Design Considerations for Sizing Industrial Generators

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INTRODUCTION

This white paper will cover the key factors to consider when sizing an industrial standby generator. Standby generators are used in critical applications such as data centers, healthcare facilities, water treatment plants, and manufacturing operations. Reliability, capacity, performance, as well as codes and standards are important to consider when sizing a standby generator.

BENEFITS OF USING SIZING SOFTWARE

GET IT RIGHT THE FIRST TIME

Most standby generators are permanently installed, so you want to get it right the first time. Sizing the generator correctlyis important to assure that site requirements will be met when the generator is installed.

Rehlko® Power Solutions Center sizing and specification software, available online at https://www.pscweb.rehlko.com/, runs calculations in the background to assure the right generator is recommended for the site conditions. Consider future electrical load or expansions that may be planned or consider how building expansions might require another generator and how that load scheme will connect with the existing infrastructure.

GENERATOR RECOMMENDED BASED ON DESIGNER INPUT

The sizing software should recommend a generator based on the inputs provided by the designer and will often show product offerings above it and below it to review the difference in performance. If the software does not recommend a generator, there may be an error in the inputs when the combination of requirements does not exist. The sizing software should consider both the engine and alternator characteristics of a generator as the engine is the mechanical source of power that is converted to electrical power by the alternator. The engine frequency dip is a good indicator of the generator's ability to pick up loads.

The construction and size of the alternator, its motor–starting capacity as well as the voltage regulation or volts per hertz setting can impact the generator's ability to accept load. Rehlko offers multiple engine and alternator combinations to meet the various site requirements.

OVERSIZED ALTERNATOR

Selecting a generator with an oversized alternator (a lower temperature rise value than the nameplate rating) may provide extra durability or increased safety factor. The alternator temperature rise is a value that is determined per National Electrical Manufacturer's Association (NEMA) testing.

Industry standard for standby generators is typically 130˚C (standby duty). The alternator temperature rise rating correlates to the number of run hours per year. Standby generators are a secondary source of power, therefore, with a reliable utility, the annual usage is typically low.

As the alternator temperature rise rating goes lower, the hours of life increase with the same load applied. The temperature rise is measured when full output power is removed from an alternator. For example, a 3000 kW generator with an 80˚C (continuous duty) temperature rise means the alternator operates under load at lower temperature than a typical standby 130˚C temperature rise alternator.

