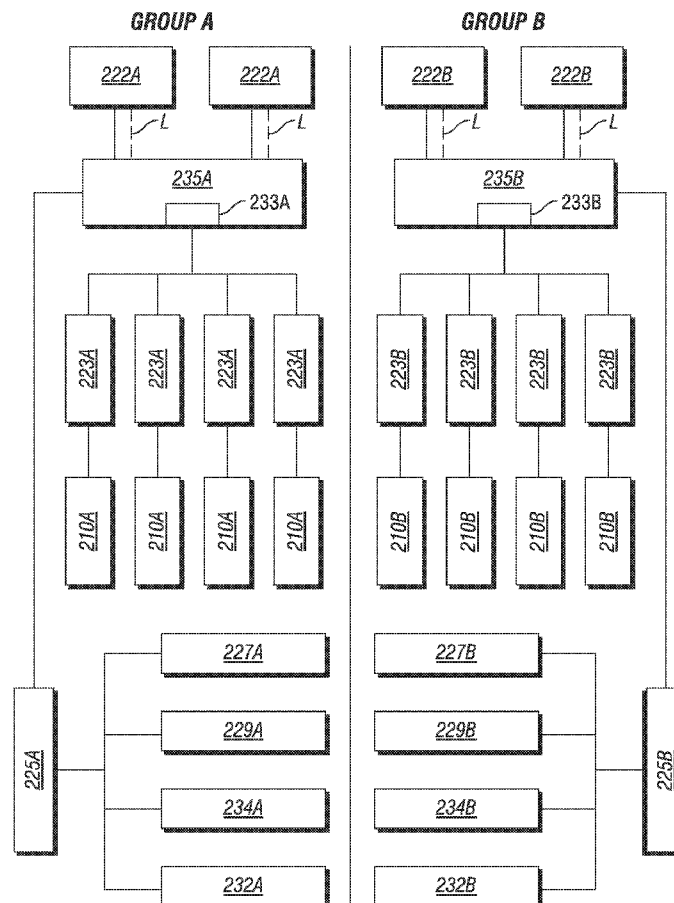




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**Oehring et al.**(10) **Pub. No.: US 2016/0105022 A1**(43) **Pub. Date: Apr. 14, 2016**(54) **SYSTEM AND METHOD FOR PARALLEL  
POWER AND BLACKOUT PROTECTION FOR  
ELECTRIC POWERED HYDRAULIC  
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(2013.01); **E21B 43/26** (2013.01); **G05B 15/02**  
(2013.01)(57) **ABSTRACT**

A system for powering equipment used in a hydraulic fracturing operation, the system including at least one first generator in electrical communication with a first switchgear for providing power to primary components of a hydraulic fracturing operation, and at least one second generator in electrical communication with a second switchgear for providing power to backup components of a hydraulic fracturing operation. The at least one first generator is independent of the at least one second generator so that if the at least one first generator loses the ability to generate electricity, the at least one second generator can continue to generate electricity.



