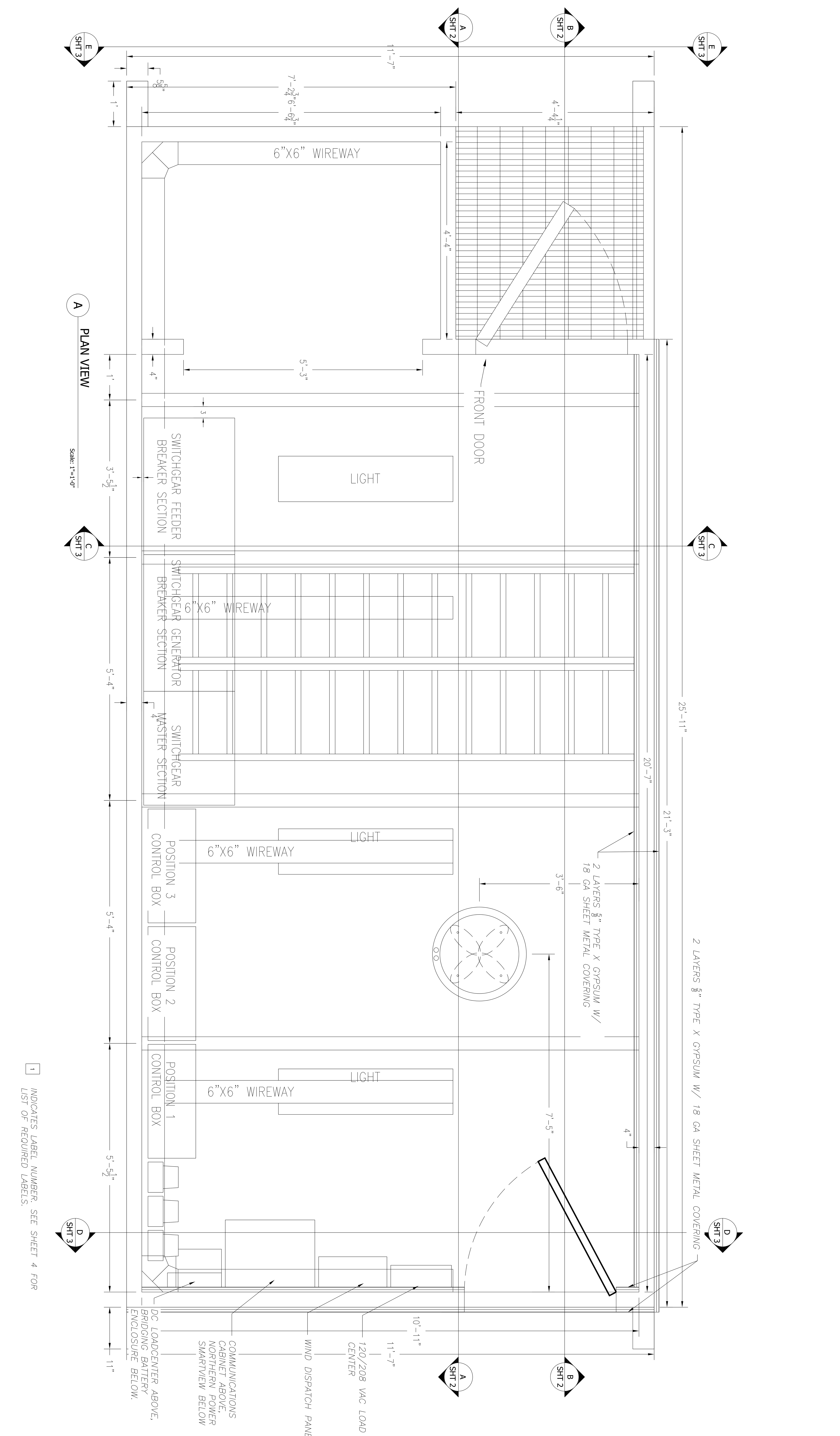



TITLE

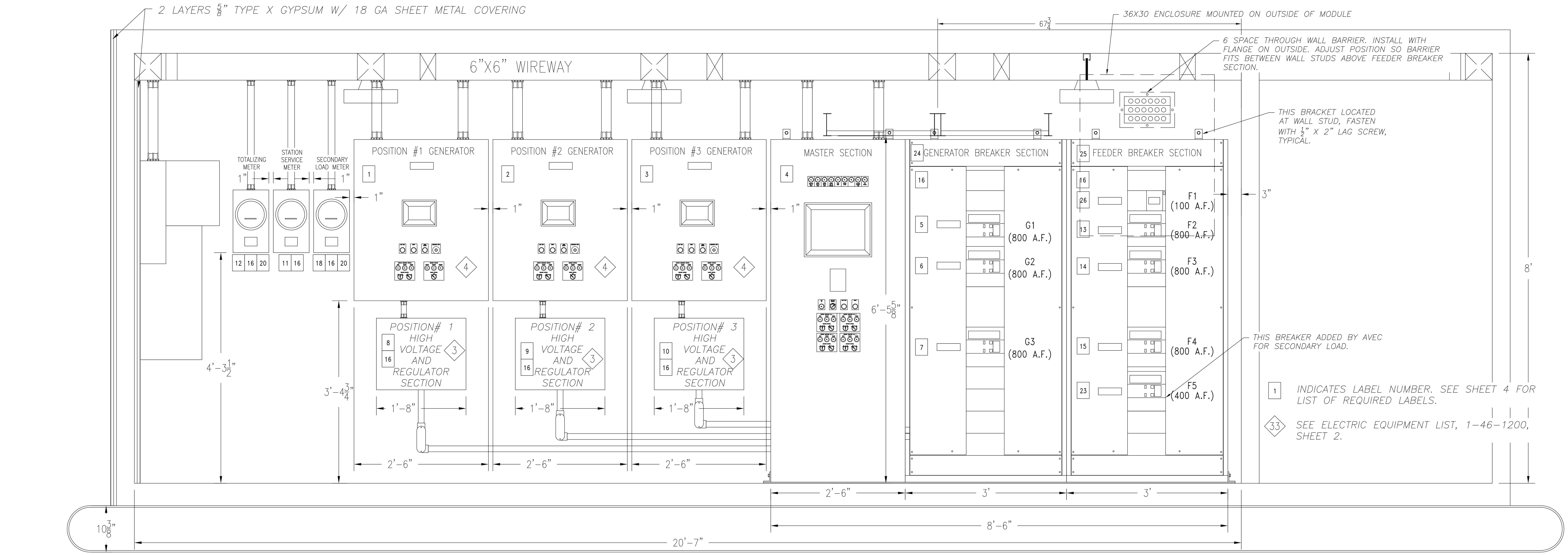
SHAKTOOLIK
TINY HUNSTMAN MODULE

| | |
|---|---|
| WORK ORDER No. | 9724621 |
| BY | SK |
| FF # | |
| ENGR. | AAC |
| CAD# | 1-46-0088 |
| VILLAGE | SHAKTOOLIK |
| SCALE | 1" = 12" |
| DATE | 09-16-10 |
| SHEET | 1 OF 4 |
| NO. | 1-46-0788 |
| REV. | 1 |

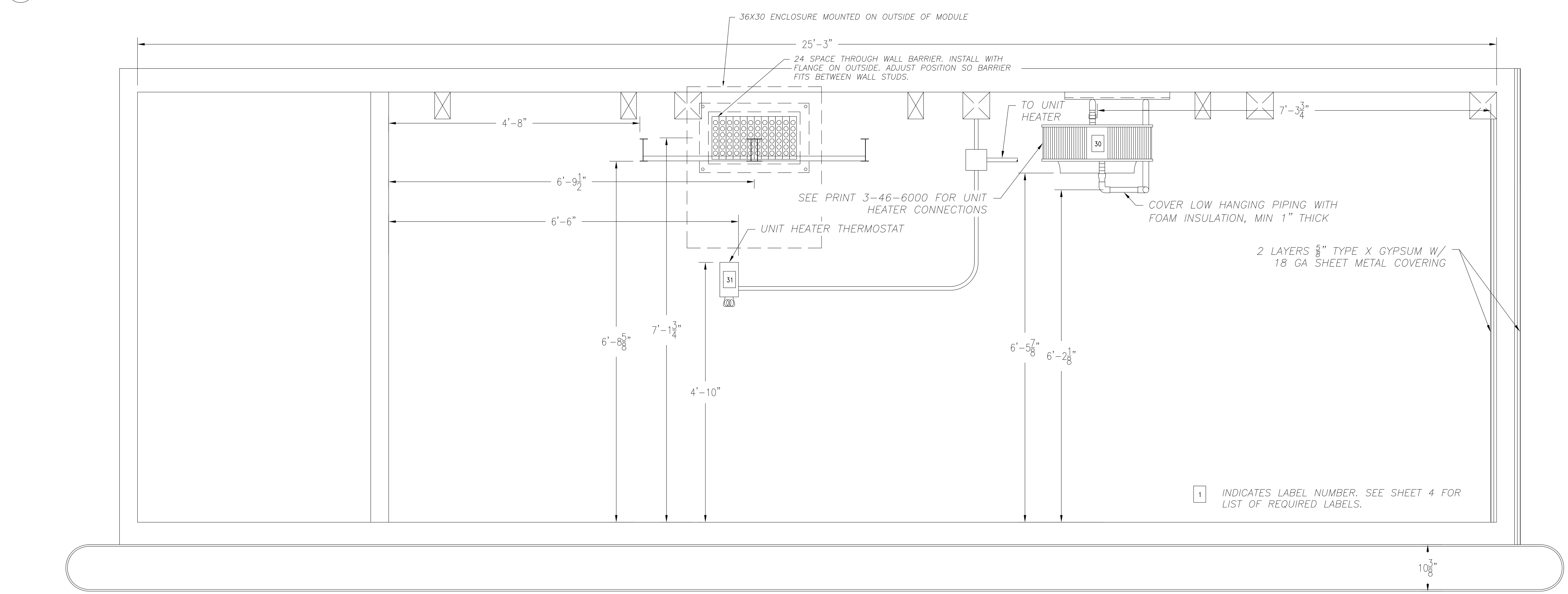
AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 1 | 5/27/11 | AAC/AAC | ADDED DIMENSIONS, EQUIPMENT |

