Contents

Getting Started

When you first start-up the program, you can either create a new project or search for an existing project. Any field that begins with orange is a required field. Hovering over any icon will bring up a short description of what it does.

<u>New Project:</u>
Select New Project.

Enter project information and select Save.

Your project will now be displayed.

Select project name you want to work on.

New Solution:
Select New Solution

Do not confuse the Solution Setup page with the User Default Settings.

Solution Setup

Solution Name

Spec Ref#

Description

Environment
Ambient Temperature
100 F / 38 C

Elevation
1000 ft / 305 m

Electrical Configuration
*Phase
Three Phase

*Frequency (Hz)
50 Hz

*Voltage (Nominal)
200V (Low Wye)

*Voltage (Specific)
200 volts

Units
*Units
Metric

Maximum Allowable Transients
Maximum Running Load
80 %

Voltage Dip
35.00 %   Percent

Frequency Dip
15 hertz   Hertz

Max Allowable Voltage Distortion (% THVD)
Continuous
11 %

Momentary
13 %

Engine
Duty
Standby

*Fuel
Diesel

Regulatory Information
Regulatory Filters
Seleziona filtri normativi

Application
Hospital

Generator Configuration
Sound (desired)
No Requirement

*Fuel Tank
No Requirement

*Run Time (desired)
16 hr

Load Sequence Configuration
Cyclic #1
75% After Largest

Cyclic #2
75% After Largest

Cancel   Restore Defaults   Save

Enter solution information and select Save.

New Load:

Use the drop down menu to select load type.

AC / Chiller
Battery Charger
Elevator-Cable
Elevator-Hydraulic
Fire Pump
Lighting
Medical Equipment
Miscellaneous
Motor
Non-linear
Office Equipment
Resistive
UPS (PC)
UPS (Servers)
Welder

Once the load is selected, use the drop down menus to select your device information.

Load   AC / Chiller

Load Basics

Description
AC / Chiller #1

Quantity
1

Sequence
Group 1 (Non-Concurrent)

Cooling
Cooling   Tons

Device Information

Compressors
1 Compressor Motors

Cooling Load
1.0 kW/ton

Reheat Load
0.0 kW/ton

Maximum Allowable Transients

Voltage Dip
35.00 %   Percent

Frequency Dip
15 hertz   Hertz

Load Characteristics

Starting Load			
sKVA	0	sKW	0

Running Load			
rKVA	0	rKW	0

Harmonic Current Distortion (%)			
Momentary	0	Continuous	0

Harmonic Current Distortion	
3rd	0
5th	0
7th	0
9th	0
11th	0
13th	0
15th	0
17th	0
19th	0

Cancel   Save

Continue adding loads until all loads to be connected to the generator have been added.

Recommended Product

801 kw, Diesel Genset -- Site rated 801 kw
35.7 L Engine with Standard (LSA 47.2 L9) Alternator

| ✉ Request for Quote |
| Convert to Natural Gas |

12 %	**0.2**	**0.0 %**
Running kW	Fdip (Hz)	THVD Cont.
12 %	**6.2 %**	**0.0 %**
Peak kW	Vdip (%)	THVD Peak

Family Selection Method
Auto Select ⌄

Sizing Method
Auto Select ⌄

| Loads | Documentation | Gas Piping | Exhaust Piping | Transient Analysis | Harmonic Analysis |

Solution Limits

Max Loading	80 %	Fdip (Hz)	15	THVD Cont.	11 %
		Vdip (%)	35 %	THVD Peak	13 %

Load Summary

	Running		Transients		Harmonics	
kW	100	kW (step)	21.18	kVA	0
kVA	117.65	kW (peak)	100	THID Cont.	0 %
PF	0.85	kVA (step)	70.59	THID Peak	0 %

+ Add Load

Description / Sequence	Starting		Running		Harmonic Distortion			Limits		
	kW	kVA	kW	kVA	Peak	Run	kVA	Vdip	Fdip	
Group 1 (Non-Concurrent)										
Resistive: **Resistive #1** 1 X 100.00 kW , @ 1.00 PF Harmonics: THID = 0.00% Group 1 (Non-Concurrent) ⌄	0	0	0	0	0	0	0	35.00 %	15 Hertz	📖 ✏ 🗑
AC / Chiller: **AC / Chiller #1** 10 X 10.00 w/ 1 Compressor Motors Cooling: 1.0 kW/ton Reheat: 0.0 kW/ton Group 1 (Non-Concurrent) ⌄	21.18	70.59	100	117.65	0	0	0	35.00 %	15 Hertz	📖 ✏ 🗑
All Loads on sequence starting 100.0kW Sequence Peak 100.0kW Application Peak	21.18	70.59	100	117.65	0	0	0	35 % 70 Volts	30 % 15 Hertz	☐ Shed

EDIT LOADS: source the tools provided at the end of load description/results 📖 ✏ 🗑

Loads

Elevator (Cable)

Elevators are either cable/traction type or hydraulic. Cable elevators utilize drive technology to control the speed of the elevator car. When a cable elevator is selected, the program defaults the motor starting method to variable frequency drive (VFD). When a hydraulic elevator is selected, the program defaults the motor to a soft starter, current limit, and 15% voltage dip. This seems to be fairly typical for this application.

Cable elevators regenerate power when they are moving in a downward direction. This power normally is dissipated by various loads in the building; however, if the elevator is isolated exclusively on the generator, there is no place for the re-generated power from the elevator to go. The amount of off-setting electrical load is equal to 80% of the elevator motor hp rating (kW regenerated = .8 x hp). Verify that the application has adequate off-setting load or add a load bank to the application. This check is outside the scope of the program but is covered in the application notes section of the output report.

For more information on configuring a cable elevator, please reference the motor load help information.

Load   Elevator-Cable

Load Basics

Description
> Elevator-Cable #1

Quantity
> 1

Sequence
> Group 1 (Non-Concurrent)

Size (Running)
> Size Running   HP

Motor Characteristics

Motor Type
> NEMA

Starting Code
> Code G (6 kVA/Hp)

Starting Load

Starting Method
> VFD

Device Type
> 6 Pulse Rectifier

Configuration Input
> Commercial(115%)

Harmonic Content (THID %)
> 30.00

Device Information

Voltage Phase
> Three Phase

Voltage Nominal
> 400V

Voltage Specific
> 400 volts

Maximum Allowable Transients

Voltage Dip
> 15.00 %   Percent

Frequency Dip
> 5 hertz   Hertz

Load Characteristics

Motor Load Level
> 100%

Motor Load Type
> Rated torque at start

Load Characteristics

Starting Load			
sKVA	0	sKW	0
Running Load			
rKVA	0.84	rKW	0.63
Harmonic Current Distortion (%)			
Momentary	30	Continuous	30

Harmonic Current Distortion	
3rd	0
5th	26.08
7th	10.43
9th	0
11th	7.74
13th	4.87
15th	0
17th	3.83
19th	3.56

Cancel   Save

Elevator (Hydraulic)

Elevators are either cable/traction type or hydraulic. Cable elevators utilize drive technology to control the speed of the elevator car. When a cable elevator is selected, the program defaults the motor starting method to variable frequency drive (VFD). When a hydraulic elevator is selected, the program defaults the motor to a soft starter, current limit, and 15% voltage dip. This seems to be fairly typical for this application.

Most industrial soft starters have support for voltage ramping and work with a voltage dip tolerance greater than 15%. This doesn't seem to be the case within the elevator market. It is our experience that the soft starter device that dominates the elevator market does not support voltage ramping (voltage is stepped to a value that matches the current limit setting). It also has a tight 15% voltage dip tolerance on the soft starter control circuit.

For more information on configuring a hydraulic elevator, please reference the motor load help information.

Fire Pump

A fire pump load is a fairly standard motor starting application with the exception of the requirement by NFPA 20 for a 15% voltage dip. This tight voltage dip tolerance can result in a very large genset when starting the fire pump across the line. For applications that have minimal other generator loads, consider a reduced voltage starting method from your fire pump controller supplier. The voltage dip default is 15%, but can be changed if you do not have to meet this requirement.

Load — Fire Pump

Load Basics

Description
Fire Pump #1

Quantity
1

Sequence
Group 1 (Non-Concurrent)

Size (Running)
Size Running | HP

Motor Characteristics

Motor Type
NEMA

Starting Code
Code G (6 kVA/Hp)

Starting Load

Starting Method
Reduced Voltage

Device Type
Wye / Delta (Open)

Configuration Input
NA

Harmonic Content (THID %)
0.00

Device Information

Voltage Phase
Three Phase

Voltage Nominal
400V

Voltage Specific
400 volts

Maximum Allowable Transients

Voltage Dip
15.00 % | Percent

Frequency Dip
15 hertz | Hertz

Load Characteristics

Motor Load Level
100%

Motor Load Type
Low torque at start

Load Characteristics

Starting Load			
sKVA	0	sKW	0

Running Load			
rKVA	0.8	rKW	0.6

Harmonic Current Distortion (%)			
Momentary	0	Continuous	0

Harmonic Current Distortion	
3rd	0
5th	0
7th	0
9th	0
11th	0
13th	0
15th	0
17th	0
19th	0

Cancel | Save

Application Notes:
The NFPA 20 required voltage dip limit (15%) applies to the fire pumps normal starting method. Reduced voltage starting methods (wye delta, soft starters, etc) allow the generator to be sized at a much smaller level. Ensure that the generator has enough capacity to perform a mechanical over ride start. This would be equivalent to an across the line start with a 35% voltage dip. This check is outside the scope of the program but is covered in the application notes section of the output report.