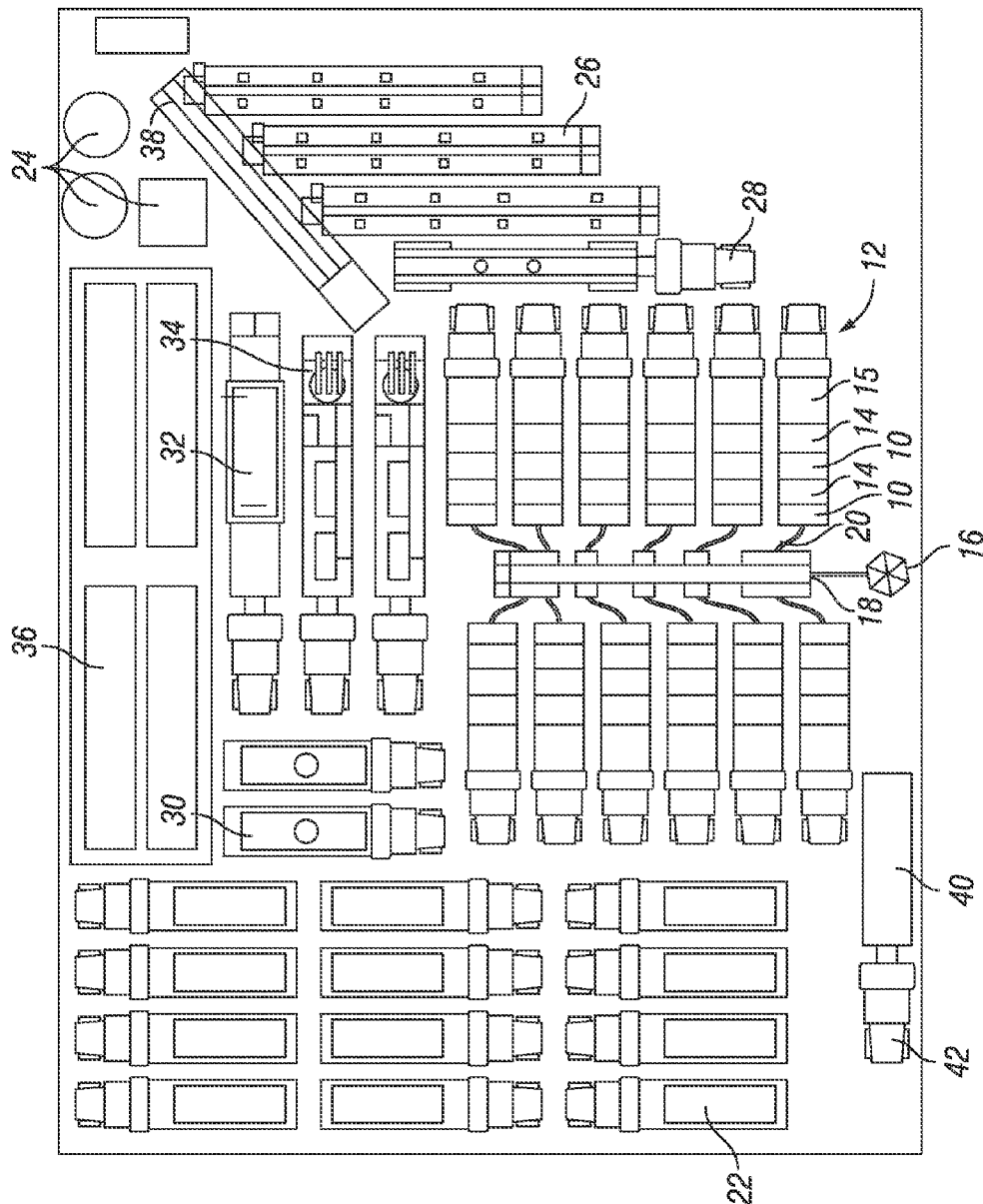


FIG. 1

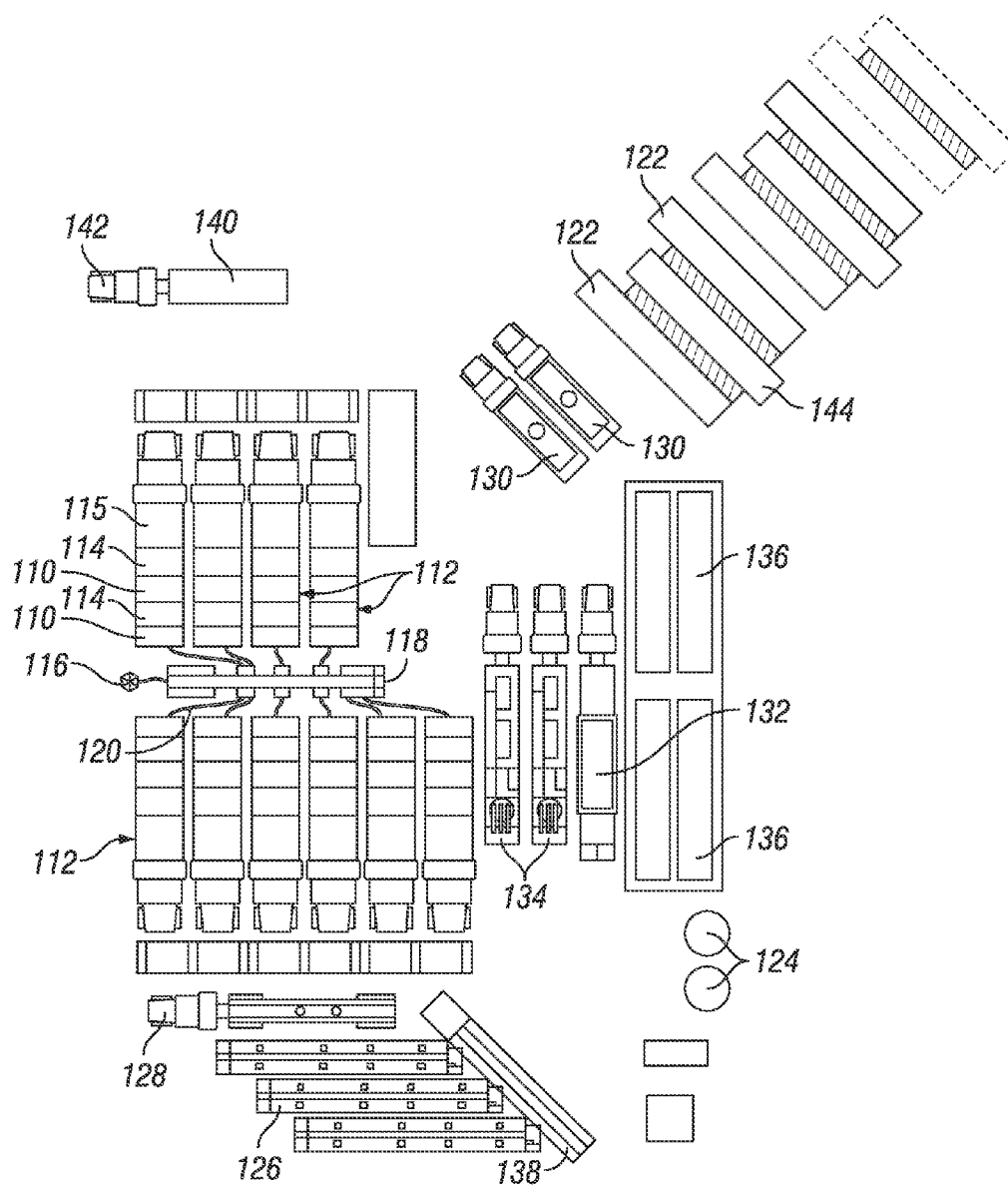


**FIG. 2**

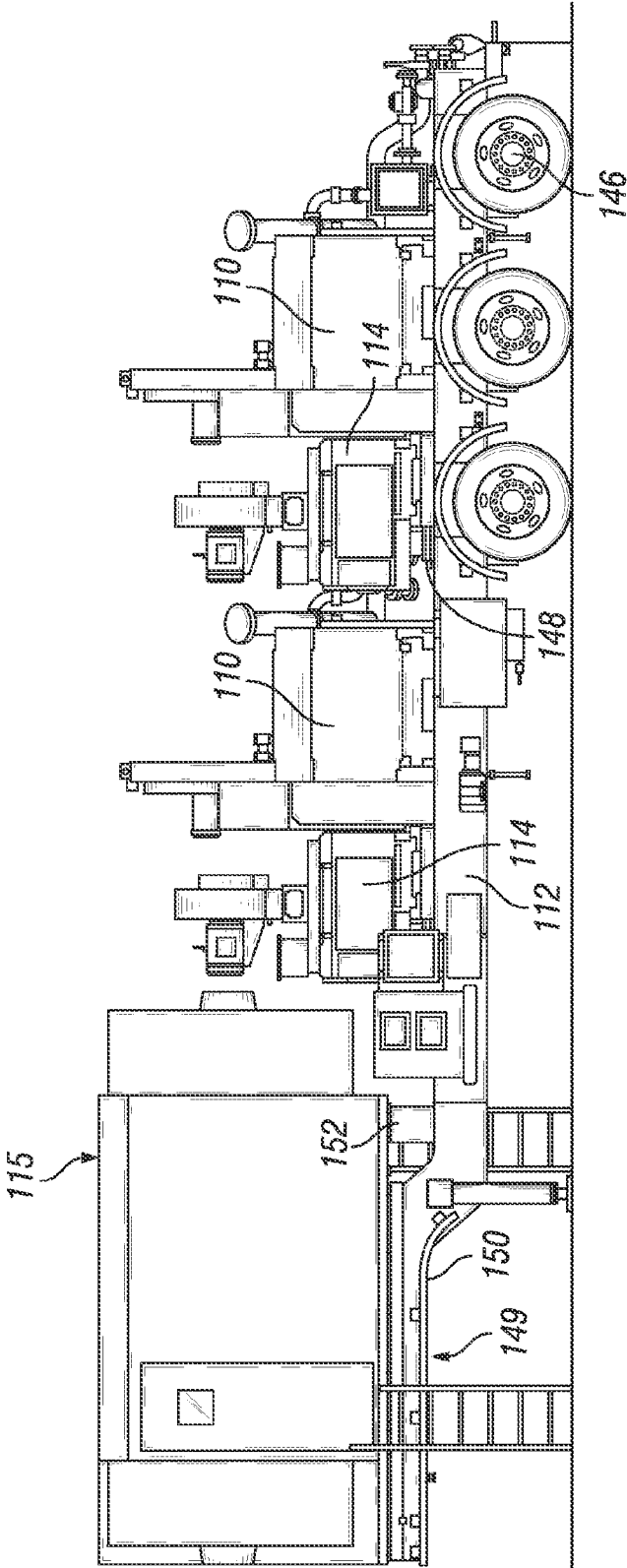


FIG. 3

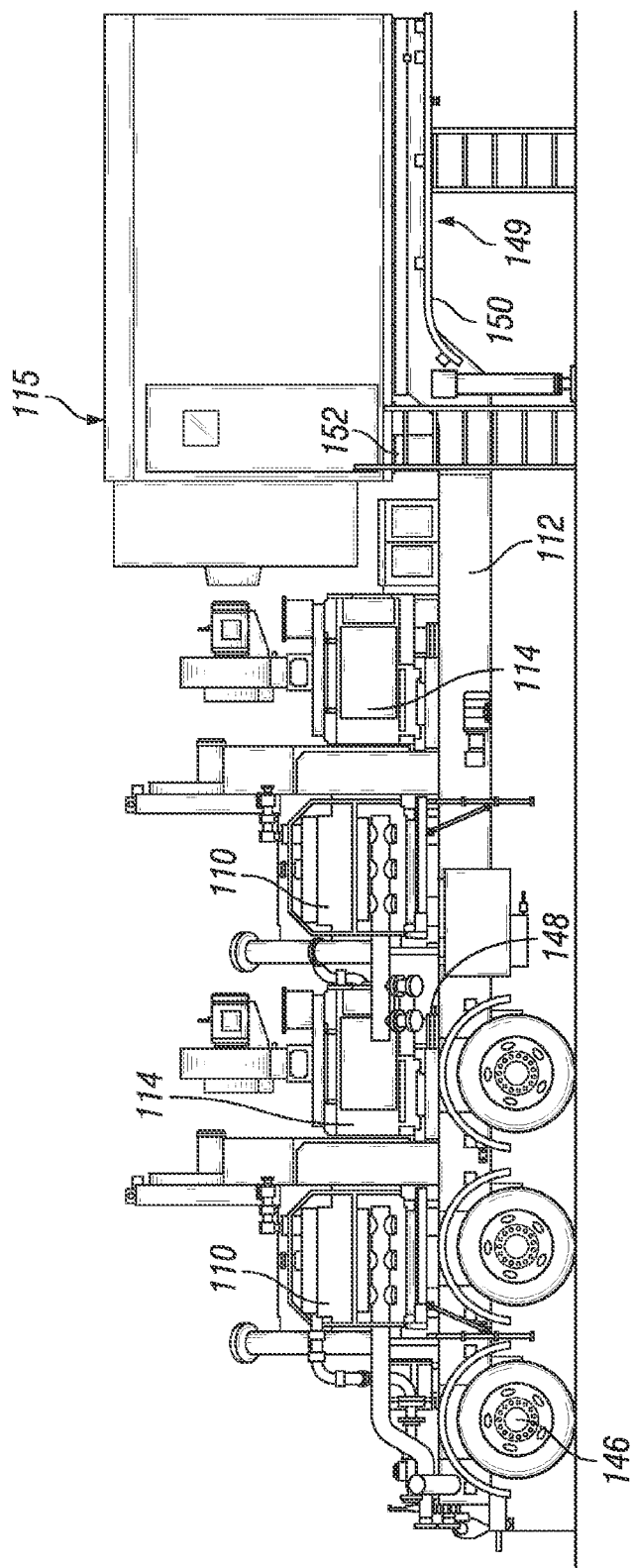


FIG. 4

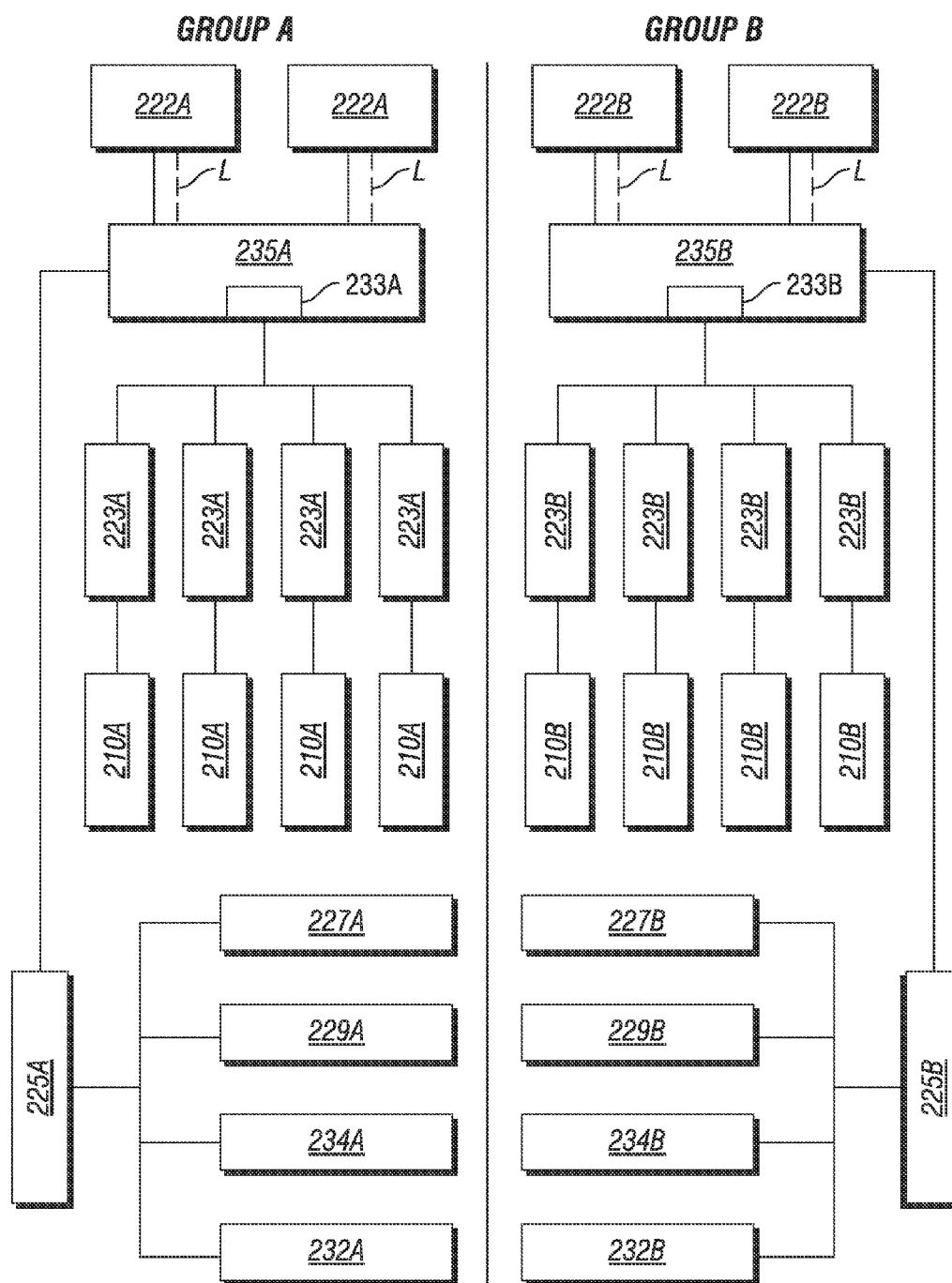


FIG. 5

**SYSTEM AND METHOD FOR PARALLEL  
POWER AND BLACKOUT PROTECTION FOR  
ELECTRIC POWERED HYDRAULIC  
FRACTURING**

CROSS-REFERENCE to RELATED PATENT  
APPLICATIONS

[0001] This application is a continuation-in-part of non-provisional U.S. patent application Ser. No. 13/679,689, filed Nov. 16, 2012, and claims priority to U.S. Provisional Patent Appln. No. 62/063,680, filed Oct. 14, 2015, the full disclosures of which are hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This technology relates to hydraulic fracturing in oil and gas wells. In particular, this technology relates to methods of powering electric hydraulic fracturing spreads.

[0004] 2. Brief Description of Related Art

[0005] Typically, most equipment, including pumps used in hydraulic fracturing operations, are diesel powered, with each pump powered by a discrete diesel engine. If one pump goes out, the remaining pumps are unaffected, so that circulation in the well can be maintained by the still-functioning pumps.

[0006] Some sites, however, utilize electric power to drive the pumps. In some such systems, the entire power supply may be routed through a single switchgear point. In such a system, all of the turbine generators are synced and tied together, which leads limited redundancy and blackout protection. In practice, this means that if one of the turbines loses power, there will not be sufficient remaining power to continue pumping operations. Thus, the entire system could cease to function, with negative consequences (e.g., a screen out) for the well. In addition, even in systems where enough turbines remain serviceable to continue pumping the well to avoid a screen out, this function is not performed because the ability to shed load, such as by shutting down power to non-critical parts of the system, is limited. The power draw from all of the units overloads the turbines causing a shutdown of the entire system.

SUMMARY OF THE INVENTION

[0007] One embodiment of the present technology provides a system for powering equipment used in a hydraulic fracturing operation. The system includes at least one first generator in electrical communication with a first switchgear for providing power to primary components of a hydraulic fracturing operation, and at least one second generator in electrical communication with a second switchgear for providing power to backup components of a hydraulic fracturing operation. The at least one first generator is independent of the at least one second generator so that if the at least one first generator loses the ability to generate electricity, the at least one second generator can continue to generate electricity.