\\Avec-file01\engineer\Eng Main\Village\Shaktoolik\Drawings\AEA_FUNDED\1-46-0788.dwg, 7/6/2011 7:52:50 AM, Adobe PDF




A INTERIOR RIGHT WALL ELEVATION
Scale: 1"=1'-0"




B INTERIOR LEFT WALL ELEVATION
Scale: 1"=1'-0"

| NO. | DATE | BY | REVISIONS |
| --- | --- | --- | --- |
| 2 | 6/30/11 | AAC AAC | ADDED CONDUIT FROM PT BOXES TO MASTER SECTION |
| 1 | 5/27/11 | AAC AAC | ADDED DIMENSIONS, EQUIPMENT |

AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE
SHAKTOOLIK
TINY HUNSTMAN MODULE

WORK ORDER No. 9724621
BY SK | FF #
ENGR. AAC | CAD# 1-46-0088
VILLAGE SHAKTOOLIK
SCALE 1" = 12" | DATE 09-16-10 | SHEET 2 OF 4
NO. 1-46-0788 | REV. 2

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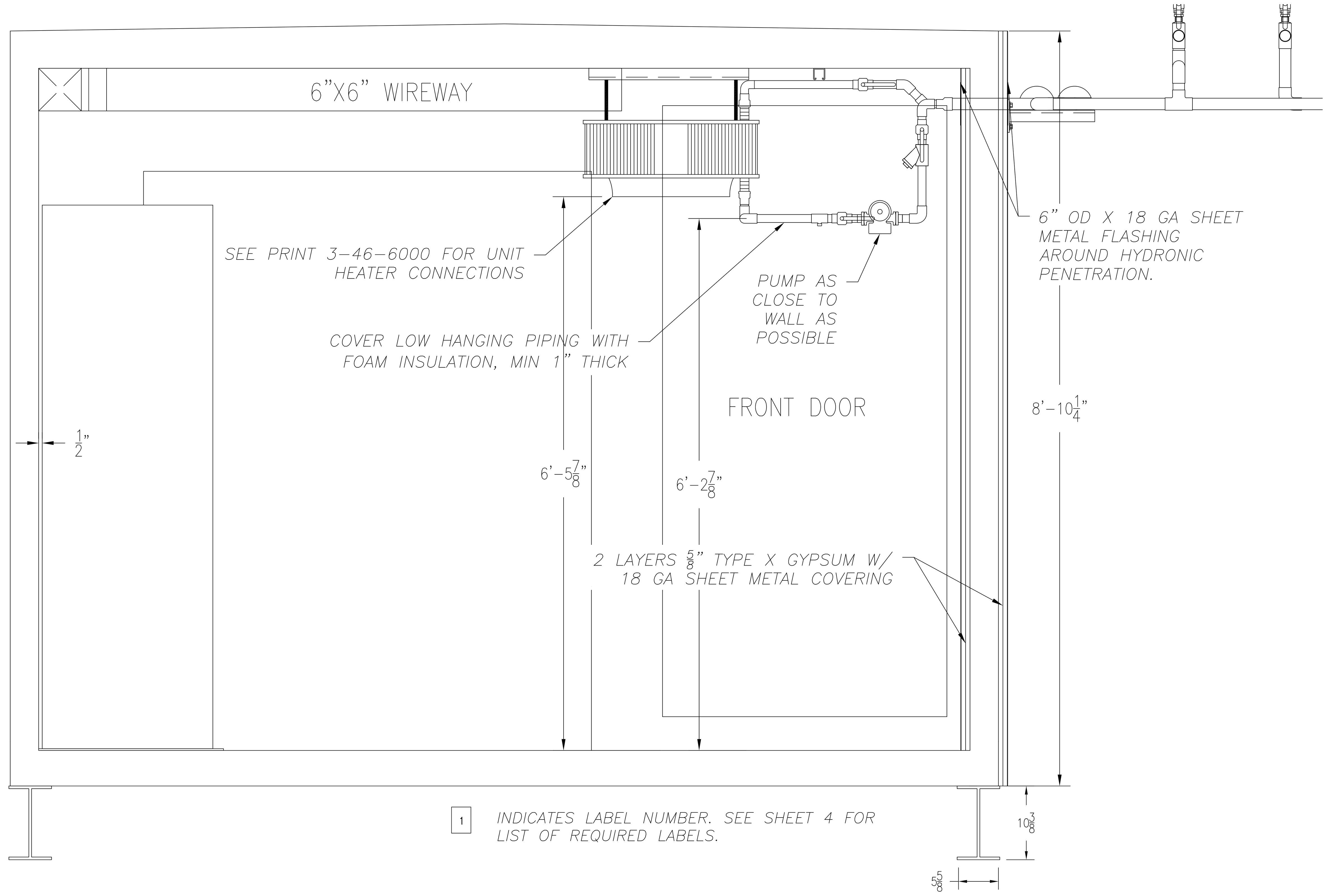
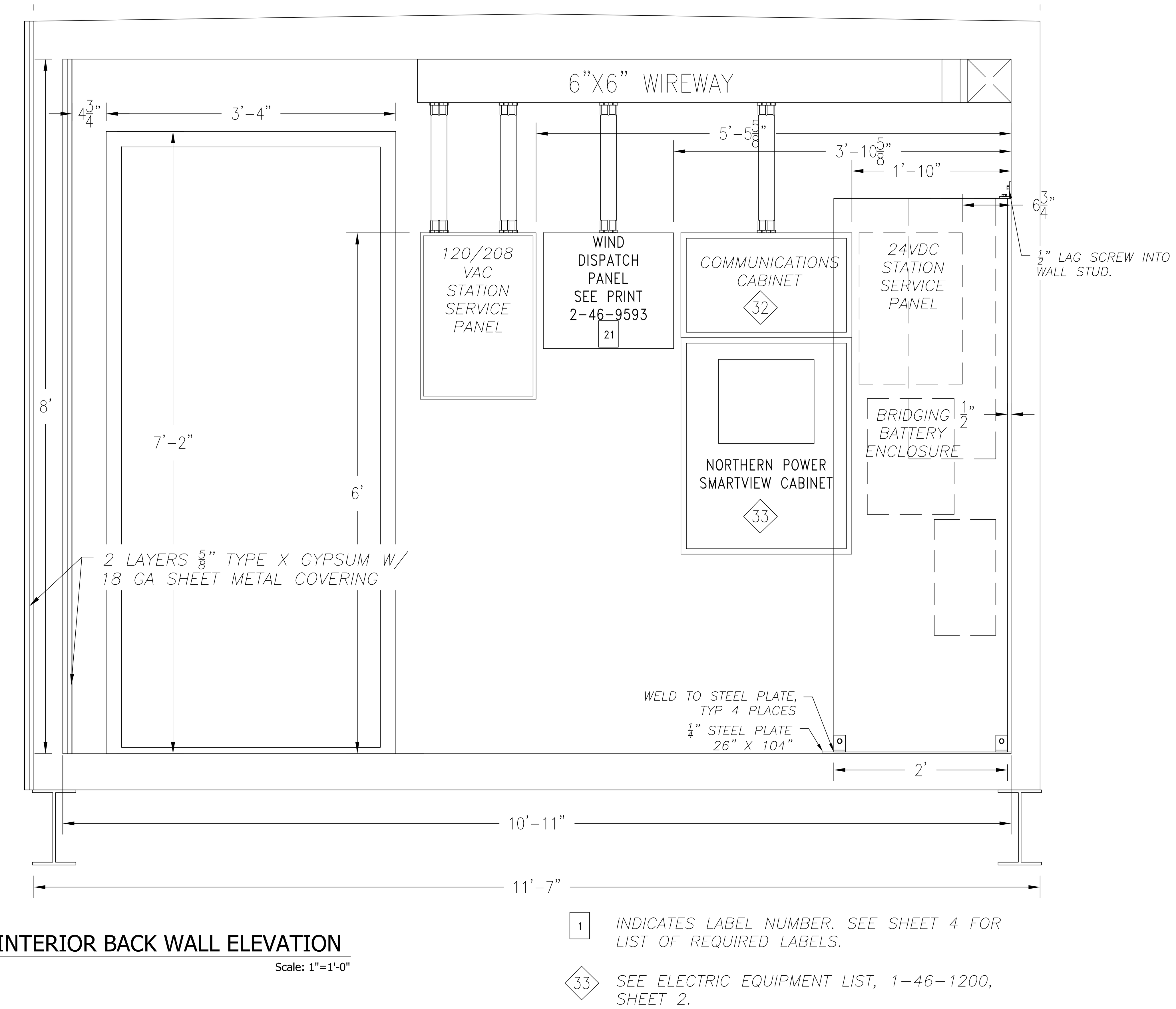
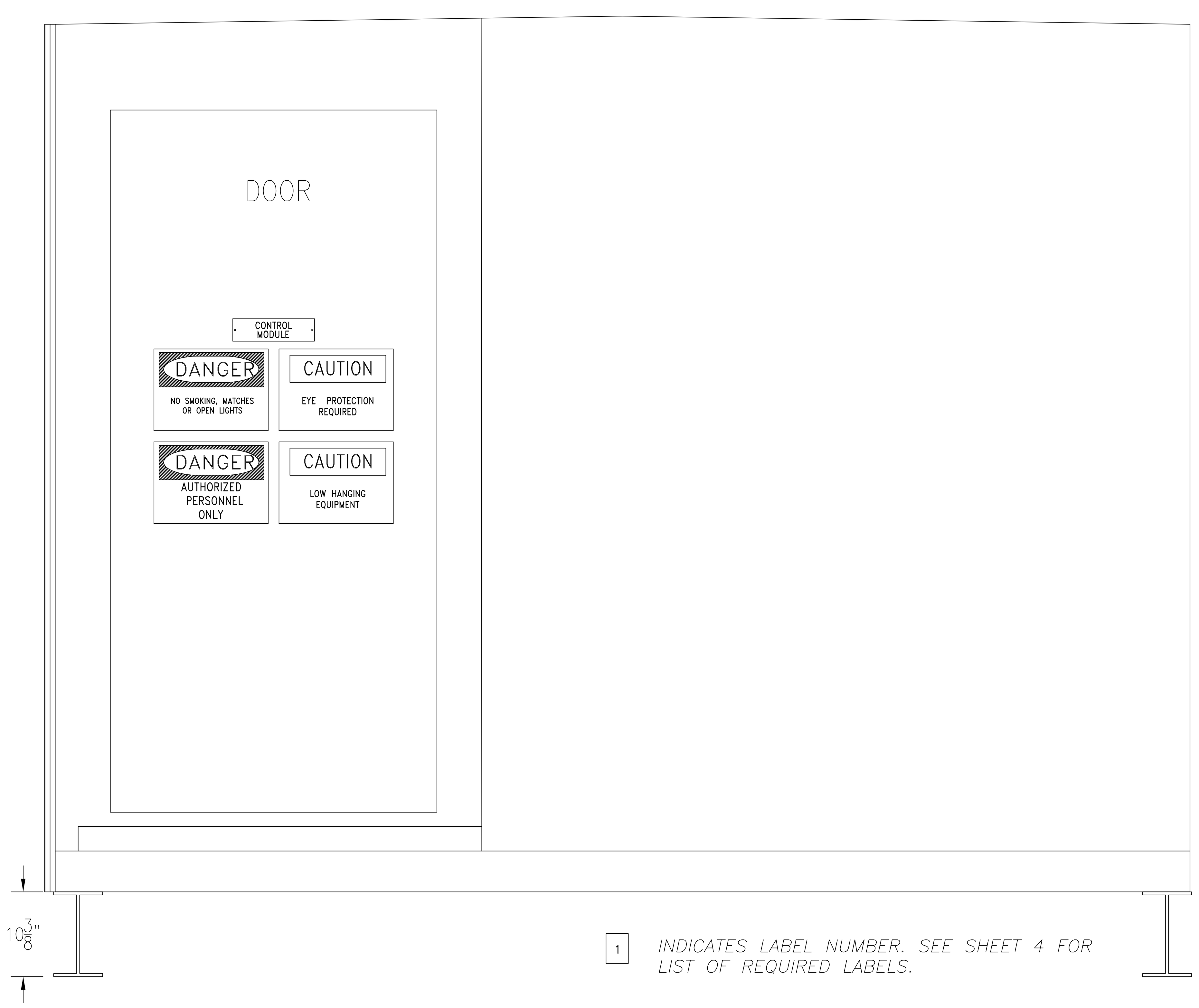