It is often recommended to shed optional standby generator load when powering the fire pump. This is to ensure that the building is safe for fire fighting. This program's load shed functionality allows you to enter all the loads (optional standby & fire pump) and then size these loads mutually exclusive. Just size the generator twice – shedding each off while the other is on. Use the larger sizing.

For more information on configuring a fire pump, please reference the motor load help information.

Motor

This load supports motors of various starting methods including across the line, reduced voltage, soft starters and variable frequency drives. It also support varying the motor load level and selecting the type of mechanical load connected to the motor.

Load Basics

Load Description:
The load description is a user field for entering a meaningful load name. The program enters a default name for the user's convenience.

Quantity:
Quantity is the quantity count of this load type. With traditional sizing programs, users were reluctant to utilize multiple quantities of a given load because it forced all the loads into a single sequence resulting in concurrent starting and over sizing the generator. This program overcomes that limitation via the non concurrent starting sequences (see sequences below). When quantities of a load are entered into a non-concurrent sequence (group1, group 2, ...), the program will

assume that each device starts at a different time (natural sequencing). The skVA and skW values will be that of a single load element. If the loads are entered into a concurrent sequence (step 1, step 2, …), the entire quantity of the devices will start at the same time.

Sequences:
There is often a misunderstanding by users that all loads or large groupings of loads within a building or application start at the same time. This typically does not happen in practice: motor have control circuits which must be re-sequenced, cooling compressors must bleed off head pressures, computers must be restarted, UPS's wait for voltage stability before coming back on-line, etc. Typically, when a generator transfer switch closes into an application there is minimal load step followed by the loads in the application naturally sequencing back on. If an application has two significant loads that seem to inadvertently start at the same time (concurrently), it is often easier and more cost effective to add a delay or interlock with a control relay then to size for the concurrent starting of two significant motor loads.

Most generator sizing programs have a contrived method of entering loads into factiously structured load steps. This method then assumes that all the loads are running and that they start concurrently. Both are generally false assumptions in the real world. Loads cycle on and off constantly and they rarely start concurrently. As a result, when users use typical sizing programs, they are forced to separate the loads into some arbitrary load sequence to avoid the oversized generator that will result from the concurrent starting assumption. This program supports both traditional concurrent starting (step #1, step #2… step #20) and the flexibility to enter loads into load steps that assume non-concurrent starting (group #1 to group #4). It also supports cyclic operation (cyclic sequence) with user selected load factors.

Non-concurrent Starting Sequences:
When loads are entered into a non-concurrent starting sequence (group #1, group #2…), natural sequencing is assumed. Each load in this load grouping will start at a different time. The sequences' skW is the largest skW in the sequence. The sequences skVA is the largest skVA value in the sequence. The momentary harmonic current distortion associated with soft starters is the value of the most distorting soft starter.

Concurrent Starting Sequences:
When loads are entered into a traditional, concurrent starting sequence (step #1, step #2...), simultaneous starting is assumed. The sequences' skW is the sum of all skW values in the sequence. The sequences' skVA is the sum of all the skVA values in the sequence. The momentary harmonic current distortion associated with soft starters is the sum of all the soft starters.

Cyclic Sequences:
All the load sequences assume a load factor of 100% (meaning all the loads are always on) with the exception of the cyclic sequences. These sequences (cyclic #1 and cyclic #2) assume that the largest load in the sequence is "on" and applies the user select load factor (see project page) to the remainder of the loads in the sequence. This allows the users to enter all the loads but not have to assume that they are all running. Also assuming that the largest load is "on" ensures that the generator has enough capacity to support the starting and running of the largest load in the load sequence. This load sequence assumes non-concurrent starting (see definition above).

Size (Running):
The motor size can be entered in horsepower (hp), kWm (mechanical kW output rating -- .746 kWm = 1 hp), or running amps.

Device Information
Voltage & Phase,
These inputs are only utilized when the load size is input in amps. The program then uses this information to convert amps into kW & kVA. Note that this is the load device's voltage and phase and may be different than the generator. To support easy data entry this field is initially defaulted to the projects voltage. If the value is modified, the defaulted value is the last value. If the load is entered in kW or kVA this information is irrelevant.

Motor Characteristics & Staring
This section of the motor load input screen is focused on the motors starting characteristics.

Motor Characteristics
Motor Type

    NEMA   ⌄

Starting Code

    Code G (6 kVA/Hp)   ⌄

Starting Load
Starting Method

    Across the Line   ⌄

Device Type

    NA   ⌄

Configuration Input

    NA   ⌄

Harmonic Content (THID %)

    0.00   ⌄

Motor Type:
The two common types of motors are NEMA (North American standard) and IEC (European standard). The main difference is in the typical starting code which determines the motors start kVA requirements. IEC motors have higher starting kVA requirements. The program changes the default starting code based on the motor type.

Starting Code:
The starting code determines the skVA / hp that the motor will require during starting. If the motor rating units are changed to amps, this field will also change to amps. The program defaults to typical starting codes that match the motor size.

Starting Method:
The starting method supports four starting methods: across the line (full voltage), reduced voltage, soft starter, and variable frequency drive (VFD). Each of these starting methods has significant impacts on the motors starting kVA, starting kW, and harmonics. The program defaults device type, configuration / input, and harmonic content accordingly.

Device Type:
The device type options change based on the starting method selected.

If the starting method is <u>reduced voltage</u>, the available device types are wye / delta, various auto transformer configurations, and one part winding option. These setting will impact the required starting kVA and starting kW requirements. The program also changes the default motor load type to be consistent with the reduced starting method. If the motor's mechanical load characteristics (motor load type) are not compatible with allowing the motor to achieve full speed on reduced voltage starting, the program will assume full voltage starting requirements. This is to avoid unexpected transient conditions associated with reduced voltage starter switching to full voltage prior to the motor achieving full speed.

If the starting method is <u>soft starter</u>, various current limit options are presented along with two user definable options. The current limit value is an adjustable parameter within most soft starters. The higher this setting the higher the potential starting kVA load step (assuming a voltage stepped configuration) and the higher the momentary harmonic currents. Soft starter current limit setting vary with the load type and desired motor acceleration time, but values in the 300% to 350% are generally workable. The harmonic content will default to an appropriate value to match the current limit setting. The user inputs allow for a custom configured device through the custom load setup page.

If the starting method is <u>variable frequency drive</u> (VFD), various rectifier input options are presented along with two user definable options. The VFD's rectifier configuration determines the devices harmonic current spectrum and total harmonic content. The most common type of input for 3 phase drives is 6 pulse non-filtered (default value). Though this is common in general equipment drives, many engineers in pump applications will incorporate harmonic mitigation in the system design. If harmonics have been mitigated, select one of the lower (less than 15% THID) options. The user inputs allow for a custom configured device through the custom load setup page.

Configuration / Input:
The device type options change based on the starting method selected.

If the starting method is <u>soft starter</u>, two options are provided relative to how the drive builds output voltage: voltage stepped and voltage ramped. Most industrial soft starters support both modes. Voltage ramping gradually builds output voltage thus producing little to no skVA and skW load steps. This is the ideal configuration for a soft starter on a generator; however, this mode of operation may not be available on your particular soft starter. In the voltage stepped configuration, the soft starter steps voltage quickly up to the current limit point. This results in a

skVA and skW load step in the system. This can be a significant disadvantage when coupled with a limited voltage dip tolerance. This is the case with the soft starter utilized on most often on hydraulic elevators.

If the starting method is <u>VFD</u>, the configuration / input allows for the selection of commercial, industrial, and oversized drives. The options vary the skW and skVA requirements modestly. The default configuration is an industrial drive.

Harmonic Type Characteristics

Harmonic Type:
The harmonic type defaults to a harmonic spectrum and harmonic content (THID %) that is typical for that load type. The harmonic spectrum is the relative amount of the different harmonic elements. Each harmonic element (3rd, 5th…) represents a different frequency multiple of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Harmonic Content (THID %):
The harmonic content will default to a typical total harmonic current distortion (THID) that is typical for that load type. The harmonic content is a special mathematical addition of all the harmonic frequencies. Though the program attempts to make a best guess of the typical harmonic characteristics of a device, actual device characteristics may vary widely. This program is simply a calculation tool and the output is only as good as input data.