[0008] In some embodiments, the system can include a load shedding system for monitoring turbine generator overload. The load shedding system can have a load shed signal line that detects when a power draw will overload the system, and can be capable of shutting down electric power to a portion of the system to prevent an overload of the system. In some example embodiments, the load shedding system can include a

breaker, and can be configured to send a signal to open the breaker to cut power to at least one of the primary or backup components.

[0009] In certain embodiments, the primary and secondary components can be selected from the group consisting of a pump, a data van, sand equipment, a blender, and a hydration unit. In addition, the load shed signal line can carry a signal of 4-20 mA to the breaker. Furthermore, the first and second switchgear can channel electrical power from the at least one first generator and the at least one second generator, respectively, to at least one transformer and/or to an auxiliary transformer. The at least one transformer can be connected to at least one pump, and the auxiliary transformer can be connected to auxiliary equipment selected from the group consisting of a data van, sand equipment, a blender, and a hydration unit.

[0010] Another embodiment of the present technology provides a system for preventing failure in a hydraulic fracturing system that includes at least one generator for transmitting power to a plurality of components of a hydraulic fracturing system, a load shedding system for monitoring power draw of the plurality of components, the load shedding system including a load shed signal line, and a breaker configured for activation by the load shed signal line to cut power to one or more of the plurality of components if the one or more of the plurality of components draws more than a predetermined acceptable amount of power to prevent overload of the system. In some embodiments, the plurality of components can be selected from the group consisting of a pump, a data van, sand equipment, a blender, and a hydration unit. In addition, the load shed signal line can carry a signal of 4-20 mA to the breaker.