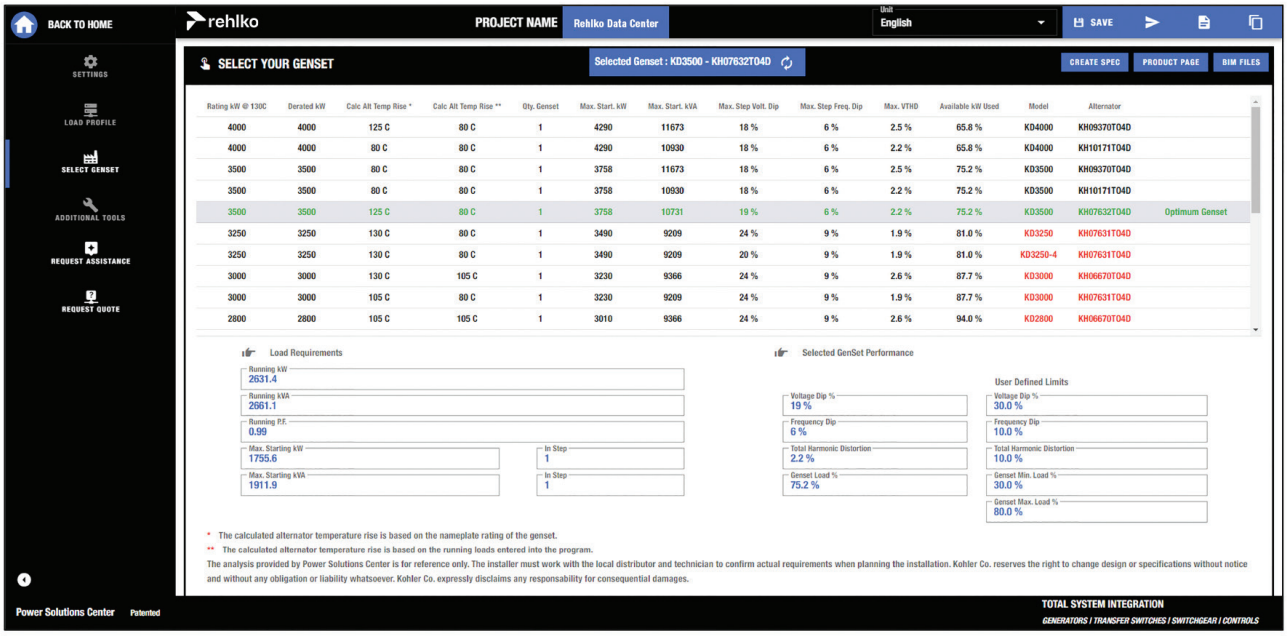
REHLKO OVERSIZED ALTERNATORS

Rehlko typically offers at least two levels of oversized alternators (105˚C and 80˚C) per generator as standard product offerings displayed in the Power Solutions Center but can also provide custom alternator solutions from the factory ordered through Rehlko distributors.

See *Figure 1* for a screenshot of the Select Genset Screen in Rehlko Power Solutions Center showing multiple data fields that allow the designer to choose the best option for their project site.

Figure 1

Rehlko Power Solutions Center Select Genset Screen



RIGHTSIZE THE GENERATOR

Sizing software allows the designer to run endless simulations and scenarios to rightsize the generator for the site today and in the future. There are many complex and dynamic calculations that the sizing software can make within seconds based on the varied inputs from the designer.

Evaluating harmonic distortion and its impact on the loads helps assure that downstream equipment won't be damaged. A practical solution is to use in-line filters at the site to reduce total harmonic distortion which will typically cost less than a larger generator recommended due to high harmonics introduced by various load types. Rehlko Power Solutions Center software allows the designer to change parameters in the Advanced Settings to match the loads specifications provided on the equipment's specification sheet.

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GENERATOR SELECTION FACTORS

SIZING PROGRAM INPUTS

There are many inputs that a generator manufacturer will ask for to properly size a standby generator. It is recommended to obtain the previous year's utility electrical load report for existing buildings where a standby generator is being added. Typically, each site and generator configuration is unique. Most generator manufacturers have accounted for this by offering a configurable design that allows for a myriad of variations.

Figure 2 shows a list of typical inputs to help size the generator(s) in the Rehlko® Power Solutions Center Sizing program. Multiple generators can be sized by selecting more than one generator in the quantity field. Load will be evenly distributed between the generators. (At the site, paralleling equipment will be required that may include on board paralleling controllers, switchboards, or switchgear.)

SIZING PROGRAM INPUTS (CONT.)

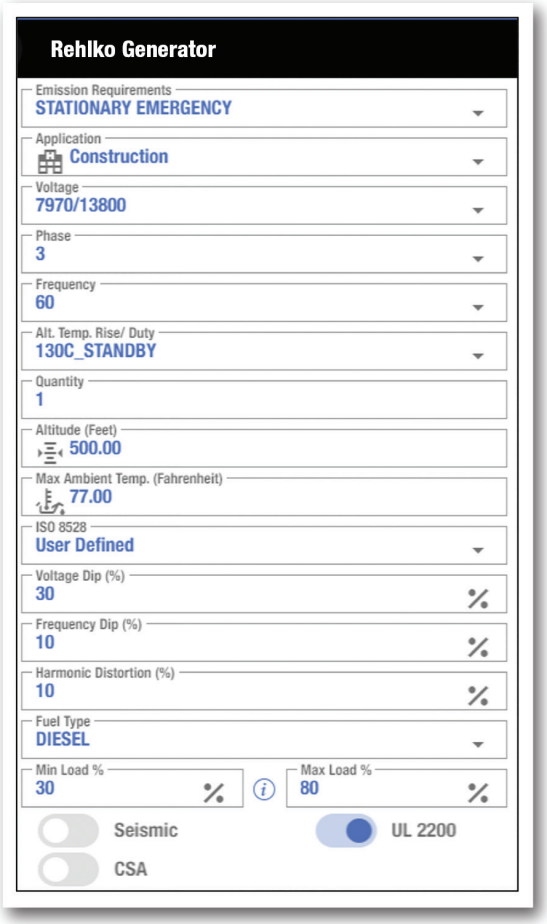
Note that most of these fields have dropdown menus which allow the user to select the site conditions and requirements, including application, emissions requirements, electrical operating parameters based on the local utility and distribution, alternator temperature rise requirements, and regional codes or standards required for the project.