Maximum Allowable Transients & Motor Load Characteristics (Mechanical)

Voltage & Frequency:
Limiting voltage dips is a common part of all generator sizing programs. This program allows the user to select a maximum voltage and frequency dip that is applied to each load. Care should be taken when selecting site appropriate values for a given application. Requiring a tolerance that is very tight may cause very significant size and cost increases in the generator. Leaving the tolerances too wide may result in more sensitive loads operating correctly.

The voltage and frequency dip limits of a given load determine the limits for all loads in the same sequence and all sequences that follow. Once a load is on the generator it is sensitive to all loads that come on after it. The sequence of loading is listed on the transient analysis page: emergency, priority, numbered load steps, and cyclic.

To help in the correct transient sizing, this program has a transient analysis page that allows the user to view the expected voltage and frequency transients and available limits for each sequence. The user can also manually select any size generator, and see the effects on the voltage dips, frequency dips, and harmonics.

Motor Load Level:
The motor load level allows the motor to be loaded to various levels including into its service factor. Adjusting this input only affects the motors running kW and running kVA. It is defaulted to 100%.

Motor Load Type:
This input defines the amount of load torque on the motor when it is accelerating. It the motor is unload, the motor accelerates vary quickly the loading effects on the engine are significantly reduced. The low torque at start setting provides a little reduction in skW engine loading. Rated torque applies full skW to the sizing. This input is also utilized with the reduced voltage starting options to determine application compatibility. If this value is set to a higher torque requirement, the program will assume that the motor can not reach full speed on reduced voltage and size the generator for across the line starting.

Load Characteristics:

Load Characteristics

Starting Load			
sKVA	0	sKW	0

Running Load			
rKVA	0	rKW	0

Harmonic Current Distortion (%)			
Momentary	0	Continuous	0

Harmonic Current Distortion	
3rd	0
5th	0
7th	0
9th	0
11th	0
13th	0
15th	0
17th	0
19th	0

Staring Load Characteristics:
Starting load -- skVA step is kVA drawn during starting. This is most prevalent for motor loads. When a motor starts, it draws a large amount of current at a low power factor. This current draw is displayed in kVA and directly impacts alternator sizing and system voltage dips.

Starting load -- skW step is kW drawn during starting. This is most prevalent for motor loads. When a motor starts, it draws a large amount of current at a low power factor. Most of the current flows as kVAR but a significant amount is also seen as kW loading on the genset engine. Starting kW values are additive to any previous running kW load. When added together,

they establish the peak loading for a given load step. The starting kW also causes a frequency transient when it loads the engine.

Running Load Characteristics:
Running kVA and kW establishes the loads running load values. These values are totaled to establish the generators running load.

Harmonic Current Distortion Characteristics:
Harmonic current distortion (THID) continuous is the distortion resulting from the running nonlinear loads. Harmonic current distortion (THID) momentary is the harmonic current resulting from the nonlinear during the load starting phase. Most non-linear loads have similar starting and running characteristics. The one exception is soft starters that have significant harmonics during starting and no harmonics when running.

The percentage values listed with a harmonic number is the expected devices harmonic current spectrum. It represents the relative amount of the different harmonic elements. Each harmonic element is represented by a different frequency multiplier of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Lighting

The three main type of lighting are incandescent, florescent, and high intensity discharge (HID). Incandescent lighting acts as a resistive load with no harmonics. Fluorescent and HID lighting utilize electronic ballasts for operation. The ballast acts as a non-linear load with a harmonic signature. The harmonic content can vary significantly based on ballast design (8% - 30% THID is a typical range). Most engineers specify low harmonic versions for new construction. Care should be taken with compact fluorescent lights which typically have an extremely high distortion level (recommend setting harmonic content to 60%).

Load — Lighting

Load Basics

Description
Lighting #1

Quantity
1

Sequence
Group 1 (Non-Concurrent)

Size (Running)
Size Running — kVA

Lighting Type
Fluorescent

Harmonic Type Characteristics

Device Type
Lighting Ballasts

Harmonic Content (THID %)
20.00

Device Information

Voltage Phase
Three Phase

Voltage Nominal
400V

Voltage Specific
400 volts

Running PF
0.97 PF

Maximum Allowable Transients

VoltageDip
25.00 % | Percent

Frequency Dip
10 hertz | Hertz

Load Characteristics

Starting Load			
sKVA	0	sKW	0

Running Load			
rKVA	0	rKW	0

Harmonic Current Distortion (%)			
Momentary	20	Continuous	20

Harmonic Current Distortion	
3rd	15
5th	9
7th	7
9th	2
11th	4.5
13th	3.5
15th	0
17th	2.5
19th	1.5

Cancel   Save

Load Basics

Load Description:
The load description is a user field for entering a meaningful load name. The program enters a default name for the user's convenience.

Quantity:
Quantity is the quantity count of this load type. With traditional sizing programs, users were reluctant to utilize multiple quantities of a given load because it forced all the loads into a single sequence resulting in concurrent starting and over sizing the generator. This program overcomes

that limitation via the non concurrent starting sequences (see sequences below). When quantities of a load are entered into a non-concurrent sequence (group1, group 2, ...), the program will assume that each device starts at a different time (natural sequencing). The skVA and skW values will be that of a single load element. If the loads are entered into a concurrent sequence (step 1, step 2, …), the entire quantity of the devices will start at the same time.

Sequences:
There is often a misunderstanding by users that all loads or large groupings of loads within a building or application start at the same time. This typically does not happen in practice: motor have control circuits which must be re-sequenced, cooling compressors must bleed off head pressures, computers must be restarted, UPS's wait for voltage stability before coming back on-line, etc. Typically, when a generator transfer switch closes into an application there is minimal load step followed by the loads in the application naturally sequencing back on. If an application has two significant loads that seem to inadvertently start at the same time (concurrently), it is often easier and more cost effective to add a delay or interlock with a control relay then to size for the concurrent starting of two significant motor loads.

Most generator sizing programs have a contrived method of entering loads into factiously structured load steps. This method then assumes that all the loads are running and that they start concurrently. Both are generally false assumptions in the real world. Loads cycle on and off constantly and they rarely start concurrently. As a result, when users use typical sizing programs, they are forced to separate the loads into some arbitrary load sequence to avoid the oversized generator that will result from the concurrent starting assumption. This program supports both traditional concurrent starting (step #1, step #2… step #20) and the flexibility to enter loads into load steps that assume non-concurrent starting (group #1 to group #4). It also supports cyclic operation (cyclic sequence) with user selected load factors.

Non-concurrent Starting Sequences:
When loads are entered into a non-concurrent starting sequence (group #1, group #2…), natural sequencing is assumed. Each load in this load grouping will start at a different time. The sequences' skW is the largest skW in the sequence. The sequences skVA is the largest skVA value in the sequence. The momentary harmonic current distortion associated with soft starters is the value of the most distorting soft starter.

Concurrent Starting Sequences:
When loads are entered into a traditional, concurrent starting sequence (step #1, step #2...), simultaneous starting is assumed. The sequences' skW is the sum of all skW values in the sequence. The sequences' skVA is the sum of all the skVA values in the sequence. The momentary harmonic current distortion associated with soft starters is the sum of all the soft starters.

Cyclic Sequences:
All the load sequences assume a load factor of 100% (meaning all the loads are always on) with the exception of the cyclic sequences. These sequences (cyclic #1 and cyclic #2) assume that the largest load in the sequence is "on" and applies the user select load factor (see project page) to the remainder of the loads in the sequence. This allows the users to enter all the loads but not have to assume that they are all running. Also assuming that the largest load is "on" ensures that

the generator has enough capacity to support the starting and running of the largest load in the load sequence. This load sequence assumes non-concurrent starting (see definition above).

Size (Running):
This input determines the running load level on the generator. The units are selectable (kVA, kW, and Amps). The program will automatically convert the input value when the unit's field is changed. When entering loads in kVA, the program will utilize the running power factor input to calculate the running kW.   When entering loads in amps, the program will utilize the voltage, phase and running power factor inputs to calculate the running kW.

<u>**Device Information**</u>
Voltage & Phase,
These inputs are only utilized when the load size is input in amps. The program then uses this information to convert amps into kW & kVA. Note that this is the load device's voltage and phase and may be different than the generator. To support easy data entry this field is initially defaulted to the projects voltage. If the value is modified, the defaulted value is the last value. If the load is entered in kW or kVA this information is irrelevant.

Running PF (Power Factor)
The running power factor is used to set the relationship between the running kW and running kVA. This is also assumed to be the starting power factor for this load.

<u>**Harmonic Type Characteristics**</u>
Harmonic Type:
The harmonic type defaults to a harmonic spectrum and harmonic content (THID %) that is typical for that load type. The harmonic spectrum is the relative amount of the different harmonic elements. Each harmonic element (3rd, 5th…) represents a different frequency multiple of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Harmonic Content (THID %):
The harmonic content will default to a typical total harmonic current distortion (THID) that is typical for that load type. The harmonic content is a special mathematical addition of all the harmonic frequencies. Though the program attempts to make a best guess of the typical harmonic characteristics of a device, actual device characteristics may vary widely. This program is simply a calculation tool and the output is only as good as input data.