[0011] Yet another embodiment of the present technology provides a method for preventing failure of an electric powered hydraulic fracturing system. The method includes the steps of powering a plurality of primary components of a hydraulic fracturing operation by a first generator in electrical communication with the primary components through a first switchgear. The method further includes electrically connecting a plurality of backup components of a hydraulic fracturing operation to a second generator through a second switchgear, and powering one or more of the plurality of backup components in lieu of one or more of the plurality of primary components in the event that power to the one or more of the plurality of primary components is lost. In some embodiments, the method can also include the steps of determining when a power draw will overload one or more of the plurality of primary components in the hydraulic fracturing system, and sending a load signal to a breaker to cut power to the one or more of the plurality of primary components to prevent overloading of the hydraulic fracturing system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present technology will be better understood on reading the following detailed description of nonlimiting embodiments thereof, and on examining the accompanying drawing, in which:

[0013] FIG. 1 is a schematic plan view of equipment used in a hydraulic fracturing operation, according to an embodiment of the present technology;

[0014] FIG. 2 is a schematic plan view of equipment used in a hydraulic fracturing operation, according to an alternate embodiment of the present technology;

[0015] FIG. 3 is a left side view of equipment used to pump fracturing fluid into a well and mounted on a trailer, according to an embodiment of the present technology; and

[0016] FIG. 4 is a right side view of the equipment and trailer shown in FIG. 3; and

[0017] FIG. 5 is diagram showing how components of the equipment can be divided into independent systems according to an embodiment of the invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] The foregoing aspects, features, and advantages of the present technology will be further appreciated when considered with reference to the following description of preferred embodiments and accompanying drawing, wherein like reference numerals represent like elements. In describing the preferred embodiments of the technology illustrated in the appended drawing, specific terminology will be used for the sake of clarity. However, the technology is not intended to be limited to the specific terms used, and it is to be understood that each specific term includes equivalents that operate in a similar manner to accomplish a similar purpose.