C INTERIOR FRONT WALL ELEVATION
Scale: 1"=1'-0"




D INTERIOR BACK WALL ELEVATION
Scale: 1"=1'-0"




E EXTERIOR FRONT WALL ELEVATION
Scale: 1"=1'-0"

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 1 | 5/27/11 | AAC / AAC | ADDED DIMENSIONS, EQUIPMENT |

AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE
SHAKTOOLIK
TINY HUNSTMAN MODULE

WORK ORDER No. 9724621
BY SK | FF #
ENGR. AAC | CAD# 1-46-0088
VILLAGE SHAKTOOLIK
SCALE 1" = 12" | DATE 09-16-10 | SHEET 3 OF 4
NO. 1-46-0788 | REV. 1

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| SIGN/LABEL # | DESCRIPTION |
|---|---|
| 1 | ENG-GEN CONTROL PANEL#1 |
| 2 | ENG-GEN CONTROL PANEL#2 |
| 3 | ENG-GEN CONTROL PANEL#3 |
| 4 | MASTER CONTROL SECTION |
| 5 | POSITION 1 GENERATOR BREAKER |
| 6 | POSITION 2 GENERATOR BREAKER |
| 7 | POSITION 3 GENERATOR BREAKER |
| 8 | POSITION 1 PT BOX |
| 9 | POSITION 2 PT BOX |
| 10 | POSITION 3 PT BOX |
| 11 | STATION SERVICE METER |
| 12 | TOTALIZING METER |
| 13 | TRANSFORMER SK-1A |
| 14 | TRANSFORMER SK-1B |
| 15 | TRANSFORMER SK-1C |
| 16 | DANGER: 480 VOLTS |
| 17 | SIGN, "DNGR, ELCT. AUTH PERSONNEL ONLY" |
| 18 | SECONDARY LOAD TOTALIZING METER |
| 19 | SECONDARY LOAD CIRCUIT BREAKER |
| 20 | WARNING: METER NOT A DISCONNECT... |
| 21 | WIND/SECONDARY LOAD DISPATCH PANEL |
| 22 | SECONDARY LOAD PUMP CONTACTOR |
| 23 | BOILER |
| 24 | GENERATOR BREAKER SECTION |
| 25 | FEEDER BREAKER SECTION |
| 26 | STATION SERVICE BREAKER |
| 27 | HOUSING, AIRPORT, FISH PLANT |
| 28 | SCHOOL |
| 29 | WATER PLANT, CLINIC, TELEPHONE OFFICE |
| 30 | UNIT HEATER #1 |
| 31 | UNIT HEATER #1 THERMOSTAT |

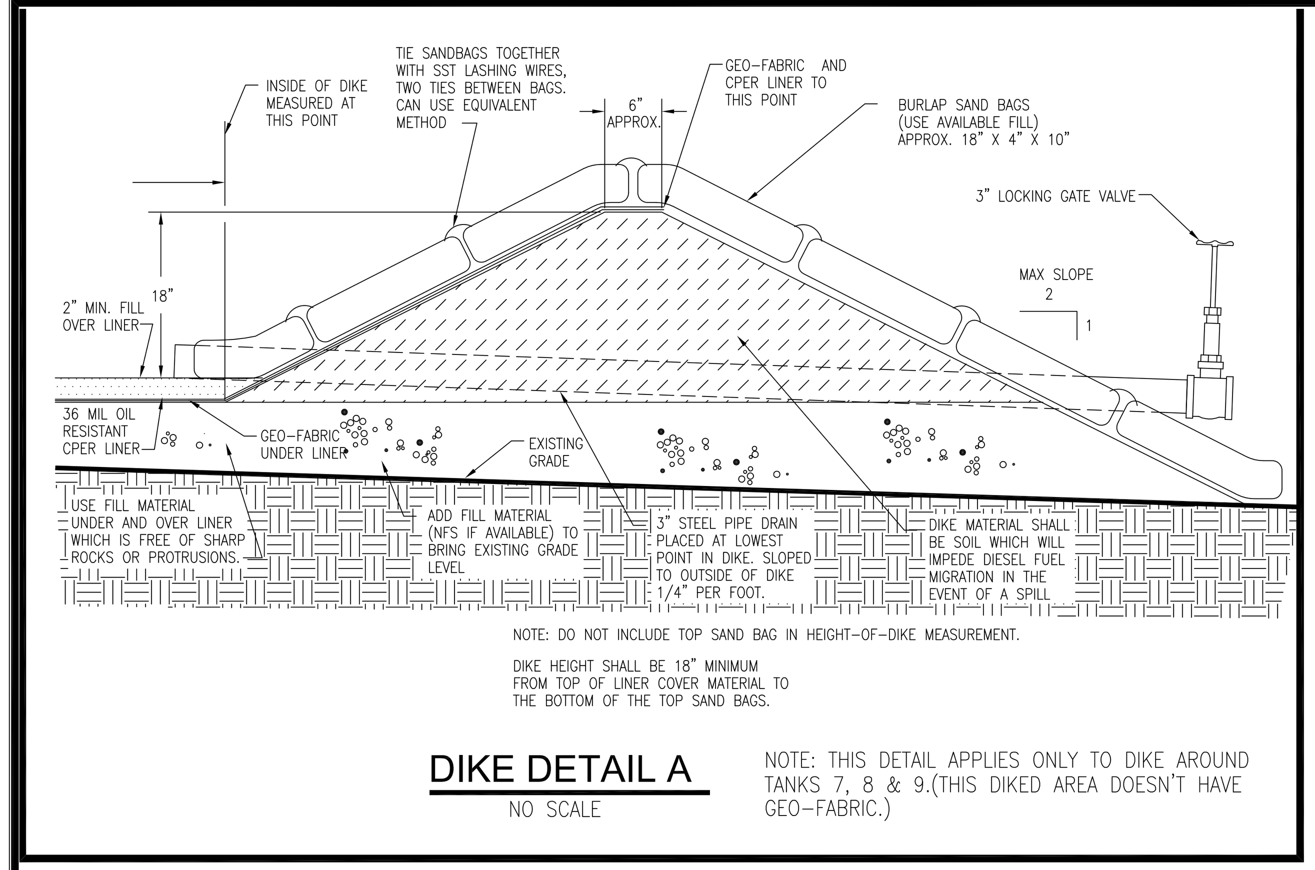
| NO. | DATE | BY | REVISIONS |
|---|---|---|---|

ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE
SHAKTOOLIK
TINY HUNSTMAN MODULE

WORK ORDER No.