Maximum Allowable Transients -- Voltage & Frequency:
Limiting voltage dips is a common part of all generator sizing programs. This program allows the user to select a maximum voltage and frequency dip that is applied to each load. Care should be taken when selecting site appropriate values for a given application. Requiring a tolerance that is very tight may cause very significant size and cost increases in the generator. Leaving the tolerances too wide may result in more sensitive loads operating correctly.

The voltage and frequency dip limits of a given load determine the limits for all loads in the same sequence and all sequences that follow. Once a load is on the generator it is sensitive to all

loads that come on after it. The sequence of loading is listed on the transient analysis page: emergency, priority, numbered load steps, and cyclic.

To help in the correct transient sizing, this program has a transient analysis page that allows the user to view the expected voltage and frequency transients and available limits for each sequence. The user can also manually select any size generator, and see the effects on the voltage dips, frequency dips, and harmonics.

Load Characteristics:

Load Characteristics

Starting Load			
sKVA	0	sKW	0
Running Load			
rKVA	0	rKW	0
Harmonic Current Distortion (%)			
Momentary	20	Continuous	20

Harmonic Current Distortion	
3rd	15
5th	9
7th	7
9th	2
11th	4.5
13th	3.5
15th	0
17th	2.5
19th	1.5

Cancel   Save

Staring Load Characteristics:
Starting load -- skVA step is kVA drawn during starting. This is most prevalent for motor loads. For this load, the starting kVA is assumed equal to the running kVA. The starting kVA directly impacts alternator sizing and system voltage dips.

Starting load -- skW step is kW drawn during starting. This is most prevalent for motor loads. For this load, the starting kW is assumed equal to the running kW. Starting kW values are additive to any previous running kW load. When added together, they establish the peak

loading for a given load step. The starting kW also causes a frequency transient when it loads the engine.

Running Load Characteristics:
<u>Running kVA and kW</u> establishes the loads running load values. These values are totaled to establish the generators running load.

Harmonic Current Distortion Characteristics:
Harmonic current distortion (THID) continuous is the distortion resulting from the running nonlinear loads. Harmonic current distortion (THID) momentary is the harmonic current resulting from the nonlinear during the load starting phase. Most non-linear loads have similar starting and running characteristics. The one exception is soft starters that have significant harmonics during starting and no harmonics when running.

The percentage values listed with a harmonic number is the expected devices harmonic current spectrum. It represents the relative amount of the different harmonic elements. Each harmonic element is represented by a different frequency multiplier of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Medical Equipment

The characteristics of medical imagining can vary widely. Some equipment presents a strong inrush of current similar to starting a motor or energizing a transformer. Other equipment presents as a non-linear load. Accurately sizing medical equipment will require device name plate information and manufacturer specifications. The input screen for medical equipment was designed to support all types of equipment.

Load Basics
Load Description:
The load description is a user field for entering a meaningful load name. The program enters a default name for the user's convenience.

Quantity:
Quantity is the quantity count of this load type. With traditional sizing programs, users were reluctant to utilize multiple quantities of a given load because it forced all the loads into a single sequence resulting in concurrent starting and over sizing the generator. This program overcomes that limitation via the non concurrent starting sequences (see sequences below). When quantities

of a load are entered into a non-concurrent sequence (group1, group 2, ...), the program will assume that each device starts at a different time (natural sequencing). The skVA and skW values will be that of a single load element. If the loads are entered into a concurrent sequence (step 1, step 2, …), the entire quantity of the devices will start at the same time.

Sequences:
There is often a misunderstanding by users that all loads or large groupings of loads within a building or application start at the same time. This typically does not happen in practice: motor have control circuits which must be re-sequenced, cooling compressors must bleed off head pressures, computers must be restarted, UPS's wait for voltage stability before coming back on-line, etc. Typically, when a generator transfer switch closes into an application there is minimal load step followed by the loads in the application naturally sequencing back on. If an application has two significant loads that seem to inadvertently start at the same time (concurrently), it is often easier and more cost effective to add a delay or interlock with a control relay then to size for the concurrent starting of two significant motor loads.

Most generator sizing programs have a contrived method of entering loads into factiously structured load steps. This method then assumes that all the loads are running and that they start concurrently. Both are generally false assumptions in the real world. Loads cycle on and off constantly and they rarely start concurrently. As a result, when users use typical sizing programs, they are forced to separate the loads into some arbitrary load sequence to avoid the oversized generator that will result from the concurrent starting assumption. This program supports both traditional concurrent starting (step #1, step #2… step #20) and the flexibility to enter loads into load steps that assume non-concurrent starting (group #1 to group #4). It also supports cyclic operation (cyclic sequence) with user selected load factors.

Non-concurrent Starting Sequences:
When loads are entered into a non-concurrent starting sequence (group #1, group #2…), natural sequencing is assumed. Each load in this load grouping will start at a different time. The sequences' skW is the largest skW in the sequence. The sequences skVA is the largest skVA value in the sequence. The momentary harmonic current distortion associated with soft starters is the value of the most distorting soft starter.

Concurrent Starting Sequences:
When loads are entered into a traditional, concurrent starting sequence (step #1, step #2...), simultaneous starting is assumed. The sequences' skW is the sum of all skW values in the sequence. The sequences' skVA is the sum of all the skVA values in the sequence. The momentary harmonic current distortion associated with soft starters is the sum of all the soft starters.

Cyclic Sequences:
All the load sequences assume a load factor of 100% (meaning all the loads are always on) with the exception of the cyclic sequences. These sequences (cyclic #1 and cyclic #2) assume that the largest load in the sequence is "on" and applies the user select load factor (see project page) to the remainder of the loads in the sequence. This allows the users to enter all the loads but not have to assume that they are all running. Also assuming that the largest load is "on" ensures that

the generator has enough capacity to support the starting and running of the largest load in the load sequence. This load sequence assumes non-concurrent starting (see definition above).

Size (Running):
This input determines the running load level on the generator. The units are selectable (kVA, kW, and Amps). The basic relationship being utilized is running kW = running kVA * running PF. The program will automatically convert the input value when the unit's field is changed. When entering loads in kVA, the program will utilize the running power factor input to calculate the running kW. When entering loads in amps, the program will utilize the voltage, phase and running power factor inputs to calculate the running kW.

Size (Starting):
The starting power input is used to calculate the starting kVA loading on the genset's alternator. It is common for medical imagining equipment to be sensitive to voltage dips. Thus to correctly size the generator, accurate starting power information is critical. Similar to the running kW relationship, the starting kW = starting kVA * starting PF. For devices that have high inrush currents, assume low starting power factors.

<u>Device Information</u>
Voltage & Phase,
These inputs are only utilized when the load size is input in amps. The program then uses this information to convert amps into kW & kVA. Note that this is the load device's voltage and phase and may be different than the generator. To support easy data entry this field is initially defaulted to the projects voltage. If the value is modified, the defaulted value is the last value. If the load is entered in kW or kVA this information is irrelevant.

Running PF (Power Factor)
The running power factor is used to set the relationship between the running kW and running kVA.

Starting PF (Power Factor)
The starting power factor is used to set the relationship between the starting kW and starting kVA. Some loads require an inrush of current during the starting phase. This current is the typically at a fairly low power factor.

<u>Harmonic Type Characteristics</u>
Harmonic Type:
The harmonic type defaults to a harmonic spectrum and harmonic content (THID %) that is typical for that load type. The harmonic spectrum is the relative amount of the different harmonic elements. Each harmonic element (3rd, 5th…) represents a different frequency multiple of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Harmonic Content (THID %):
The harmonic content will default to a typical total harmonic current distortion (THID) that is typical for that load type. The harmonic content is a special mathematical addition of all the

harmonic frequencies. Though the program attempts to make a best guess of the typical harmonic characteristics of a device, actual device characteristics may vary widely. This program is simply a calculation tool and the output is only as good as input data.

Maximum Allowable Transients -- Voltage & Frequency:
Limiting voltage dips is a common part of all generator sizing programs. This program allows the user to select a maximum voltage and frequency dip that is applied to each load. Care should be taken when selecting site appropriate values for a given application. Requiring a tolerance that is very tight may cause very significant size and cost increases in the generator. Leaving the tolerances too wide may result in more sensitive loads operating correctly.

The voltage and frequency dip limits of a given load determine the limits for all loads in the same sequence and all sequences that follow. Once a load is on the generator it is sensitive to all loads that come on after it. The sequence of loading is listed on the transient analysis page: emergency, priority, numbered load steps, and cyclic.

To help in the correct transient sizing, this program has a transient analysis page that allows the user to view the expected voltage and frequency transients and available limits for each sequence. The user can also manually select any size generator, and see the effects on the voltage dips, frequency dips, and harmonics.