[0019] FIG. 1 shows a plan view of equipment used in a hydraulic fracturing operation. Specifically, there is shown a plurality of pumps 10 mounted to vehicles 12, such as trailers (as shown, for example, in FIGS. 3 and 4). In the embodiment shown, the pumps 10 are powered by electric motors 14, which can also be mounted to the vehicles 12. The pumps 10 are fluidly connected to the wellhead 16 via the missile 18 (although in some embodiments, high pressure piping or hose can be used in place of the missile). As shown, the vehicles 12 can be positioned near enough to the missile 18 to connect fracturing fluid lines 20 between the pumps 10 and the missile 18. The missile 18 is then connected to the wellhead 16 and configured to deliver fracturing fluid provided by the pumps 10 to the wellhead 16. Although the vehicles 12 are shown in FIGS. 3 and 4 to be trailers, the vehicles could alternately be trucks, wherein the pumps 10, motors 14, and other equipment are mounted directly to the truck.

[0020] In some embodiments, each electric motor 14 can be an induction motor, and can be capable of delivering about 1500 horsepower (HP), 1750 HP, or more. Use of induction motors, and in particular three-phase induction motors, allows for increased power output compared to other types of electric motors, such as permanent magnet (PM) motors. This is because three-phase induction motors have nine poles (3 poles per phase) to boost the power factor of the motors. Conversely, PM motors are synchronous machines that are accordingly limited in speed and torque. This means that for a PM motor to match the power output of a three-phase induction motor, the PM motor must rotate very fast, which can lead to overheating and other problems.

[0021] Each pump 10 can optionally be rated for about 2250 horsepower (HP) or more. In addition, the components of the system, including the pumps 10 and the electric motors 14, can be capable of operating during prolonged pumping operations, and in temperature in a range of about -20 degrees C. or less to about 55 degrees C. or more. In addition, each electric motor 14 can be equipped with a variable frequency drive (VFD) 15, and an A/C console, that controls the speed of the electric motor 14, and hence the speed of the pump 10.

[0022] The VFDs 15 of the present technology can be discrete to each vehicle 12 and/or pump 10. Such a feature is advantageous because it allows for independent control of the

pumps 10 and motors 14. Thus, if one pump 10 and/or motor 14 becomes incapacitated, the remaining pumps 10 and motors 14 on the vehicle 12 or in the fleet can continue to function, thereby adding redundancy and flexibility to the system. In addition, separate control of each pump 10 and/or motor 14 makes the system more scalable, because individual pumps 10 and/or motors 14 can be added to or removed from a site without modification to the VFDs 15.

[0023] The electric motors 14 of the present technology can be designed to withstand an oilfield environment. Specifically, some pumps 10 can have a maximum continuous power output of about 1500 HP, 1750 HP, or more, and a maximum continuous torque of about 8750 ft-lb, 11,485 ft-lb, or more. Furthermore, electric motors 14 of the present technology can include class H insulation and high temperature ratings, such as about 1100 degrees C. or more. In some embodiments, the electric motor 14 can include a single shaft extension and hub for high tension radial loads, and a high strength 4340 alloy steel drive shaft, although other suitable materials can also be used.

[0024] The VFD 15 can be designed to maximize the flexibility, robustness, serviceability, and reliability required by oilfield applications, such as hydraulic fracturing. For example, as far as hardware is concerned, the VFD 15 can include packaging receiving a high rating by the National Electrical Manufacturers Association (such as nema 1 packaging), and power semiconductor heat sinks having one or more thermal sensors monitored by a microprocessor to prevent semiconductor damage caused by excessive heat. Furthermore, with respect to control capabilities, the VFD 15 can provide complete monitoring and protection of drive internal operations while communicating with an operator via one or more user interfaces. For example, motor diagnostics can be performed frequently (e.g., on the application of power, or with each start), to prevent damage to a grounded or shorted electric motor 14. The electric motor diagnostics can be disabled, if desired, when using, for example, a low impedance or high-speed electric motor.

[0025] In some embodiments, the pump 10 can optionally be a 2250 HP triplex or quintuplex pump. The pump 10 can optionally be equipped with 4.5 inch diameter plungers that have an eight (8) inch stroke, although other size plungers or stroke lengths can be used, depending on the preference of the operator. The pump 10 can further include additional features to increase its capacity, durability, and robustness, including, for example, a 6.353 to 1 gear reduction, autofrettaged steel or steel alloy fluid end, wing guided slush type valves, and rubber spring loaded packing. Alternately, pumps having slightly different specifications could be used. For example, the pump 10 could be equipped with 4 inch diameter plungers, and/or plungers having a ten (10) inch stroke.

[0026] In addition to the above, certain embodiments of the present technology can optionally include a skid (not shown) for supporting some or all of the above-described equipment. For example, the skid can support the electric motor 14 and the pump 10. In addition, the skid can support the VFD 15. Structurally, the skid can be constructed of heavy-duty longitudinal beams and cross-members made of an appropriate material, such as, for example, steel. The skid can further include heavy-duty lifting lugs, or eyes, that can optionally be of sufficient strength to allow the skid to be lifted at a single lift point. It is to be understood, however, that a skid is not necessary for use and operation of the technology, and the mounting of the equipment directly to a vehicle 12 without a

skid can be advantageous because it enables quick transport of the equipment from place to place, and increased mobility of the pumping system.

**[0027]** Referring back to FIG. 1, also included in the equipment is a plurality of electric generators **22** that are connected to, and provide power to, the electric motors **14** on the vehicles **12**. To accomplish this, the electric generators **22** can be connected to the electric motors **14** by power lines (not shown). The electric generators **22** can be connected to the electric motors **14** via power distribution panels (not shown). In certain embodiments, the electric generators **22** can be powered by natural gas. For example, the generators can be powered by liquefied natural gas. The liquefied natural gas can be converted into a gaseous form in a vaporizer prior to use in the generators. The use of natural gas to power the electric generators **22** can be advantageous because the units can run off of a pipeline supply to simplify fuel delivery and increase safety. Other embodiments allow use of natural gas stored in above ground natural gas vessels **24** already in place on site in a field that produces gas in sufficient quantities. Thus, a portion of this natural gas can be used to power the electric generators **22**, thereby reducing or eliminating the need to import fuel from offsite. If desired by an operator, the electric generators **22** can optionally be natural gas turbine generators, such as those shown in FIG. 2. The generators can run on any appropriate type of fuel, including liquefied natural gas (LNG), compressed natural gas (CNG), diesel fuel, or a combination of these fuels.