BY SK | FF #
ENGR. AAC | CAD# 1-46-0088
VILLAGE SHAKTOOLIK
SCALE 1" = 12" | DATE 09-16-10 | SHEET 4 OF 4
NO. 1-46-0788 | REV. 1

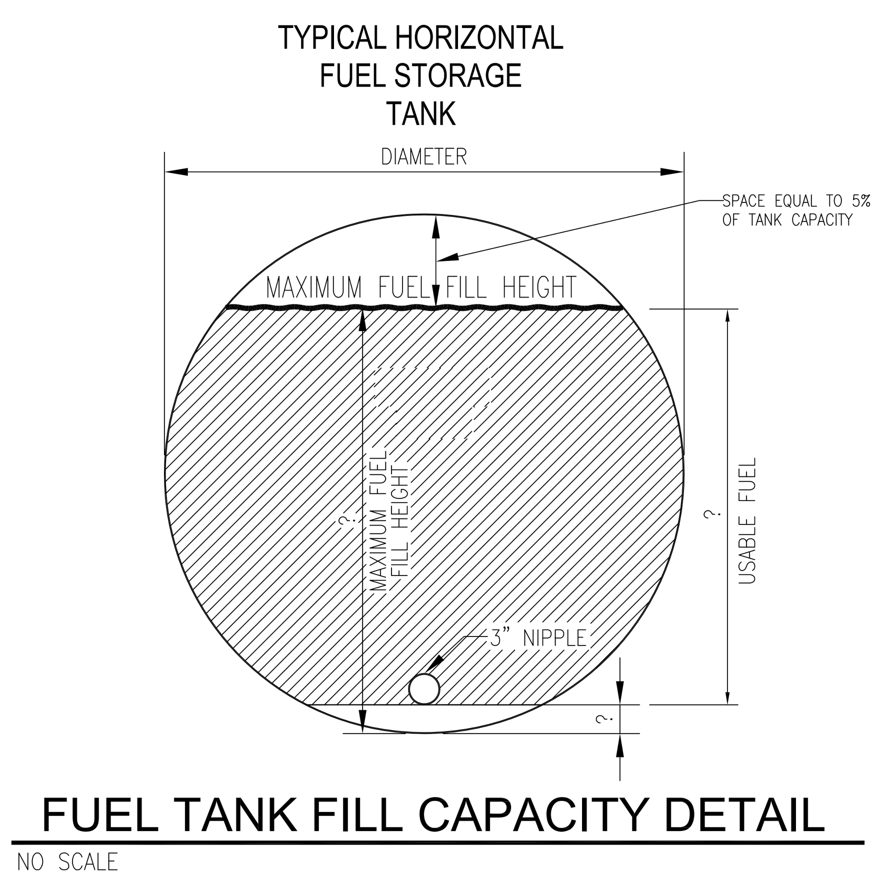



## DIKE DETAIL A

NO SCALE

NOTE: THIS DETAIL APPLIES ONLY TO DIKE AROUND TANKS 7, 8 & 9.(THIS DIKED AREA DOESN'T HAVE GEO-FABRIC.)

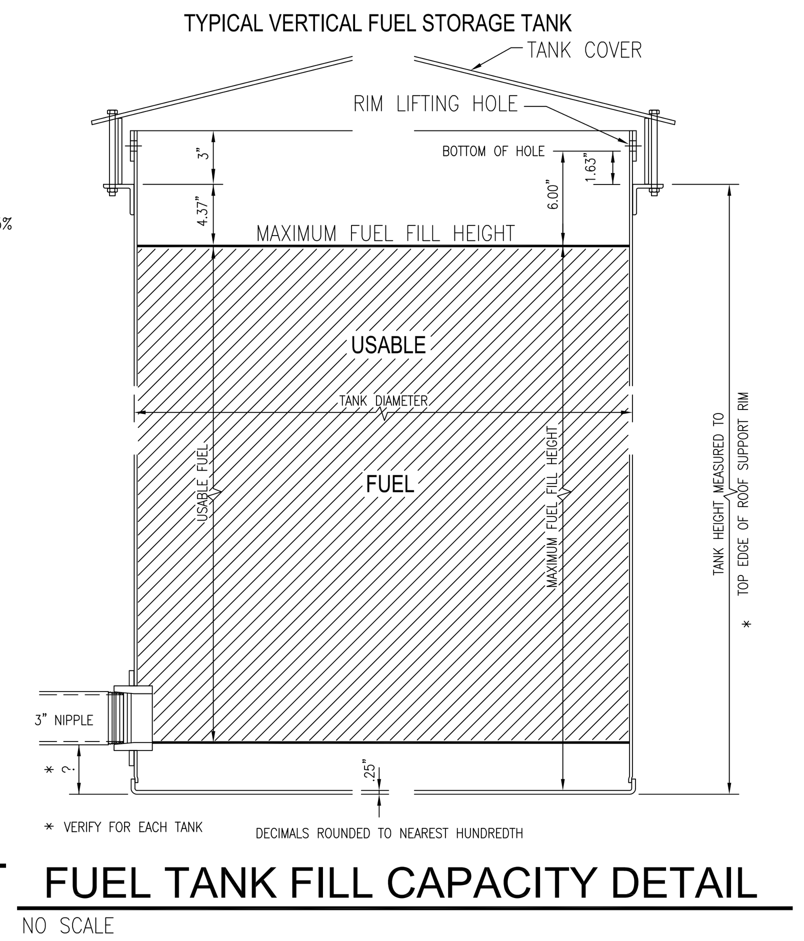
### TYPICAL HORIZONTAL FUEL STORAGE TANK




## FUEL TANK FILL CAPACITY DETAIL

NO SCALE

### TYPICAL VERTICAL FUEL STORAGE TANK




## FUEL TANK FILL CAPACITY DETAIL

NO SCALE

| TANK DIMENSIONS FOR SHAKTOOLIK: CIRCUMFERENCE feet – inches | RIM ANGLE HEIGHT feet – inches | BOTTOM NIPPLE HEIGHT (inches) | OUTSIDE DIAMETER feet | LENGTH feet – inches | MAX FUEL FILL HEIGHT feet – inches | TANK No. | FIELD INVENTORY: WATER inches | LIQUID IN TANK feet – inches | FOR OFFICE USE ONLY: GALLONS PER FOOT MULTIPLER | GALLONS PER FOOT CALCULATION | GALLONS PER INCH MULTIPLER | GALLONS PER INCH CALCULATION | FUEL (gallons): QUANTITY INVENTORIED | MAXIMUM FILL CAPACITY | USABLE CAPACITY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34' 5.75" | 13' 4.50" | 3.38" | 10.975' | N/A | 12' 9.75" | 1 | | | 703.32 | | 58.610 | | | 9016 | 8817 |
| 31' 3.50" | 13' 5.13" | 3.25" | 9.960' | N/A | 12' 10.38" | 2 | | | 578.93 | | 48.244 | | | 7452 | 7295 |
| 32' 10.50" | 13' 5.50" | 4.00" | 10.464' | N/A | 12' 10.75" | 3 | | | 639.21 | | 53.267 | | | 8247 | 8034 |
| 29' 8.75" | 13' 5.50" | 3.50" | 9.463' | N/A | 12' 10.75" | 4 | | | 522.37 | | 43.531 | | | 6740 | 6588 |
| 34' 8.25" | 13' 10.38" | 3.75" | 11.041' | N/A | 13' 3.38" | 5 | | | 711.87 | | 59.323 | | | 9459 | 9236 |
| 33' 0.5" | 13' 10.50" | 4.25" | 10.517' | N/A | 13' 3.50" | 6 | | | 645.72 | | 53.810 | | | 8587 | 8358 |
| HORIZONTAL TANK | | 3.5" | 7.917' | 27' – 6" | 7' – 2.0" | 7 | | | READING AT MANIFOLD END / READING AT FAR END | | APPLY AVERAGE READING TO TANK 7 FORMULA | | | 9558 | 9439 |
| 34' 3.0" | 14' 1.13" | 3.75" | 10.902' | N/A | 13' 6.00" | 8 | | | 693.97 | | 57.831 | | | 9373 | 9156 |
| 33' 0.5" | 14' 1.0" | 3.50" | 10.517' | N/A | 13' 5.88" | 9 | | | 645.72 | | 53.810 | | | 8715 | 8526 |
| | | | | | | | | | TANK FARM TOTALS | | | | | 77,146 | 75,450 |

FOR VERTICAL TANKS

MAXIMUM FUEL FILL HEIGHT F.H.) (BASED ON 95% OF TANK CAPACITY FOR EXPANSION OR TILT) = [[OUTSIDE BOTTOM OF THE TANK TO THE TOP EDGE OF THE ROOF SUPPORT RIM] −0.25"+1.63"] x 0.95