<u>Load Characteristics:</u>

Load Characteristics

Starting Load			
sKVA	0	sKW	0

Running Load			
rKVA	0	rKW	0

Harmonic Current Distortion (%)			
Momentary	0	Continuous	0

Harmonic Current Distortion	
3rd	0
5th	0
7th	0
9th	0
11th	0
13th	0
15th	0
17th	0
19th	0

Cancel   Save

Staring Load Characteristics:
Starting load -- skVA step is kVA drawn during starting. This is most prevalent for motor loads. When a motor starts, it draws a large amount of current at a low power factor. This current draw is displayed in kVA and directly impacts alternator sizing and system voltage dips.

Starting load -- skW step is kW drawn during starting. This is most prevalent for motor loads. When a motor starts, it draws a large amount of current at a low power factor. Most of the current flows as kVAR but a significant amount is also seen as kW loading on the genset engine. Starting kW values are additive to any previous running kW load. When added together, they establish the peak loading for a given load step. The starting kW also causes a frequency transient when it loads the engine.

Running Load Characteristics:
Running kVA and kW establishes the loads running load values. These values are totaled to establish the generators running load.

Harmonic Current Distortion Characteristics:
Harmonic current distortion (THID) continuous is the distortion resulting from the running nonlinear loads. Harmonic current distortion (THID) momentary is the harmonic current resulting from the nonlinear during the load starting phase. Most non-linear loads have similar starting and running characteristics. The one exception is soft starters that have significant harmonics during starting and no harmonics when running.

The percentage values listed with a harmonic number is the expected devices harmonic current spectrum. It represents the relative amount of the different harmonic elements. Each harmonic element is represented by a different frequency multiplier of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Office Equipment

The office equipment loads page is designed as a general input page for office devices. These devices tend to be 120 volt devices that use switch power supplies (PCs, copiers, printers, faxes, etc). There main characteristic tends to be harmonic noise. The program defaults to a moderate level of harmonic content which is typical of newer equipment. Older equipment may require that the harmonic content be increased.

Load — Office Equipment

Load Basics

Description
Office Equipment #1

Quantity
1

Sequence
Group 1 (Non-Concurrent)

Size (Running)
Size Running — kW

Harmonic Type Characteristics

Device Type
Single Phase Rectifier

Harmonic Content (THID %)
45.00

Device Information

Voltage Phase
Three Phase

Voltage Nominal
400V

Voltage Specific
400 volts

Running PF
0.80 PF

Maximum Allowable Transients

Voltage Dip
20.00 %   Percent

Frequency Dip
10 hertz   Hertz

Load Characteristics

Starting Load			
sKVA	0	sKW	0
Running Load			
rKVA	0	rKW	0
Harmonic Current Distortion (%)			
Momentary	45	Continuous	45

Harmonic Current Distortion	
3rd	38.41
5th	10.52
7th	9.6
9th	2.74
11th	9.15
13th	11.89
15th	0
17th	7.77
19th	7.32

Cancel   Save

Load Basics
Load Description:
The load description is a user field for entering a meaningful load name. The program enters a default name for the user's convenience.

Quantity:
Quantity is the quantity count of this load type. With traditional sizing programs, users were reluctant to utilize multiple quantities of a given load because it forced all the loads into a single sequence resulting in concurrent starting and over sizing the generator. This program overcomes that limitation via the non concurrent starting sequences (see sequences below). When quantities

of a load are entered into a non-concurrent sequence (group1, group 2, ...), the program will assume that each device starts at a different time (natural sequencing). The skVA and skW values will be that of a single load element. If the loads are entered into a concurrent sequence (step 1, step 2, …), the entire quantity of the devices will start at the same time.

Sequences:
There is often a misunderstanding by users that all loads or large groupings of loads within a building or application start at the same time. This typically does not happen in practice: motor have control circuits which must be re-sequenced, cooling compressors must bleed off head pressures, computers must be restarted, UPS's wait for voltage stability before coming back on-line, etc. Typically, when a generator transfer switch closes into an application there is minimal load step followed by the loads in the application naturally sequencing back on. If an application has two significant loads that seem to inadvertently start at the same time (concurrently), it is often easier and more cost effective to add a delay or interlock with a control relay then to size for the concurrent starting of two significant motor loads.

Most generator sizing programs have a contrived method of entering loads into factiously structured load steps. This method then assumes that all the loads are running and that they start concurrently. Both are generally false assumptions in the real world. Loads cycle on and off constantly and they rarely start concurrently. As a result, when users use typical sizing programs, they are forced to separate the loads into some arbitrary load sequence to avoid the oversized generator that will result from the concurrent starting assumption. This program supports both traditional concurrent starting (step #1, step #2… step #20) and the flexibility to enter loads into load steps that assume non-concurrent starting (group #1 to group #4). It also supports cyclic operation (cyclic sequence) with user selected load factors.

Non-concurrent Starting Sequences:
When loads are entered into a non-concurrent starting sequence (group #1, group #2…), natural sequencing is assumed. Each load in this load grouping will start at a different time. The sequences' skW is the largest skW in the sequence. The sequences skVA is the largest skVA value in the sequence. The momentary harmonic current distortion associated with soft starters is the value of the most distorting soft starter.

Concurrent Starting Sequences:
When loads are entered into a traditional, concurrent starting sequence (step #1, step #2...), simultaneous starting is assumed. The sequences' skW is the sum of all skW values in the sequence. The sequences' skVA is the sum of all the skVA values in the sequence. The momentary harmonic current distortion associated with soft starters is the sum of all the soft starters.

Cyclic Sequences:
All the load sequences assume a load factor of 100% (meaning all the loads are always on) with the exception of the cyclic sequences. These sequences (cyclic #1 and cyclic #2) assume that the largest load in the sequence is "on" and applies the user select load factor (see project page) to the remainder of the loads in the sequence. This allows the users to enter all the loads but not have to assume that they are all running. Also assuming that the largest load is "on" ensures that

the generator has enough capacity to support the starting and running of the largest load in the load sequence. This load sequence assumes non-concurrent starting (see definition above).

Size (Running):
This input determines the running load level on the generator. The units are selectable (kVA, kW, and Amps). The program will automatically convert the input value when the unit's field is changed. When entering loads in kVA, the program will utilize the running power factor input to calculate the running kW.   When entering loads in amps, the program will utilize the voltage, phase and running power factor inputs to calculate the running kW.

Device Information
Voltage & Phase,
These inputs are only utilized when the load size is input in amps. The program then uses this information to convert amps into kW & kVA. Note that this is the load device's voltage and phase and may be different than the generator. To support easy data entry this field is initially defaulted to the projects voltage. If the value is modified, the defaulted value is the last value. If the load is entered in kW or kVA this information is irrelevant.

Running PF (Power Factor)
The running power factor is used to set the relationship between the running kW and running kVA. This is also assumed to be the starting power factor for this load.

Harmonic Type Characteristics
Harmonic Type:
The harmonic type defaults to a harmonic spectrum and harmonic content (THID %) that is typical for that load type. The harmonic spectrum is the relative amount of the different harmonic elements. Each harmonic element (3rd, 5th…) represents a different frequency multiple of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Harmonic Content (THID %):
The harmonic content will default to a typical total harmonic current distortion (THID) that is typical for that load type. The harmonic content is a special mathematical addition of all the harmonic frequencies. Though the program attempts to make a best guess of the typical harmonic characteristics of a device, actual device characteristics may vary widely. This program is simply a calculation tool and the output is only as good as input data.

Maximum Allowable Transients -- Voltage & Frequency:
Limiting voltage dips is a common part of all generator sizing programs. This program allows the user to select a maximum voltage and frequency dip that is applied to each load. Care should be taken when selecting site appropriate values for a given application. Requiring a tolerance that is very tight may cause very significant size and cost increases in the generator. Leaving the tolerances too wide may result in more sensitive loads operating correctly.

The voltage and frequency dip limits of a given load determine the limits for all loads in the same sequence and all sequences that follow. Once a load is on the generator it is sensitive to all

loads that come on after it. The sequence of loading is listed on the transient analysis page: emergency, priority, numbered load steps, and cyclic.

To help in the correct transient sizing, this program has a transient analysis page that allows the user to view the expected voltage and frequency transients and available limits for each sequence. The user can also manually select any size generator, and see the effects on the voltage dips, frequency dips, and harmonics.

Load Characteristics:

Load Characteristics

Starting Load			
sKVA	0	sKW	0

Running Load			
rKVA	0	rKW	0

Harmonic Current Distortion (%)			
Momentary	45	Continuous	45

Harmonic Current Distortion	
3rd	38.41
5th	10.52
7th	9.6
9th	2.74
11th	9.15
13th	11.89
15th	0
17th	7.77
19th	7.32

Staring Load Characteristics:
Starting load -- skVA step is kVA drawn during starting. This is most prevalent for motor loads. For this load, the starting kVA is assumed equal to the running kVA. The starting kVA directly impacts alternator sizing and system voltage dips.