**[0028]** FIG. 1 also shows equipment for transporting and combining the components of the hydraulic fracturing fluid used in the system of the present technology. In many wells, the fracturing fluid contains a mixture of water, sand or other proppant, acid, and other chemicals. Examples of fracturing fluid components include acid, anti-bacterial agents, clay stabilizers, corrosion inhibitors, friction reducers, gelling agents, iron control agents, pH adjusting agents, scale inhibitors, and surfactants. Historically, diesel has at times been used as a substitute for water in cold environments, or where a formation to be fractured is water sensitive, such as, for example, clay. The use of diesel, however, has been phased out over time because of price, and the development of newer, better technologies.

**[0029]** In FIG. 1, there are specifically shown sand transporting vehicles **26**, an acid transporting vehicle **28**, vehicles for transporting other chemicals **30**, and a vehicle carrying a hydration unit **32**. Also shown are fracturing fluid blenders **34**, which can be configured to mix and blend the components of the hydraulic fracturing fluid, and to supply the hydraulic fracturing fluid to the pumps **10**. In the case of liquid components, such as water, acids, and at least some chemicals, the components can be supplied to the blenders **34** via fluid lines (not shown) from the respective component vehicles, or from the hydration unit **32**. In the case of solid components, such as sand, the component can be delivered to the blender **34** by a conveyor belt **38**. The water can be supplied to the hydration unit **32** from, for example, water tanks **36** onsite. Alternately, the water can be provided by water trucks. Furthermore, water can be provided directly from the water tanks **36** or water trucks to the blender **34**, without first passing through the hydration unit **32**.

**[0030]** In certain embodiments of the technology, the hydration units **32** and blenders **34** can be powered by electric motors. For example, the blenders **34** can be powered by more than one motor, including motors having 600 horsepower or

more, and motors having 1150 horsepower or more. The hydration units **32** can be powered by electric motors of 600 horsepower or more. In addition, in some embodiments, the hydration units **32** can each have up to five (5) chemical additive pumps or more, and a 200 bbl steel hydration tank.

**[0031]** Pump control and data monitoring equipment **40** can be mounted on a control vehicle **42**, and connected to the pumps **10**, electric motors **14**, blenders **34**, and other down-hole sensors and tools (not shown) to provide information to an operator, and to allow the operator to control different parameters of the fracturing operation. For example, the pump control and data monitoring equipment **40** can include an A/C console that controls the VFD **15**, and thus the speed of the electric motor **14** and the pump **10**. Other pump control and data monitoring equipment can include pump throttles, a VFD fault indicator with a reset, a general fault indicator with a reset, a main estop, a programmable logic controller for local control, and a graphics panel. The graphics panel can include, for example, a touchscreen interface.

**[0032]** Referring now to FIG. 2, there is shown an alternate embodiment of the present technology. Specifically, there is shown a plurality of pumps **110** which, in this embodiment, are mounted to pump trailers **112**. As shown, the pumps **110** can optionally be loaded two to a trailer **112**, thereby minimizing the number of trailers needed to place the requisite number of pumps at a site. The ability to load two pumps **110** on one trailer **112** is possible because of the relatively light weight of the electric powered pumps **110** compared to other known pumps, such as diesel pumps. This is specifically due to the removal of the diesel engine and transmission. In the embodiment shown, the pumps **110** are powered by electric motors **114**, which can also be mounted to the pump trailers **112**. Furthermore, each electric motor **114** can be equipped with a VFD **115**, and an A/C console, that controls the speed of the motor **114**, and hence the speed of the pumps **110**.

**[0033]** The VFDs **115** shown in FIG. 2 can be discrete to each pump trailer **112** and/or pump **110**. Such a feature is advantageous because it allows for independent control of the pumps **110** and motors **114**. Thus, if one pump **110** and/or motor **114** becomes incapacitated, the remaining pumps **110** and motors **114** on the pump trailers **112** or in the fleet can continue to function, thereby adding redundancy and flexibility to the system. In addition, separate control of each pump **110** and/or motor **114** makes the system more scalable, because individual pumps **110** and/or motors **114** can be added to or removed from a site without modification to the VFDs **115**.

**[0034]** In addition to the above, and still referring to FIG. 2, the system can optionally include a skid (not shown) for supporting some or all of the above-described equipment. For example, the skid can support the electric motors **114** and the pumps **110**. In addition, the skid can support the VFD **115**. Structurally, the skid can be constructed of heavy-duty longitudinal beams and cross-members made of an appropriate material, such as, for example, steel. The skid can further include heavy-duty lifting lugs, or eyes, that can optionally be of sufficient strength to allow the skid to be lifted at a single lift point. It is to be understood that a skid is not necessary for use and operation of the technology and the mounting of the equipment directly to a trailer **112** may be advantageous because it enables quick transport of the equipment from place to place, and increased mobility of the pumping system, as discussed above.

[0035] The pumps 110 are fluidly connected to a wellhead 116 via a missile 118. As shown, the pump trailers 112 can be positioned near enough to the missile 118 to connect fracturing fluid lines 120 between the pumps 110 and the missile 118. The missile 118, or other fluid connection device, such as high pressure piping or hose, is then connected to the wellhead 116 and configured to deliver fracturing fluid provided by the pumps 110 to the wellhead 116.

[0036] This embodiment also includes a plurality of turbine generators 122 that are connected to, and provide power to, the electric motors 114 on the pump trailers 112. To accomplish this, the turbine generators 122 can be connected to the electric motors 114 by power lines (not shown). The turbine generators 122 can be connected to the electric motors 114 via power distribution panels (not shown). In certain embodiments, the turbine generators 122 can be powered by natural gas, similar to the electric generators 22 discussed above in reference to the embodiment of FIG. 1. Also included are control units 144 for the turbine generators 122. The control units 144 can be connected to the turbine generators 122 in such a way that each turbine generator 122 is separately controlled. This provides redundancy and flexibility to the system, so that if one turbine generator 122 is taken off line (e.g., for repair or maintenance), the other turbine generators 122 can continue to function.