MAXIMUM FUEL FILL CAPACITY = MAXIMUM FUEL FILL HEIGHT (F.H.) X MULTIPLIER

USABLE FUEL CAPACITY = [MAXIMUM FUEL FILL HEIGHT (F.H.) − BOTTOM NIPPLE HEIGHT] X MULTIPLIER

FOR HORIZONTAL TANKS

MAXIMUM FUEL FILL HEIGHT (F.H.) (ASSUMING 5% FOR EXPANSION) = INSIDE DIAMETER OF TANK – 5% OF CAPACITY
MAXIMUM FUEL FILL CAPACITY: USE MAXIMUM FUEL FILL HEIGHT TO DETERMINE "K". USE "K" TO FIND "P"

USABLE FUEL CAPACITY: MAXIMUM FUEL FILL CAPACITY – UNUSABLE FUEL CAPACITY
UNUSABLE FUEL CAPACITY: USE BOTTOM NIPPLE HEIGHT TO DETERMINE "K". USE "K" TO FIND "P"

### DAYTANK READING

| DATE | AMOUNT OF FUEL IN TANK | REGISTER TOTAL | FUEL INVENTORY AND DAYTANK READING TAKEN BY: SIGNATURE |
|---|---|---|---|
| | | | |
| DAYTANK DIMENSIONS | | | NUMBER OF BARRELS OF LUBE OIL ON SITE |
| LENGTH | OUTSIDE DIAMETER | | |
| | | | GALLONS OF ANTIFREEZE ON SITE |

### TANK 7 FORMULA

FUEL IN INCHES / 94.50 = K (USE "K" TO FIND "P")
TOTAL FUEL IN GALLONS = P x 8930 x 329.50 x .0034
ASSUMED WALL THICKNESS = .25"

### FOR HORIZONTAL TANK NO. 7

MAXIMUM FUEL FILL CAPACITY CALCULATION

FUEL IN INCHES / INSIDE DIAM. IN INCHES = K

USING K, FIND CORRESPONDING P FACTOR IN TABLE BELOW

TOTAL GAL. = P X INSIDE DIAM. IN INCHES$^2$ X INSIDE LENGTH IN INCHES X.0034

FOR TANK # 7 = 86/94.50 = .91 = K (USE K TO FIND P)

P = .9556

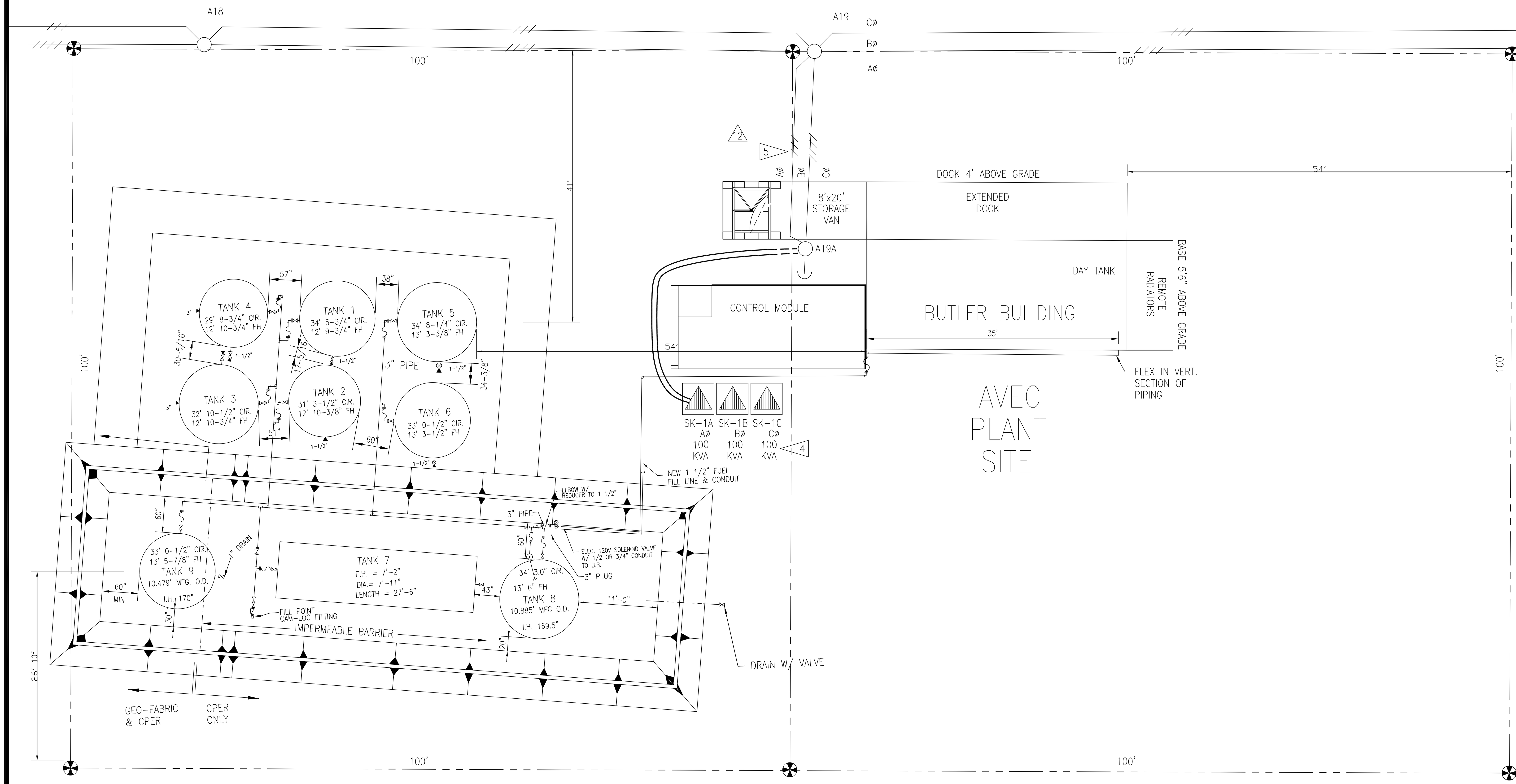
.9556 * 8930 * 329.50 * .0034 = 9558 MAX. FUEL FILL CAPACITY

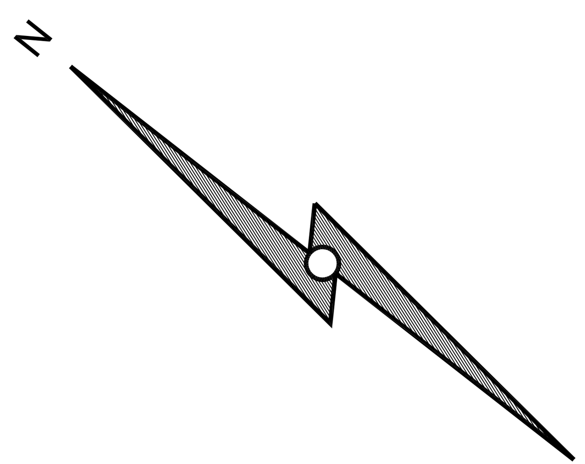
UNUSABLE FUEL CALCULATION
3.5/94.50 = .04 = K
USE K TO FIND P
P = .0134
.0134 * 8930 * 329.50 * .0034 = APPROX 120 GALLONS UNUSABLE FUEL

USABLE FUEL CALCULATION
USABLE FUEL CAPACITY = MAXIMUM FUEL FILL CAPACITY – UNUSABLE FUEL
9558 – 120 = 9438 USEABLE FUEL CAPACITY

### FACTOR TABLE

| K | P | K | P | K | P | K | P |
|---|---|---|---|---|---|---|---|
| .02 | .0048 | .26 | .2066 | .51 | .5128 | .76 | .8155 |
| .03 | .0087 | .27 | .2178 | .52 | .5256 | .77 | .8263 |
| .04 | .0134 | .28 | .2291 | .53 | .5383 | .78 | .8370 |
| .05 | .0187 | .29 | .2405 | .54 | .5510 | .79 | .8474 |
| .06 | .0244 | .30 | .2523 | .55 | .5636 | .80 | .8577 |
| .07 | .0308 | .31 | .2640 | .56 | .5763 | .81 | .8677 |
| .08 | .0375 | .32 | .2757 | .57 | .5889 | .82 | .8776 |
| .09 | .0446 | .33 | .2876 | .58 | .6012 | .83 | .8874 |
| .10 | .0520 | .34 | .2997 | .59 | .6140 | .84 | .8968 |
| .11 | .0598 | .35 | .3118 | .60 | .6265 | .85 | .9060 |
| .12 | .0680 | .36 | .3241 | .61 | .6390 | .86 | .9150 |
| .13 | .0764 | .37 | .3363 | .62 | .6514 | .87 | .9236 |
| .14 | .0850 | .38 | .3486 | .63 | .6637 | .88 | .9320 |
| .15 | .0940 | .39 | .3610 | .64 | .6759 | .89 | .9402 |
| .16 | .1032 | .40 | .3735 | .65 | .6882 | .90 | .9480 |
| .17 | .1126 | .41 | .3860 | .66 | .7003 | .91 | .9556 |
| .18 | .1224 | .42 | .3988 | .67 | .7124 | .92 | .9625 |
| .19 | .1328 | .43 | .4111 | .68 | .7243 | .93 | .9692 |
| .20 | .1423 | .44 | .4237 | .69 | .7360 | .94 | .9761 |
| .21 | .1528 | .45 | .4364 | .70 | .7477 | .95 | .9813 |
| .22 | .1638 | .46 | .4490 | .71 | .7595 | .96 | .9866 |
| .23 | .1737 | .47 | .4617 | .72 | .7709 | .97 | .9913 |
| .24 | .1845 | .48 | .4744 | .73 | .7822 | .98 | .9952 |
| .25 | .1954 | .49 | .4872 | .74 | .7934 | .99 | .9983 |
| | | .50 | .5000 | .75 | .8046 | 1.00 | 1.000 |