Starting load -- skW step is kW drawn during starting. This is most prevalent for motor loads. For this load, the starting kW is assumed equal to the running kW. Starting kW values are additive to any previous running kW load. When added together, they establish the peak loading for a given load step. The starting kW also causes a frequency transient when it loads the engine.

Running Load Characteristics:

<u>Running kVA and kW</u> establishes the loads running load values. These values are totaled to establish the generators running load.

Harmonic Current Distortion Characteristics:
Harmonic current distortion (THID) continuous is the distortion resulting from the running nonlinear loads. Harmonic current distortion (THID) momentary is the harmonic current resulting from the nonlinear during the load starting phase. Most non-linear loads have similar starting and running characteristics. The one exception is soft starters that have significant harmonics during starting and no harmonics when running.

The percentage values listed with a harmonic number is the expected devices harmonic current spectrum. It represents the relative amount of the different harmonic elements. Each harmonic element is represented by a different frequency multiplier of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Miscellaneous

This load input is for loads that don't fit into any particular classification. The inputs for this load type are very flexible allowing the user to define the characteristics of the load.

Load Basics
Load Description:
The load description is a user field for entering a meaningful load name. The program enters a default name for the user's convenience.

Quantity:
Quantity is the quantity count of this load type. With traditional sizing programs, users were reluctant to utilize multiple quantities of a given load because it forced all the loads into a single sequence resulting in concurrent starting and over sizing the generator. This program overcomes that limitation via the non concurrent starting sequences (see sequences below). When quantities of a load are entered into a non-concurrent sequence (group1, group 2, ...), the program will assume that each device starts at a different time (natural sequencing). The skVA and skW

values will be that of a single load element. If the loads are entered into a concurrent sequence (step 1, step 2, …), the entire quantity of the devices will start at the same time.

Sequences:
There is often a misunderstanding by users that all loads or large groupings of loads within a building or application start at the same time. This typically does not happen in practice: motor have control circuits which must be re-sequenced, cooling compressors must bleed off head pressures, computers must be restarted, UPS's wait for voltage stability before coming back on-line, etc. Typically, when a generator transfer switch closes into an application there is minimal load step followed by the loads in the application naturally sequencing back on. If an application has two significant loads that seem to inadvertently start at the same time (concurrently), it is often easier and more cost effective to add a delay or interlock with a control relay then to size for the concurrent starting of two significant motor loads.

Most generator sizing programs have a contrived method of entering loads into factiously structured load steps. This method then assumes that all the loads are running and that they start concurrently. Both are generally false assumptions in the real world. Loads cycle on and off constantly and they rarely start concurrently. As a result, when users use typical sizing programs, they are forced to separate the loads into some arbitrary load sequence to avoid the oversized generator that will result from the concurrent starting assumption. This program supports both traditional concurrent starting (step #1, step #2… step #20) and the flexibility to enter loads into load steps that assume non-concurrent starting (group #1 to group #4). It also supports cyclic operation (cyclic sequence) with user selected load factors.

Non-concurrent Starting Sequences:
When loads are entered into a non-concurrent starting sequence (group #1, group #2…), natural sequencing is assumed. Each load in this load grouping will start at a different time. The sequences' skW is the largest skW in the sequence. The sequences skVA is the largest skVA value in the sequence. The momentary harmonic current distortion associated with soft starters is the value of the most distorting soft starter.

Concurrent Starting Sequences:
When loads are entered into a traditional, concurrent starting sequence (step #1, step #2...), simultaneous starting is assumed. The sequences' skW is the sum of all skW values in the sequence. The sequences' skVA is the sum of all the skVA values in the sequence. The momentary harmonic current distortion associated with soft starters is the sum of all the soft starters.

Cyclic Sequences:
All the load sequences assume a load factor of 100% (meaning all the loads are always on) with the exception of the cyclic sequences. These sequences (cyclic #1 and cyclic #2) assume that the largest load in the sequence is "on" and applies the user select load factor (see project page) to the remainder of the loads in the sequence. This allows the users to enter all the loads but not have to assume that they are all running. Also assuming that the largest load is "on" ensures that the generator has enough capacity to support the starting and running of the largest load in the load sequence. This load sequence assumes non-concurrent starting (see definition above).

Size (Running):
This input determines the running load level on the generator. The units are selectable (kVA, kW, and Amps). The basic relationship being utilized is running kW = running kVA * running PF. The program will automatically convert the input value when the unit's field is changed. When entering loads in kVA, the program will utilize the running power factor input to calculate the running kW. When entering loads in amps, the program will utilize the voltage, phase and running power factor inputs to calculate the running kW.

Size (Starting):
The starting power input is used to calculate the starting kVA loading on the genset's alternator. Some devices have a starting load value that is minimal while other devices have significant starting load step or current inrush. To correctly size the generator, accurate starting power information can be important for some application. Similar to the running kW relationship, the starting kW = starting kVA * starting PF. For devices that have high inrush currents, assume low starting power factors.

Device Information
Voltage & Phase,
These inputs are only utilized when the load size is input in amps. The program then uses this information to convert amps into kW & kVA. Note that this is the load device's voltage and phase and may be different than the generator. To support easy data entry this field is initially defaulted to the projects voltage. If the value is modified, the defaulted value is the last value. If the load is entered in kW or kVA this information is irrelevant.

Running PF (Power Factor)
The running power factor is used to set the relationship between the running kW and running kVA.

Starting PF (Power Factor)
The starting power factor is used to set the relationship between the starting kW and starting kVA. Some loads require an inrush of current during the starting phase. This current is the typically at a fairly low power factor.

Harmonic Type Characteristics
Harmonic Type:
The harmonic type defaults to a harmonic spectrum and harmonic content (THID %) that is typical for that load type. The harmonic spectrum is the relative amount of the different harmonic elements. Each harmonic element (3rd, 5th…) represents a different frequency multiple of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Harmonic Content (THID %):
The harmonic content will default to a typical total harmonic current distortion (THID) that is typical for that load type. The harmonic content is a special mathematical addition of all the harmonic frequencies. Though the program attempts to make a best guess of the typical

harmonic characteristics of a device, actual device characteristics may vary widely. This program is simply a calculation tool and the output is only as good as input data.

Maximum Allowable Transients -- Voltage & Frequency:
Limiting voltage dips is a common part of all generator sizing programs. This program allows the user to select a maximum voltage and frequency dip that is applied to each load. Care should be taken when selecting site appropriate values for a given application. Requiring a tolerance that is very tight may cause very significant size and cost increases in the generator. Leaving the tolerances too wide may result in more sensitive loads operating correctly.

The voltage and frequency dip limits of a given load determine the limits for all loads in the same sequence and all sequences that follow. Once a load is on the generator it is sensitive to all loads that come on after it. The sequence of loading is listed on the transient analysis page: emergency, priority, numbered load steps, and cyclic.

To help in the correct transient sizing, this program has a transient analysis page that allows the user to view the expected voltage and frequency transients and available limits for each sequence. The user can also manually select any size generator, and see the effects on the voltage dips, frequency dips, and harmonics.

<u>**Load Characteristics:**</u>

Load Characteristics

Starting Load			
sKVA	0	sKW	0
Running Load			
rKVA	0	rKW	0
Harmonic Current Distortion (%)			
Momentary	0	Continuous	0

Harmonic Current Distortion	
3rd	0
5th	0
7th	0
9th	0
11th	0
13th	0
15th	0
17th	0
19th	0

Cancel   Save

Staring Load Characteristics:
Starting load -- skVA step is kVA drawn during starting. This is most prevalent for motor loads. When a motor starts, it draws a large amount of current at a low power factor. This current draw is displayed in kVA and directly impacts alternator sizing and system voltage dips.

Starting load -- skW step is kW drawn during starting. This is most prevalent for motor loads. When a motor starts, it draws a large amount of current at a low power factor. Most of the current flows as kVAR but a significant amount is also seen as kW loading on the genset engine. Starting kW values are additive to any previous running kW load. When added together, they establish the peak loading for a given load step. The starting kW also causes a frequency transient when it loads the engine.

Running Load Characteristics:
Running kVA and kW establishes the loads running load values. These values are totaled to establish the generators running load.

Harmonic Current Distortion Characteristics:
Harmonic current distortion (THID) continuous is the distortion resulting from the running nonlinear loads. Harmonic current distortion (THID) momentary is the harmonic current resulting from the nonlinear during the load starting phase. Most non-linear loads have similar starting and running characteristics. The one exception is soft starters that have significant harmonics during starting and no harmonics when running.

The percentage values listed with a harmonic number is the expected devices harmonic current spectrum. It represents the relative amount of the different harmonic elements. Each harmonic element is represented by a different frequency multiplier of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Non-linear

The non-linear loads page is designed as a general input page for loads whose main characteristic is there harmonic distortion. If the loads have significant starting transients in addition to the harmonics enter the load using the Miscellaneous input page. Please follow the "Common Input Elements" link above for more information.