[0037] The embodiment of FIG. 2 can include other equipment similar to that discussed above. For example, FIG. 2 shows sand transporting vehicles 126, acid transporting vehicles 128, other chemical transporting vehicles 130, hydration unit 132, blenders 134, water tanks 136, conveyor belts 138, and pump control and data monitoring equipment 140 mounted on a control vehicle 142. The function and specifications of each of these is similar to corresponding elements shown in FIG. 1.

[0038] Use of pumps 10, 110 powered by electric motors 14, 114 and natural gas powered electric generators 22 (or turbine generators 122) to pump fracturing fluid into a well is advantageous over known systems for many different reasons. For example, the equipment (e.g. pumps, electric motors, and generators) is lighter than the diesel pumps commonly used in the industry. The lighter weight of the equipment allows loading of the equipment directly onto a truck body or trailer. Where the equipment is attached to a skid, as described above, the skid itself can be lifted on the truck body, along with all the equipment attached to the skid. Furthermore, and as shown in FIGS. 3 and 4, trailers 112 can be used to transport the pumps 110 and electric motors 114, with two or more pumps 110 carried on a single trailer 112. Thus, the same number of pumps 110 can be transported on fewer trailers 112. Known diesel pumps, in contrast, cannot be transported directly on a truck body or two on a trailer, but must be transported individually on trailers because of the great weight of the engine and transmissions that are replaced by a motor.

[0039] The ability to transfer the equipment of the present technology directly on a truck body or two to a trailer increases efficiency and lowers cost. In addition, by eliminating or reducing the number of trailers to carry the equipment, the equipment can be delivered to sites having a restricted amount of space, and can be carried to and away from work-sites with less damage to the surrounding environment. Another reason that the electric powered pump system of the present technology is advantageous is that it runs on natural gas. Thus, the fuel is lower cost, the components of the system

require less maintenance, and emissions are lower, so that potentially negative impacts on the environment are reduced.

[0040] More detailed side views of the trailers 112, having various system components mounted thereon, are shown in FIGS. 3 and 4, which show left and right side views of a trailer 112, respectively. As can be seen, the trailer 112 can be configured to carry pumps 110, electric motors 114 and a VFD 115. Thus configured, the motors 114 and pumps 110 can be operated and controlled while mounted to the trailers 112. This provides advantages such as increased mobility of the system. For example, if the equipment needs to be moved to a different site, or to a repair facility, the trailer can simply be towed to the new site or facility without the need to first load the equipment onto a trailer or truck, which can be a difficult and hazardous endeavor. This is a clear benefit over other systems, wherein motors and pumps are attached to skids that are delivered to a site and placed on the ground.

[0041] In order to provide a system wherein the pumps 110, motors 114, and VFDs 115 remain trailer mounted, certain improvements can be made to the trailers 112. For example, a third axle 146 can be added to increase the load capacity of the trailer and add stability. Additional supports and cross members 148 can be added to support the motors' torque. In addition, the neck 149 of the trailer can be modified by adding an outer rib 150 to further strengthen the neck 149. The trailer can also include specially designed mounts 152 for the VFD 115 that allow the trailer to move independently of the VFD 115, as well as specially designed cable trays for running cables on the trailer 112. Although the VFD 115 is shown attached to the trailer in the embodiment of FIGS. 3 and 4, it could alternately be located elsewhere on the site, and not mounted to the trailer 112.

[0042] In practice, a hydraulic fracturing operation can be carried out according to the following process. First, the water, sand, and other components are blended to form a fracturing fluid, which is pumped down the well by the electric-powered pumps. Typically, the well is designed so that the fracturing fluid can exit the wellbore at a desired location and pass into the surrounding formation. For example, in some embodiments the wellbore can have perforations that allow the fluid to pass from the wellbore into the formation. In other embodiments, the wellbore can include an openable sleeve, or the well can be open hole. The fracturing fluid can be pumped into the wellbore at a high enough pressure that the fracturing fluid cracks the formation, and enters into the cracks. Once inside the cracks, the sand, or other proppants in the mixture, wedges in the cracks, and holds the cracks open. In some embodiments, a fluid other than water can be used to the proppant.

[0043] Using the pump control and data monitoring equipment 40, 140 the operator can monitor, gauge, and manipulate parameters of the operation, such as pressures, and volumes of fluids and proppants entering and exiting the well. For example, the operator can increase or decrease the ratio of sand to water as the fracturing process progresses and circumstances change.

[0044] This process of injecting fracturing fluid into the wellbore can be carried out continuously, or repeated multiple times in stages, until the fracturing of the formation is optimized. Optionally, the wellbore can be temporarily plugged between each stage to maintain pressure, and increase fracturing in the formation. Generally, the proppant is inserted into the cracks formed in the formation by the fracturing, and

left in place in the formation to prop open the cracks and allow oil or gas to flow into the wellbore.

[0045] In FIG. 5 there is shown an embodiment of the invention wherein a plurality of generators 222A, 222B are divided into separate, parallel, and independent groups, including group A and group B. Each group A, B of generators 222A, 222B is connected in turn to separate and distinct groups of transformers 223A, 223B and pumps 210A, 210B, as well as separate and distinct auxiliary trailers 225A, 225B, each including its own ancillary equipment, such as, for example, data vans 227A, 227B, sand equipment 229A, 229B, blenders 234A, 234B, and hydration units 232A, 232B. Although FIG. 5 shows more than one generator 222A, 222B in each group A, B, it is possible that any individual group could include a single generator 222A, 222B. Furthermore, although not shown in FIG. 5, multiple gas compressors can be utilized to supply fuel to the generators 222A, 222B so that there is redundancy in the gas compression portion of the system as well.

[0046] The advantages provided by the arrangement shown in FIG. 5 are many. For example, the use of separate independent power sources adds a layer of protection by helping to prevent the complete loss of power of the hydraulic fracturing system. This is accomplished by eliminating any single point electric power generation and distribution failure points. This means that if power is lost in one group A, B, then the other group(s) A, B will continue to operate. In practice, this could be beneficial, for example, where power is lost to some of the generators 222A, so that normal pumping operations must cease. In such a scenario, the remaining generators 222B could continue to power a sufficient number of pumps 223B to pump and flush the well, thereby avoiding an expensive screen out that would require a drilling rig to come in and service the well.