## PLANT SITE LEGAL DESCRIPTION

BY RESOLUTION FROM THE CITY COUNCIL OF SHAKTOOLIK GRANTING RIGHT-OF-WAY FOR PLANT SITE, PENDING ISSUE OF TRUSTEE DEED FROM B.L.M. SEE R/W FILE

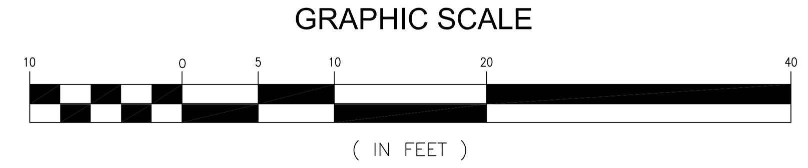
## NOTES

1. THE ACCURACY OF THIS DRAWING IS APPROXIMATE. NO RELIABLE DATA IS AVAILABLE ON EXACT LOCATIONS OF MANMADE STRUCTURES, LOTLINES, VALVES, FUEL LINES, TANK PLACEMENTS, ETC. A FIELD SURVEY IS NECESSARY TO ESTABLISH ACTUAL LOCATIONS.
2. SEE SHAKTOOLIK DISTRIBUTION MAP, DRAWING 2-46-0000 FOR MORE DETAIL.
3. ASBUILD/UPGRADE THE PLANT SITE GROUND GRID TO MEET SPECIFICATIONS IDENTIFIED IN FIELD NOTES FOR W.O. 46G032. REDLINE THIS DRAWING AS REQUIRED TO ACCURATELY REPRESENT THE COMPLETE GROUND GRID SYSTEM AND SUBMIT TO AVEC ENGINEERING IN ANCHORAGE.
4. W/O 46G032: REPLACE EXISTING TRANSFORMERS WITH (3) 100KVA PLANT STEP-UP TRANSFORMERS PER 480V GENERATION CONVERSION. UPGRADE GROUNDING, LOW AND HIGH VOLTAGE FEEDERS, AND PROVIDE EMERGENCY JUMPERS PER DWG. 2-46-1500.
5. PRIOR TO 480V CONVERSION OF GENERATION STATION, SECONDARY DROP IS TO BE CONVERTED TO OVERHEAD DISTRIBUTION PER W.O. 46D048.

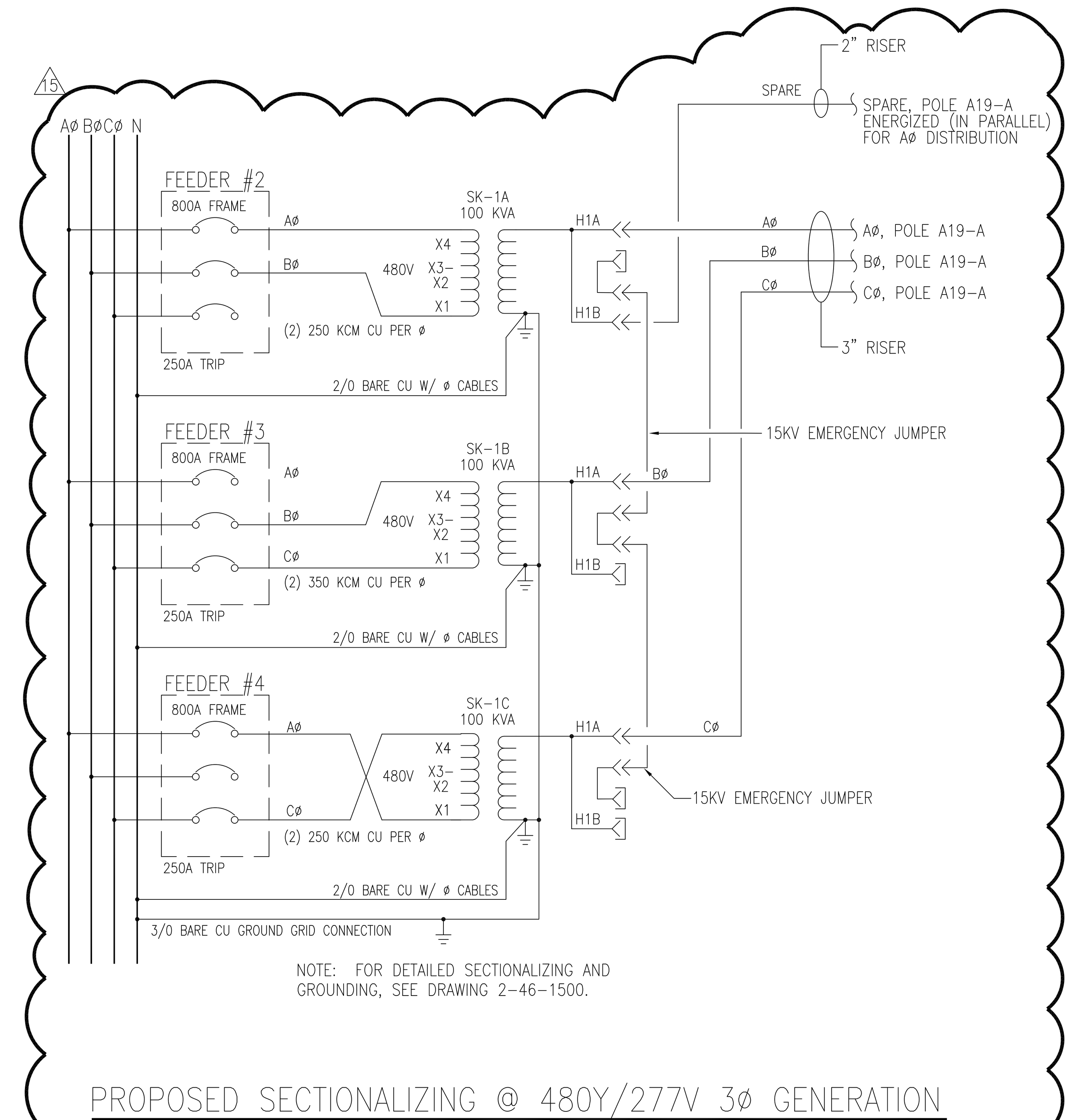
## LEGEND

| | |
|---|---|
| BALL VALVE | ELBOW |
| GATE VALVE | UNION |
| CHECK VALVE | PLUG |
| FLEX | 3-WAY VALVE, DURCO MG411-13 (ARRANGEMENT #13) |
| FLANGE | CAP |
| TEE | FOUND MONUMENT (5/96) |
| CROSS | |

### GRAPHIC SCALE




( IN FEET )
1 inch= 10 FT.




PROPOSED SECTIONALIZING @ 480Y/277V 3ø GENERATION

CHANGES TO SEALED DRAWINGS NOT AUTHORIZED IN WRITING BY THE STAMPING ENGINEER SHALL VOID THE SEAL OF THE ENTIRE DRAWING. THE SEAL IS VALID ONLY FOR CLOUDED MODIFICATIONS MADE UNDER THIS ONE DRAWING REVISION.

VERIFICATION OF ELECTRICAL CLEARANCES NOT INCLUDED IN NANA/COLT ENG. SCOPE OF WORK. NANA/COLT ENGINEERING, LLC HAS NOT CONFIRMED THE ACCURACY OF RECORD INFORMATION PRESENTED ON THIS DRAWING.

### REVISIONS

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 16 | 6/7/11 | AAC | ADDED CONTROL MODULE |
| 15 | 4/5/11 | AAC | MODIFIED SECTIONALIZING FOR KOHLER SWITCHGEAR |
| 14 | 3/15/11 | TVM | ADDED 6'DISH |
| 13 | 9-27-04 | AAC | Re-calc tank 7 max fill based on 5% expansion |
| 12 | 8/16/01 | ALA / SJP | 480V CONV., ET., AL. (46G032, 46G034) |
| 11 | 3-18-97 | MBP / MET | REVISED HORIZONTAL TANK FORMULAS |
| 10 | 12-17-96 | MBP / MET | PLANT&TANK ASB PER B.NOTHAM & DOE PIPING ASB |
| 9 | 1-30-95 | RM / DRB | REVISED INFO OF TANKS 8 & 9 PER DRB |
| | | | |
| 4 | 7/27/89 | RM / MET | ADDED TANK, NEW CAD SHEET |

AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE

# A.V.E.C PLANT SITE SHAKTOOLIK AFTER 480V CONVERSION AND KOHLER SWITCHGEAR

| | |
|---|---|
| WORK ORDER No. | |
| BY R. MONAHAN | FF # |
| ENGR. D. BIEGEL | CAD# P46GP000 |
| VILLAGE SHAKTOOLIK | |
| SCALE 1"=10'-0" | DATE 7/27/89 / SHEET 1 OF 1 |
| NO. 1-46-0000 | REV. 16 |