Load Basics
Load Description:
The load description is a user field for entering a meaningful load name. The program enters a default name for the user's convenience.

Quantity:
Quantity is the quantity count of this load type. With traditional sizing programs, users were reluctant to utilize multiple quantities of a given load because it forced all the loads into a single sequence resulting in concurrent starting and over sizing the generator. This program overcomes that limitation via the non concurrent starting sequences (see sequences below). When quantities of a load are entered into a non-concurrent sequence (group1, group 2, ...), the program will assume that each device starts at a different time (natural sequencing). The skVA and skW

values will be that of a single load element. If the loads are entered into a concurrent sequence (step 1, step 2, …), the entire quantity of the devices will start at the same time.

Sequences:
There is often a misunderstanding by users that all loads or large groupings of loads within a building or application start at the same time. This typically does not happen in practice: motor have control circuits which must be re-sequenced, cooling compressors must bleed off head pressures, computers must be restarted, UPS's wait for voltage stability before coming back on-line, etc. Typically, when a generator transfer switch closes into an application there is minimal load step followed by the loads in the application naturally sequencing back on. If an application has two significant loads that seem to inadvertently start at the same time (concurrently), it is often easier and more cost effective to add a delay or interlock with a control relay then to size for the concurrent starting of two significant motor loads.

Most generator sizing programs have a contrived method of entering loads into factiously structured load steps. This method then assumes that all the loads are running and that they start concurrently. Both are generally false assumptions in the real world. Loads cycle on and off constantly and they rarely start concurrently. As a result, when users use typical sizing programs, they are forced to separate the loads into some arbitrary load sequence to avoid the oversized generator that will result from the concurrent starting assumption. This program supports both traditional concurrent starting (step #1, step #2… step #20) and the flexibility to enter loads into load steps that assume non-concurrent starting (group #1 to group #4). It also supports cyclic operation (cyclic sequence) with user selected load factors.

Non-concurrent Starting Sequences:
When loads are entered into a non-concurrent starting sequence (group #1, group #2…), natural sequencing is assumed. Each load in this load grouping will start at a different time. The sequences' skW is the largest skW in the sequence. The sequences skVA is the largest skVA value in the sequence. The momentary harmonic current distortion associated with soft starters is the value of the most distorting soft starter.

Concurrent Starting Sequences:
When loads are entered into a traditional, concurrent starting sequence (step #1, step #2...), simultaneous starting is assumed. The sequences' skW is the sum of all skW values in the sequence. The sequences' skVA is the sum of all the skVA values in the sequence. The momentary harmonic current distortion associated with soft starters is the sum of all the soft starters.

Cyclic Sequences:
All the load sequences assume a load factor of 100% (meaning all the loads are always on) with the exception of the cyclic sequences. These sequences (cyclic #1 and cyclic #2) assume that the largest load in the sequence is "on" and applies the user select load factor (see project page) to the remainder of the loads in the sequence. This allows the users to enter all the loads but not have to assume that they are all running. Also assuming that the largest load is "on" ensures that the generator has enough capacity to support the starting and running of the largest load in the load sequence. This load sequence assumes non-concurrent starting (see definition above).

Size (Running):
This input determines the running load level on the generator. The units are selectable (kVA, kW, and Amps). The program will automatically convert the input value when the unit's field is changed. When entering loads in kVA, the program will utilize the running power factor input to calculate the running kW. When entering loads in amps, the program will utilize the voltage, phase and running power factor inputs to calculate the running kW.

Device Information
Voltage & Phase,
These inputs are only utilized when the load size is input in amps. The program then uses this information to convert amps into kW & kVA. Note that this is the load device's voltage and phase and may be different than the generator. To support easy data entry this field is initially defaulted to the projects voltage. If the value is modified, the defaulted value is the last value. If the load is entered in kW or kVA this information is irrelevant.

Running PF (Power Factor)
The running power factor is used to set the relationship between the running kW and running kVA. This is also assumed to be the starting power factor for this load.

Harmonic Type Characteristics
Harmonic Type:
The harmonic type defaults to a harmonic spectrum and harmonic content (THID %) that is typical for that load type. The harmonic spectrum is the relative amount of the different harmonic elements. Each harmonic element (3rd, 5th…) represents a different frequency multiple of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Harmonic Content (THID %):
The harmonic content will default to a typical total harmonic current distortion (THID) that is typical for that load type. The harmonic content is a special mathematical addition of all the harmonic frequencies. Though the program attempts to make a best guess of the typical harmonic characteristics of a device, actual device characteristics may vary widely. This program is simply a calculation tool and the output is only as good as input data.

Maximum Allowable Transients -- Voltage & Frequency:
Limiting voltage dips is a common part of all generator sizing programs. This program allows the user to select a maximum voltage and frequency dip that is applied to each load. Care should be taken when selecting site appropriate values for a given application. Requiring a tolerance that is very tight may cause very significant size and cost increases in the generator. Leaving the tolerances too wide may result in more sensitive loads operating correctly.

The voltage and frequency dip limits of a given load determine the limits for all loads in the same sequence and all sequences that follow. Once a load is on the generator it is sensitive to all loads that come on after it. The sequence of loading is listed on the transient analysis page: emergency, priority, numbered load steps, and cyclic.

To help in the correct transient sizing, this program has a transient analysis page that allows the user to view the expected voltage and frequency transients and available limits for each sequence. The user can also manually select any size generator, and see the effects on the voltage dips, frequency dips, and harmonics.

Load Characteristics:

Load Characteristics

Starting Load			
sKVA	0	sKW	0

Running Load			
rKVA	0	rKW	0

Harmonic Current Distortion (%)			
Momentary	30	Continuous	30

Harmonic Current Distortion	
3rd	0
5th	26.08
7th	10.43
9th	0
11th	7.74
13th	4.87
15th	0
17th	3.83
19th	3.56

Cancel   Save

Staring Load Characteristics:
Starting load -- skVA step is kVA drawn during starting. This is most prevalent for motor loads. For this load, the starting kVA is assumed equal to the running kVA. The starting kVA directly impacts alternator sizing and system voltage dips.

Starting load -- skW step is kW drawn during starting. This is most prevalent for motor loads. For this load, the starting kW is assumed equal to the running kW. Starting kW values are additive to any previous running kW load. When added together, they establish the peak loading for a given load step. The starting kW also causes a frequency transient when it loads the engine.

Running Load Characteristics:

<u>Running kVA and kW</u> establishes the loads running load values. These values are totaled to establish the generators running load.

Harmonic Current Distortion Characteristics:
Harmonic current distortion (THID) continuous is the distortion resulting from the running nonlinear loads. Harmonic current distortion (THID) momentary is the harmonic current resulting from the nonlinear during the load starting phase. Most non-linear loads have similar starting and running characteristics. The one exception is soft starters that have significant harmonics during starting and no harmonics when running.

The percentage values listed with a harmonic number is the expected devices harmonic current spectrum. It represents the relative amount of the different harmonic elements. Each harmonic element is represented by a different frequency multiplier of the fundamental frequency. For a 60 hertz system, 60 hertz is the fundamental and the 5th harmonic element is 300 hertz (60 x 5).

Harmonic Analysis

Most traditional sizing programs use simple rules of thumb for non-linear loads leaving the user guessing at the true effects of the loads on the generator system.

This program utilizes harmonic analysis to size the generator. This harmonic analysis page allows the user to look at the full harmonic spectrum for each load step, the cumulative result of each load step, and the total result for the entire application. Once a desired sequence(s) is selected, the harmonic current and voltage spectrum are listed and the effects on the system voltage wave form is displayed. The kVA of the non-linear load for the selected sequence(s) is given in kVA and % alternator loading. The harmonic current spectrum is given relative to the kVA base value which is equal to the sum of all the non-linear loads.

Transient Analysis

Most traditional sizing programs simply size the generator and provide little in the way of transient analysis tools. It is a common mistake by many users to inadvertently place too many loads in a single load step resulting in a false transient condition and an oversized generator.

The transient analysis page makes it easy to analyze the transient effects of various loads and load steps on the generator system. This page identifies the load sequence and the load within that sequence that has the greatest impact on engine and alternator sizing.

| Loads | Documentation | Gas Piping | Exhaust Piping | Transient Analysis | Harmonic Analysis |

Transient Analysis

Most difficult alternator transient requirements (Vdip)		Most difficult engine transient requirements (Fdip)	
Sequence:	Group 1 (Non-Concurrent)	Sequence:	Group 1 (Non-Concurrent)
Load:	Motor #1	Load:	Resistive #1
Starting kVA:	321	Starting kW:	321
Vdip Tolerance:	20.00 %	Fdip Tolerance:	4
Vdip Expected:	12.2 %	Fdip Expected:	2.34

Alternator Transient Analysis (Vdip)

Sequence	Allowable Vdip	Expected Vdip	Sequence Starting kVA	Largest Transient Load
Group 1 (Non-Concurrent)	20.0 %	12.20 %	321	Motor #1
Step 1 (Concurrent)	15.0 %	10.40 %	29	Elevator-Cable #2

Engine Transient Analysis (Fdip)

Sequence	Allowable Fdip	Expected Fdip	Sequence Starting kW	Largest Transient Load
Group 1 (Non-Concurrent)	4	2.34	321	Resistive #1
Step 1 (Concurrent)	4	0.18	24.65	Elevator-Cable #2

Alternator Transient Requirements:
The alternator size is determined by the skVA requirement and voltage dip limit of each sequence. The program allows for sequence unique voltage dip limits (set by the limits of each

load in the sequence) and global limits (set on the project page). The transient analysis identifies the most demanding sequence and the most demanding load in that sequence. In the example below, the most demanding sequence is "Group 2" because it is using the greatest percentage of its available voltage dip limit. Sequence "Group 1" has a greater skVA and voltage dip but it is not constrained as tightly as "Group 2".   In addition to identifying the most demanding sequence, the transient analysis identifies the load in each sequence which is the most demanding.