Figure 2 shows typical input values for an indoor standby generator site in Wisconsin. This might differ greatly from the inputs provided for outdoor units in Texas or Northern Canada. In addition, transient performance of the generator and total harmonic distortion required for the load will depend on the types of electrical loads the generator will be supporting.

Finally, the fuel type and capacity of the generator is necessary to later select the possible product offerings from the generator manufacturer. Note that the lower limit defaults to 30% to avoid under– sizing a diesel generator to avoid wet stacking (internal carbon buildup) in the engine. The default upper limit is set to 80% to account for long–term durability, future loads not accounted for, and equipment tolerances. Rehlko Power Solutions Center allows the user to set their base input levels as part of their profile to reduce the number of changes required for regional designs each time a project is created.

Figure 2

Rehlko Power Solutions Center Sizing Program Inputs



TYPICAL LOAD TYPES

Figure 3 shows typical load types that can be used to create a load calculation in estimating the size of a generator. These load types have inputs that can be used to simulate most types of electrical loads.

For example, pump loads have motor characteristics such as a compressor (pump) for a refrigerator.

A fire pump has the same load inputs and calculations as a motor load in the sizing software but also requires that the transient voltage dip performance of a fire pump not exceed 15% per the National Electric Code (NEC).

There are many types of linear and nonlinear electrical loads as well. The load types in *Figure 3* should be able to size nearly all site locations.

Figure 3

Sample ICONS Depicting Load Types

DESIGNING THE LOAD PROFILES

CLASSIFYING LOADS

When designing the load profile, it is important to first classify the loads (e.g. life safety, critical, non-essential, etc.). This will help later with maximizing the size of the generator to fit the application. In addition, it is important to consider whether the load will be continuous or intermittent.

MOTOR LOADS

For example, refrigeration systems use a compressor motor which is intermittent in use to maintain the temperature once the refrigeration has reached the set temperature.

Further, if there are several refrigerators counted as a continuous load, it can lead to an oversized generator. In fact, many electrical loads have different starting and running loads. Loads like these will typically have a larger initial current requirement (in-rush current), then reduce to their running levels once the motor is running at its normal speed.

This information can be found on the equipment data sheets for your electrical loads.

TIMING OF LOAD SCHEME

Another consideration is the timing of the load scheme. Do all the loads need to start and run at the same time or is it possible to delay each load coming online? In the refrigerator example, the temperature will be stable for several minutes or longer if the power goes out.

In this case, if there are multiple refrigerators at a site, consideration should be made to allow for a delay (a few seconds) between each refrigerator restarting. Each delay can be established using a step scheme where the first refrigerator is started in step one, then the next refrigerator load is started on step two, and so forth.

With loads that are not continuous, using the stepscheme avoids all the load being applied to the generator at the same time which may ultimately reduce the size of the generator recommended by the sizing program.

There is a point of diminishing returns related to the number of steps used, but Rehlko® Power Solutions Center Sizing program makes it easy to change steps and view how the change impacts the size of the generator.

INSTALLATION REQUIREMENTS CONSIDERATIONS

There's a lot more to consider than just sizing electrical loads applied to a generator.