\\Avec-file01\engineer\Eng Main\Village\Shaktoolik\Drawings_PLANT SITE\P46GP000_KOHLER_SWITCHGEAR.dwg, 7/6/2011 7:54:09 AM, Adobe PDF

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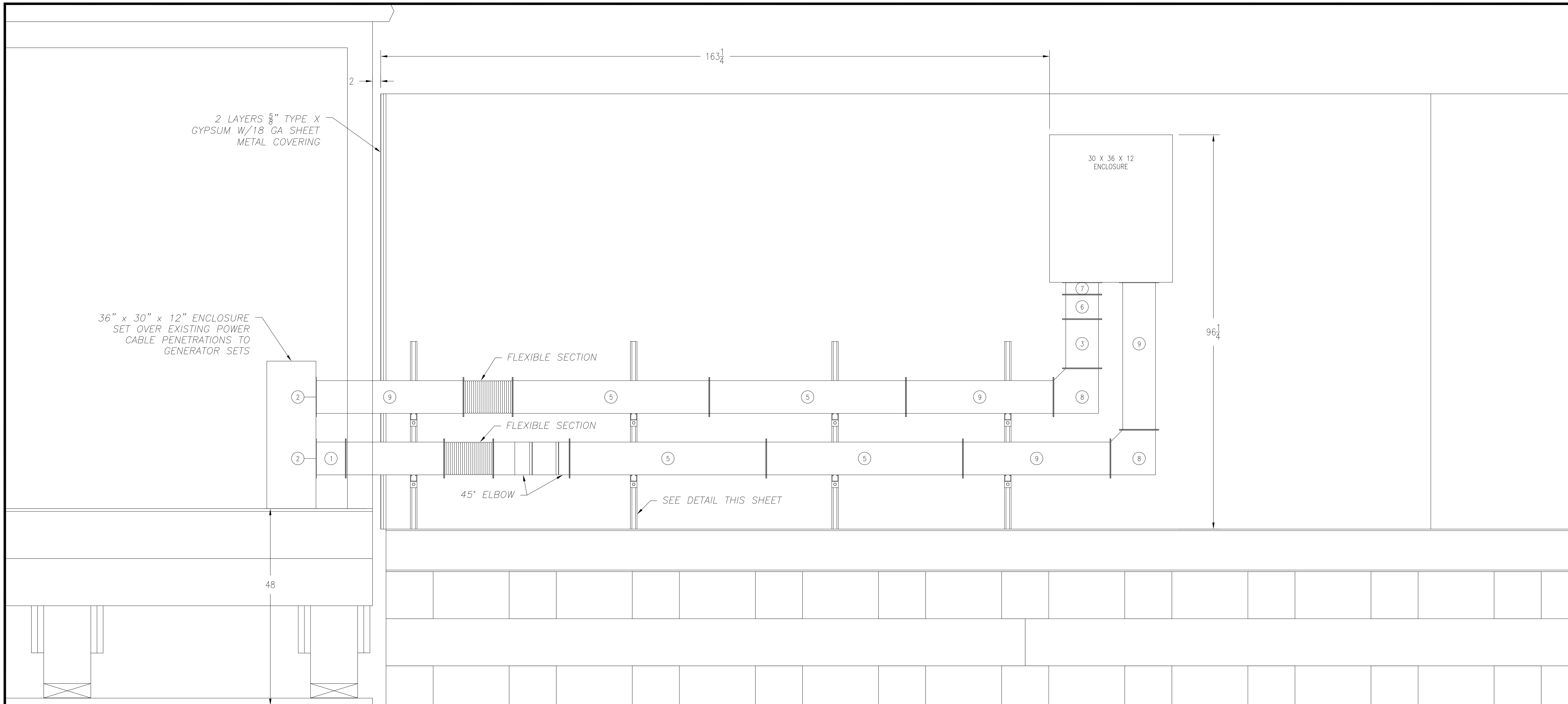
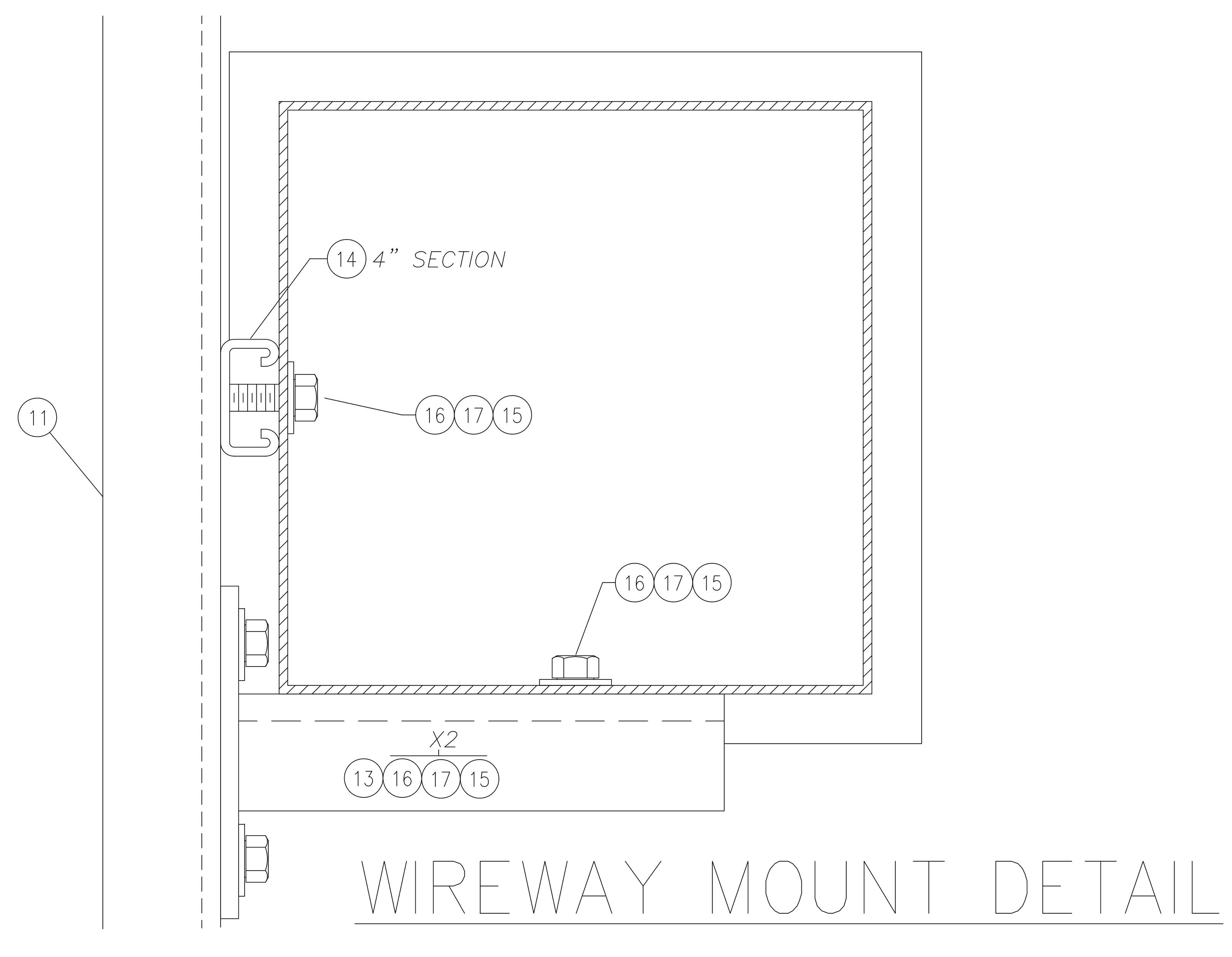



# WIREWAY INSTALLATION TO BUTLER BUILDING

SCALE: 1" = 1'

## MATERIALS LIST

1. 8" X 8" TELESCOPING WIREWAY SECTION, AVEC STOCK #553-2757
2. BOX CONNECTOR, AVEC STOCK #553-2752
3. 8" X 8" X 12" WIREWAY SECTION, AVEC STOCK #553-3777
4. 8" X 8", 45° WIREWAY ELBOW, AVEC STOCK #553-3865
5. 8" X 8" X 48" WIREWAY SECTION, AVEC STOCK #553-3776
6. 8" X 8" X 6" WIREWAY NIPPLE, AVEC STOCK #553-2751
7. 8" X 8" X 3" WIREWAY NIPPLE, AVEC STOCK #553-3845
8. 8" X 8" X 90° WIREWAY ELBOW, AVEC STOCK #553-2754
9. 8" X 8" X 36" WIREWAY SECTION, AVEC STOCK #553-2750
10. 8" X 8" X 24" WIREWAY SECTION, AVEC STOCK #553-3690
11. 1-5/8" X 1-5/8" X 10'-0" CHANNEL, AVEC STOCK #553-3604
12. 1/4" X 2" LAG SCREW, AVEC STOCK #600-0059
13. 12" CHANNEL BRACKET, AVEC STOCK #594-0307 (CUT CHANNEL TO 6-3/4")
14. 13/16" X 1-5/8" X 10'-0" CHANNEL, AVEC STOCK #553-4356
15. 3/8" CHANNEL NUT, AVEC STOCK #600-0147
16. 3/8" X 1-1/4" HEX BOLT, AVEC STOCK #600-0170
17. 3/8" FLAT WASHER, AVEC STOCK #600-0139