Most difficult alternator transient requirements (Vdip)

Sequence:	Group 1
Load:	50 HP Fire Pump
Starting kVA:	300
Vdip Tolerance:	15.00 %
Vdip Expected:	13.4 %

Alternator Transient Analysis (Vdip)

Sequence	Allowable Vdip	Expected Vdip	Sequence Starting kVA	Largest Transient Load
Group 1	15.0 %	13.40 %	300	50 HP Fire Pump

Voltage dip limits:
Since it is possible for each sequence to have a unique voltage dip limit, the project may display a voltage dip that is greater than the most restrictive device. In this example, Motor #2 starts causing a voltage dip of 11.7%, then Motor #1 starts later with its more restrictive 10% voltage dip limit. This is an acceptable sizing solution because Motor #1 is not running when Motor #2 causes the larger voltage dip. The program automatically rolls the voltage dip limits of previous load steps into the sizing and analysis for subsequent load steps. This is illustrated by the 10% voltage dip tolerance being imposed on the following sequence "group 1".

The ability to have unique voltage dips per sequence is an advanced feature of this program. For applications that you want a global limit placed on all loads, set the voltage dip limit on the project set-up page to the desired volt dip.

For loads that cycle (on and off) once other loads are running, this program supports two cyclic load sequences. These sequences are placed at the end of all the load steps to capture the voltage dip limits of all previous loads. This prevents a load that is re-starting later from causing a sensitive load that is already running from tripping on low voltage.

Engine Transient Requirements:

The engine is typically sized based on the running and peak kW requirements of the application. This program also supports sizing the engine based on frequency dip limitations. The engine is then sized by the skW requirement and frequency dip limit of each sequence. The program allows for sequence unique frequency dip limits (set by the limits of each load in the sequence) and global limits (set on the project page). The transient analysis identifies the most demanding sequence and the most demanding load in that sequence. In the example below, the most demanding sequence is "Group 3" because it is using the greatest percentage of its available frequency dip limit. Sequence "Group 1" has a greater skW and frequency dip but it is not constrained as tightly as "Group 3". In addition to identifying the most demanding sequence, the transient analysis identifies the load in each sequence which is the most demanding.

Most difficult engine transient requirements (Fdip)

Sequence:	Group 1
Load:	Server #1
Starting kW:	93.54
Fdip Tolerance:	5
Fdip Expected:	1.5

Engine Transient Analysis (Fdip)

Sequence	Allowable Fdip	Expected Fdip	Sequence Starting kW	Largest Transient Load
Group 1	5	1.5	93.54	Server #1

Frequency dip limits:
Since it is possible for each sequence to have a unique frequency dip limit, the project may display a frequency dip that is greater than the most restrictive device. In this example, Motor #2 starts causing a frequency dip of 3.9 hertz, then Resistive #1 starts later with its more restrictive 3 hertz limit. This is an acceptable sizing solution because Resistive #1 is not running when Motor #2 causes the larger frequency dip. The program automatically rolls the frequency dip limits of previous load steps into the sizing and analysis for subsequent load steps.

The ability to have unique frequency dips per sequence is an advanced feature of this program. For applications that you want a global limit placed on all loads, set the frequency dip limit on the project set-up page to the desired volt dip.

For loads that cycle (on and off) once other loads are running, this program supports two cyclic load sequences. These sequences are placed at the end of all the load steps to capture the frequency dip limits of all previous loads. This prevents a load that is re-starting later from causing a sensitive load that is already running from tripping on low frequency.

UPS special case:

The program allows for the UPS to revert to batteries, if so selected, when other load in the system cause transients. This keeps the UPS tolerance from rolling into other loads in the system, but the sizing algorithm ensures that the generator has enough capacity to maintain UPS tolerances while the UPS is stepping on line. This is typically an issue with passive & line interactive UPS technologies due to their tight frequency tolerances.

Project Summary Report

Project summary report summarizes the information on the project setup, load summary, transient analysis and harmonic analysis pages. The summary report is accessed via the left navigation bar analysis tab and then selecting the "project summary report" option. The summary report can be viewed on screen, printed, or exported as a pdf file.

To print the project report, simply select the printer icon over the top of the report. To print the project report to a pdf file for easy emailing, simply select the floppy disk icon over the top of the report.

Project Sharing

Project sharing has been made much easier with the cloud based Power Design Pro. From the home screen there is a share project icon for each project. Once you are in the project the icon is part of the project header.

		Created	Modified		
First Project		11/10/2018 09:38	11/10/2018 09:38		

Displaying all projects updated within the last 90 days.

Select the share project icon which will open the share project window. Enter the recipient's email address, click the solutions you want to share, and add any notes you want to send with the project.

Share Project

Recipient Email

Solutions

☐ **Diesel Solution**
Description :

☐ **Gas Solution**
Description :

Notes

Close   Share Project

Although the person you shared your project with will not be notified, any updates you make to the shared solution will be visible to the shared person by either re-entering the project or by refreshing the screen if they are already in the project. The shared person cannot make any changes to your solution, but can create a revision of the solution and can share that revision with the original sender.

Gas Piping

The gas piping module is a tool to determine required pipe size for gaseous fuel generator. The gas piping tool supports single unit and Generac's Modular Power System (MPS) configurations. The gas piping module is accessed from the mechanical design tab on the left navigation bar and selecting gas piping.

The imagine is not avaible

Gas Piping Inputs:
Generator Selection:
The generator selection is made on the project tab, load summary page. The generator can be selected automatically by the program or manually by the user.

Fuel type:
The fuel type is selected on the project setup page.

Supply Gas Pressure:
This is the available gas pressure at the supply end of the gas piping. The program uses this gas pressure as a starting point and then sizes the pipe to ensure adequate gas pressure at the generator under full fuel flow. Note that under full flow conditions the supplying service and system pressure regulators may have some pressure reduction. The supply gas pressure entered should match the available pressure under this full gas flow condition.

Length of run:
This is the total pipe length from the supplying service or supplying pressure regulator to the generator.

Number of Elbows and Tees:
Elbows and tees add restriction to the gas flow. Enter the number of these items.

Single Module Only:
This sizing tool is designed to support sizing a single generator or a combination of generators on one gas line. When the single module check box is selected, the program pulls the gas flow requirement for a single generator module of the size listed. Use this option if sizing piping feeding a single generator.   If the box is unchecked, the program multiplies the gas flow by the number of units. Use this option if sizing piping that is feeding multiple generators.

Sizing Method:

The program provides four methods of sizing the gas pipe – three automatic methods and one manual method. Each of the automatic methods allow the user to select a different sizing requirement.

The first option is limiting the piping to .5" of water column pressure drop. This option will match most gas piping handbook calculations. This method allows for very little pressure drop and requires the largest size pipe. Though the most conservative, this method provides the most robustness if the input gas pressure is less than expected.

The next two options are based on utilizing a percentage of the potential allowable pressure drop. For example, if the input is 15" w.c. and the generator requires 5", there is the potential for the piping to drop 10" w.c. and still meet the generator's requirements. Though possible this is not desired because it doesn't allow for variation in the input gas pressure that may occur in application. But 33% of the allowable pressure drop does seem reasonable (assuming the gas source pressure is reliable). The program defaults to 33% of allowable pressure drop with on option for 50% of allowable pressure drop.

The final option is a manual pipe size selection. This allows the user to see the effects of selecting different size pipes on available generator gas pressure. When this option is selected, pipe size is a user input (pipe size is a program output when in an automatic sizing method).

Gas Piping Outputs:
Generator Summary:
This is a summary of the requirements for the generator. The product family and generator are selected on the project, load summary page. The fuel type is selected on the project, project setup page. The fuel consumption rate and the generator minimum pressure are provided by the program to match the generator(s) requirements.

Solution:
The "Pressure Drop" is the pressure lost in the piping. The "Available pressure" is the pressure at the generator after losing pressure in the piping. The "percent of allowable" pressure drop is the percentage of the maximum allowable pressure drop consumed by the piping (see sizing method for more information).