SPACE AND LOGISTICS

The space and logistics available for a generator is often limited. This is especially the case when a generator is installed inside a basement room or parking structure. The footprint (typically the length, width, and height) of the generator, its cooling air intake, and heat and exhaust discharge piping are critical considerations for life and codes.

FUEL AND EXHAUST PIPE SIZING

The fuel supply pipe sizing is also very important to consider and is based upon the distance from the fuel source, especially for gaseous fueled (natural gas or propane) generators. However, each site can have its own challenges with routing of fuel pipes and exhaust piping.

SOUND CONSIDERATIONS

In cases where the generator is installed outside, often there are local sound regulations in urban areas which must be met.

Most of these parameters or limits are found on a generator spec sheet. Sound level requirements are not consistent and can vary based on county as well as local codes.

ROOM SIZING

Rehlko® Power Solutions Center has additional tools which help with these installation considerations including a room sizing tool report providing minimum dimensions in a top view and side view drawing including exhaust pipe height for discharge piping.

REGIONAL CODES AND STANDARDS

Regional codes and standards are something that should also be considered when selecting the generator in the sizing program. Stationary gensets in North America have an option for UL2200 or Canadian Safety Association (CSA), and International Building code (IBC) seismic standards. Europe has requirements for Certification Europe (CE), Eurasian Conformity Certification (EAC), and Restriction of Hazardous Substances (RoHS) certification.

The manufacturer should offer these options as a selection in the sizing program to assure that the generator meets the necessary regional standard(s).

REHLKO ADVANTAGES

At Rehlko we strive to delight our customers with easy-to-use tools that aid in the design process to meet installation requirements. Rehlko® Power Solutions Center meets that definition.
It is more than just a sizing program and provides access to a library of technical documents that support each generator model on the *https://www.powersystems.rehlko.com/* website.

In addition to the sizing and installation tools mentioned in this white paper, Power Solutions Center guides the designer from creation of the single line to installation and commissioning.

Once a generator is sized and selected, a tailored guide specification written in a common industry format can be downloaded and modified to further meet the designer's specific site needs.

Access to the product website page and Building Information Modeling (BIM) files require only a click of the button to download technical documentation and gain more insight into the product's capabilities.

Power Solutions Center guides the designer through the process, then provides a link to the closest Rehlko distributor for assistance, quotation, and eventually the delivery and commissioning of the power system.

Rehlko has a worldwide network of distributors who assist locally at the job site in coordination with Rehlko factories around the world.

ABOUT THE AUTHOR

Todd Matte currently works as Principal Engineer – Technical Marketing and is the Rehlko® Power Solutions Center Administrator for North America. Todd has a bachelor's degree in electrical engineering from University of Wisconsin–Milwaukee and an MBA from Marquette University. He has been with Rehlko since 1995, having served both the Engines and Power Systems divisions in various capacities, including quality engineering, applications engineering, project management, product management, marketing communications, and leadership roles.

ABOUT POWER SYSTEMS

Power Systems, Rehlko's largest division, delivers worldwide energy solutions designed to ensure resilience for mission-critical applications of all sizes. Building on more than a century of expertise and dedication, the company offers complete power systems, including industrial backup generators (HVO, diesel, gaseous), enclosures, hydrogen fuel cells systems, automatic transfer switches, switchgear, monitoring controls, genuine parts and end-to-end services. As a global company with service partners in every country, Power Systems provides reliable, cutting-edge technology to keep industries and businesses running.
www.powersystems.rehlko.com

ABOUT REHLKO

A global leader in energy resilience, Rehlko delivers innovative energy solutions critical to sustain and improve life across home energy, industrial energy systems, and powertrain technologies, by delivering control, resilience and innovation. Leveraging the strength of its portfolio of businesses – Power Systems, Home Energy, Uninterruptible Power, Clarke Energy, Heila Technologies, Curtis Instruments, and Engines, and more than a century of industry leadership, Rehlko builds resilience where and when the grid cannot, and goes beyond functional, individual recovery to create better lives and communities, and a more durable and reliable energy future.

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