# WIREWAY MOUNT DETAIL

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|

ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

TITLE

**SHAKTOOLIK POWER/CONTROL CABLE WIREWAY TO BUTLER BUILDING**

| | |
|---|---|
| WORK ORDER No. 9724621 | |
| BY AAC | FF # |
| ENGR. AAC | CAD# 3-46-1334 |
| VILLAGE SHAKTOOLIK | |
| SCALE 1"=1' | DATE 5/25/11 |
| SHEET 1 OF 3 | |
| NO. 3-46-1334 | REV. 0 |

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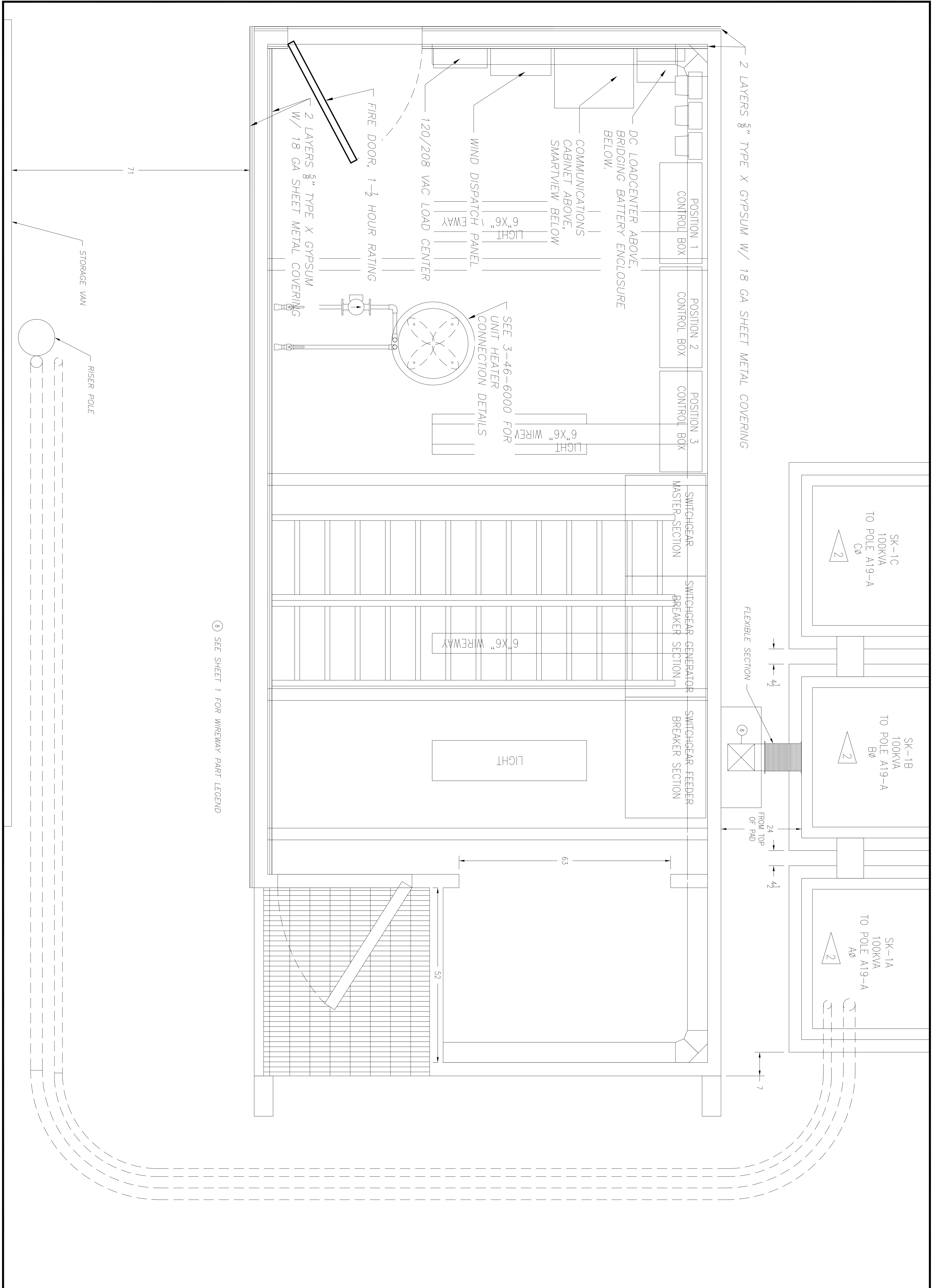


TITLE

**SHAKTOOLIK TRANSFORMER CABLE WIREWAY TO TRANSFORMERS**

WORK ORDER No. 972621

BY AAC | ENGR. AAC | CAD# 3-46-1334 | FF #

VILLAGE SHAKTOOLIK

SCALE 1"=1' | DATE 5/25/11 | SHEET 2 OF 3

NO. 3-46-1334 | REV. 1

AVEC
ALASKA VILLAGE ELECTRIC COOPERATIVE
4831 Eagle Street Anchorage, Alaska 99503

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 1 | 6/28/11 | AAC/AAC | CHANGED SHEET TITLE |

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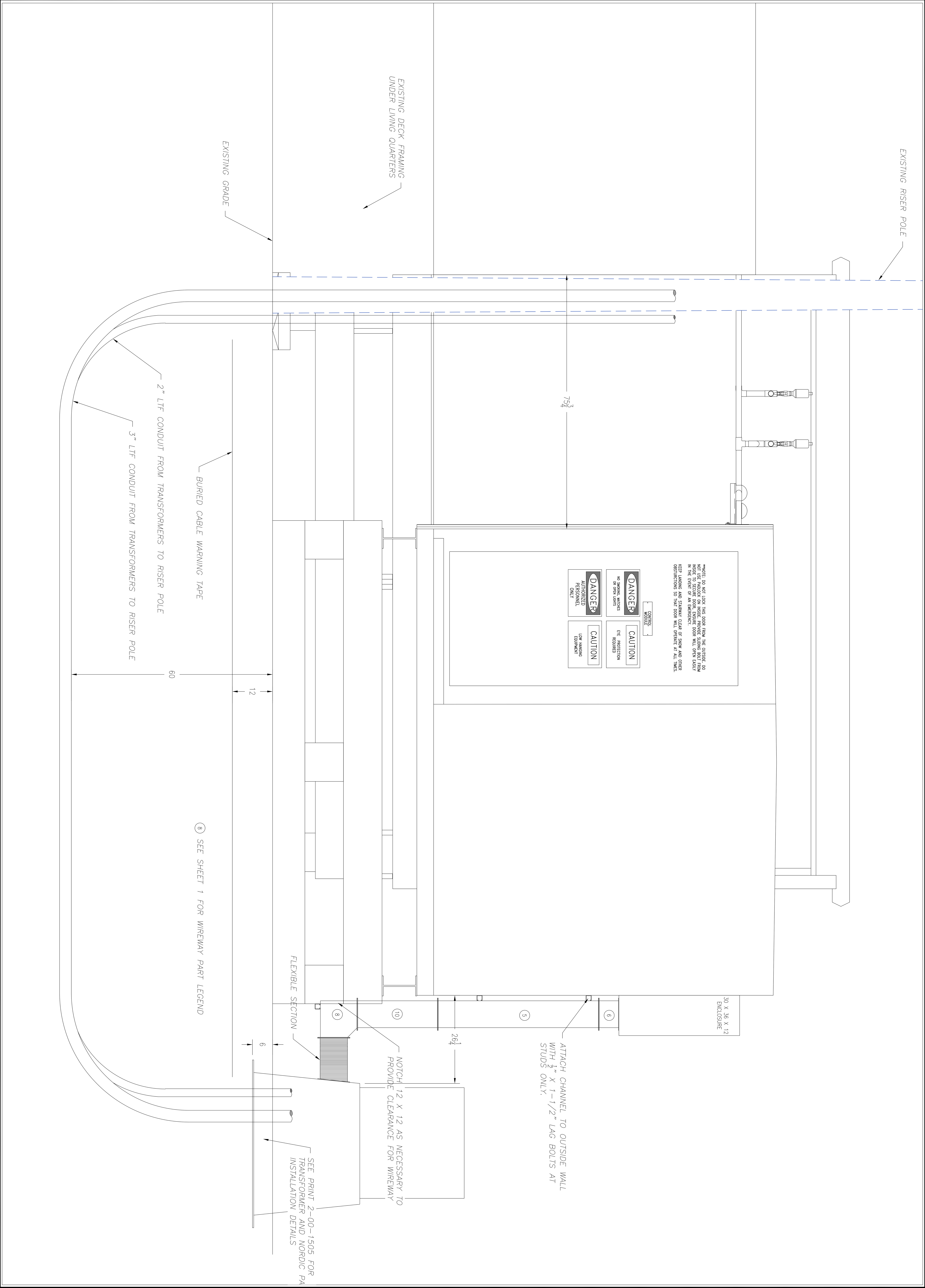


| | |
|---|---|
| WORK ORDER No. | 972621 |
| TITLE | **SHAKTOOLIK TRANSFORMER CABLE WIREWAY TO TRANSFORMERS** |
| BY | AAC |
| ENGR. | AAC |
| FF # | |
| CAD # | 3-46-1334 |
| VILLAGE | SHAKTOOLIK |
| SCALE | 1"=1' |
| DATE | 5/25/11 |
| SHEET | 3 OF 3 |
| NO. | 3-46-1334 |
| REV. | 1 |

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4831 Eagle Street Anchorage, Alaska 99503

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|
| 1 | 6/28/11 | AAC AAC | ADDED ADDITIONAL DETAIL |

| NO. | DATE | BY | REVISIONS |
|---|---|---|---|