[0047] In addition, the arrangement of FIG. 5 provides the ability to load shed, as indicated by the load shed signal lines L. Load shedding is the deliberate shutdown of electric power in parts of a system to prevent the failure of the entire system when demand strains the capacity of the system. The load shed system of the embodiment of FIG. 5 can monitor when power draw will overload the system (i.e., when demand is higher than supply), and it will send a signal to open a breaker 233A, 233B to cut certain pumps 210A, 210B, thereby reducing power before the entire bank is overloaded. Thus, the system can actively prevent a blackout of the entire fracturing system by incorporating load shed into the system.

[0048] These two advantages (i.e., the provision of independent groups of generators 222A, 222B and load shedding) are made possible by certain features of the embodiment of FIG. 5, including the provision of two or more generators 222A, 222B grouped into two or more banks of power, which are kept separate to create redundancy and backup capabilities in the system. In addition, the load shed technology can monitor when the generators 222A, 222B will overload, and, in response, can send a signal to open a breaker 233A, 233B to cut power to individual pumps 210A, 210B, thereby preventing overload of the entire bank. In this regard, power may be cut to a pump 210A, 210B by sending, for example, a 4-20 mA (or other) signal to open a breaker 233A, 233B.

[0049] Furthermore, there can be provided both primary and secondary equipment related to other parts of the fracturing system. For example, there can be a primary blender 234A and a backup blender 234B, as well as primary and backup data vans 227A, 227B, sand equipment 229A, 229B, and

hydration equipment 232A, 232B. The hydraulic fracturing pumps can be split evenly between the banks. The primary equipment can be powered by one group A of generators 222A, and the secondary equipment can be powered by a secondary group B of generators 222B, thereby assuring that the equipment will function, even if one group A, B of generators 222A, 222B loses power.

[0050] As shown in the diagram of FIG. 5, one or more generators 222A can make up group A for power generation. The different generators 222A for group A are all phase synced together. The power from the generators 222A of group A goes to switchgear 235A. From switchgear 235A, the power goes to the transformers 223A, and to the auxiliary trailer 225A, which can have a transformer, as well as a VFD and softstarts for the blender and hydration units. Power can then go to one or more of the following: the primary blender 234A, the primary hydration unit 232A, the primary data van 227A, and/or the primary sand equipment 229A. Power from the transformers 223A also goes to pumps 210A.

[0051] Similarly, one or more generators can make up group B for separate power generation. The different generators 222B of group B are all phase synced together. The power from the generators 222B of group B goes to switchgear 235B. From switchgear 235B, the power goes to the transformers 223B, and from there to pumps 210B. Power also goes from switchgear 235B to an auxiliary trailer 225B, which can have a transformer, as well as a VFD and softstarts for the blender and hydration units. Power can then go to one or more of the following: the backup blender 234B, the backup hydration unit 232B, the backup data van 227B, and/or the backup sand equipment 229B.

[0052] The embodiment shown in FIG. 5 can be utilized with different types of units, including trailerized, skidded, and body loaded units. In addition, although two groups A, B are shown in FIG. 5, more than two groups can be used. Furthermore, different types of power generation can be used, such as diesel generators, and other types of generators. Moreover, the system could be backed up by a traditionally powered source. For example, a conventional diesel or bi-fuel powered frack system could be tied into the system as a backup, so that conventional means could be used to power the system if the electric system becomes incapacitated or ineffective. In such a scenario, a transfer switch could be used to switch a blender over to another bank, instead of having blenders rigged into different power supply banks.

[0053] While the technology has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the technology. Furthermore, it is to be understood that the above disclosed embodiments are merely illustrative of the principles and applications of the present technology. Accordingly, numerous modifications can be made to the illustrative embodiments and other arrangements can be devised without departing from the spirit and scope of the present technology as defined by the appended claims.

What is claimed is:

1. A system for powering equipment used in a hydraulic fracturing operation, the system comprising:

at least one first generator in electrical communication with a first switchgear for providing power to primary components of a hydraulic fracturing operation;

at least one second generator in electrical communication with a second switchgear for providing power to backup components of a hydraulic fracturing operation; and the at least one first generator being independent of the at least one second generator so that if the at least one first generator loses the ability to generate electricity, the at least one second generator can continue to generate electricity.

**2.** The system of claim **1**, further comprising:

a load shedding system for monitoring turbine generator overload, the load shedding system having a load shed signal line that detects when a power draw will overload the system, and capable of shutting down electric power to a portion of the system to prevent an overload of the system.

**3.** The system of claim **2**, wherein the load shedding system includes a breaker, and is configured to send a signal to open the breaker to cut power to at least one of the primary or backup components.

**4.** The system of claim **1**, wherein the primary and secondary components are selected from the group consisting of a pump, a data van, sand equipment, a blender, and a hydration unit.

**5.** The system of claim **3**, wherein the load shed signal line carries a signal of 4-20 mA to the breaker.

**6.** The system of claim **1**, wherein the first and second switchgear channel electrical power from the at least one first generator and the at least one second generator, respectively, to at least one transformer.

**7.** The system of claim **1**, wherein the first and second switchgear channel electrical power from the at least one first generator and the at least one second generator, respectively, to an auxiliary transformer.

**8.** The system of claim **6**, wherein the at least one transformer is connected to at least one pump.

**9.** The system of claim **7**, wherein the auxiliary transformer is connected to auxiliary equipment selected from the group consisting of a data van, sand equipment, a blender, and a hydration unit.

**10.** A system for preventing failure in a hydraulic fracturing system, the system comprising:

at least one generator for transmitting power to a plurality of components of a hydraulic fracturing system;

a load shedding system for monitoring power draw of the plurality of components, the load shedding system including a load shed signal line; and

a breaker configured for activation by the load shed signal line to cut power to one or more of the plurality of components if the one or more of the plurality of components draws more than a predetermined acceptable amount of power to prevent overload of the system.

**11.** The system of claim **10**, wherein the plurality of components are selected from the group consisting of a pump, a data van, sand equipment, a blender, and a hydration unit.

**12.** The system of claim **10**, wherein the load shed signal line carries a signal of 4-20 mA to the breaker.

**13.** A method for preventing failure of an electric powered hydraulic fracturing system, the method comprising:

powering a plurality of primary components of a hydraulic fracturing operation by a first generator in electrical communication with the primary components through a first switchgear;

electrically connecting a plurality of backup components of a hydraulic fracturing operation to a second generator through a second switchgear;

powering one or more of the plurality of backup components in lieu of one or more of the plurality of primary components in the event that power to the one or more of the plurality of primary components is lost.

**14.** The method of claim **13**, further comprising:

determining when a power draw will overload one or more of the plurality of primary components in the hydraulic fracturing system, and

sending a load signal to a breaker to cut power to the one or more of the plurality of primary components to prevent overloading of the hydraulic fracturing system.

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