Nav aid system ensures safety of drilling rigs

Uninterruptible power supply for the navigation markers on an offshore drilling platform in the Black Sea

by Jürgen Poidl

Figure 1: Picture of an oil platform

A long way from dry land, drilling platforms on the high seas provide crude oil and natural gas to meet the world's energy needs. Unlike roads on land with their related signs and physical limits, it is necessary to mark boundaries and hazards on maritime routes at sea. Light signals, acoustic signalling devices, and radio beacons are used for this purpose. For instance, a so-called ›nav aid system‹ in the form of a radio beacon along with fog horns and position lights ensures that offshore installations can always be detected in time by passing ships and aircraft.

Such a system must also remain fully functional after a failure in the supply network. This aspect is extraordinarily important particularly in poor visibility (at night or in bad weather) so that ships can change course in time if there is a drilling platform on their route.

Emergency power units are used to supply such signalling systems with power without interruption, as described in the following, and marketed by R. STAHL. There are a number of different design variants and operating mode variants for these units that are of high quality. The individual components are also available in explosion protected designs, depending on the place they are installed.

UPS systems for harsh (offshore) operation

Unlike UPS systems for normal industrial usage in an unproblematic environment, the conditions on drilling platforms with salt-laden air and high atmospheric humidity, and in some cases also in explosion hazardous areas, are considerably harder. The requirements on the technology and functional safety over extended periods are therefore correspondingly high.

› **Design and operating modes**
The core components of a UPS are the accumulators for the supply of power to the loads in the event of supply network failure, the charger, and the control system for various operating modes that are defined in accordance with the applicable standards and applications.

› **Parallel stand-by operation**
In active parallel stand-by operation (online) (Figure 2), the power supply and the charger are connected in parallel. As a result, the charger must supply both the load current and the charging current. In this circuit the charging voltage must follow the corresponding charging characteristic for the accumulator. A control system is therefore to be used for monitoring the charging current and charging voltage. If the supply network fails, the energy is fed from the accumulators to the loads connected.

› **Transfer stand-by operation**
In the transfer stand-by mode (off line), the battery supply is connected as a separate circuit to supply the loads (Figure 3). In the event of supply network failure, the load output is changed over to the back-up supply as a function of the mains voltage. This configuration makes the charging system significantly simpler, however the transfer stand-by operation takes a certain amount of transfer time. The more suitable of the two methods is therefore to be selected as a function of the application.

Batteries for use in hazardous areas

› **Version in type of protection flameproof enclosures**
In the standard IEC/EN 60079-1 Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures ›d‹ the secondary cells allowed to be used are given in Table E.2 in Annex E. Accordingly, only nickel-cadmium or nickel-metal hydride cells are allowed to be used that meet specific IEC standards. Restrictions on certain types of cells are to be noted. For instance, only gas-tight and sealed, valve regulated cells are allowed to be used inside flameproof enclosures. However, only gas-tight cells can be charged inside flameproof enclosures, except for cells with a maximum capacity that does not exceed 1.5 Ah and with a volume that is a maximum of 1 % of the free volume of the enclosure. On the usage of batteries with a capacity greater than 1.5 Ah, protection against exhaustive discharge is required that safely prevents polarity reversal on individual cells or ensures individual cells are monitored. Due to these restrictions, the flameproof enclosure is less suitable for larger batteries. →

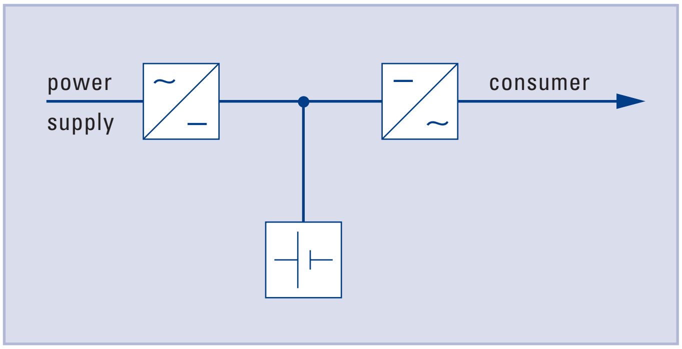

Figure 2: Parallel stand-by operation (online)

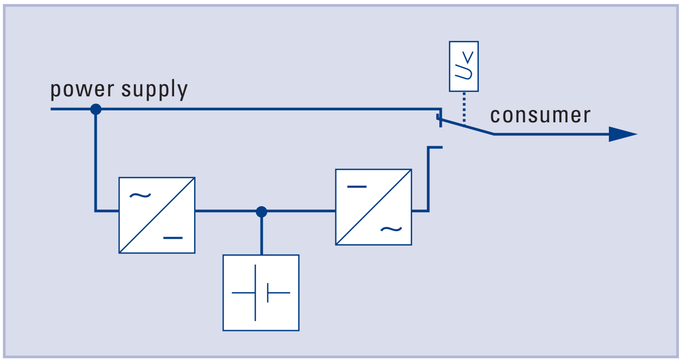

Figure 3: Transfer stand-by operation (off line)

Figure 4: Battery container made of stainless steel in the type of protection increased safety

- **Version in type of protection increased safety**
  The type of protection increased safety ›e‹ in accordance with the standard IEC/EN 60079-7 Explosive atmospheres Part 7: Equipment protection by increased safety ›e‹ provides a better method here for the application in a UPS system. The requirements for accumulators larger and smaller than 25 Ah are different. For a ›nav aid system‹, a capacity of 32 Ah at 24 V DC is required as a rule. Other systems are equipped with capacities up to 2,800 Ah at 24 V DC. For accumulators with a capacity >25 Ah, lead acid, nickel-iron or nickel-cadmium types are allowed. The battery enclosure must meet special requirements. Among other aspects, adequate ventilation is to be ensured such that the hydrogen that may be released at a defined level of overcharging can escape. On the usage of gas-tight or sealed, valve regulated cells, this requirement is easy to meet. Figure 4 and 5 show examples of battery enclosures in the type of protection increased safety. Battery and charger are to be considered together as one piece of equipment for explosion protection. It must be ensured that even with the occurrence of a fault in the charger, the maximum charging voltage and the maximum charging current are not exceeded. The objective of this requirement is compliance with the limiting temperature for the related temperature class and as a result the avoidance of a source of ignition. It is also to be ensured that no flammable gas escapes from the accumulator.
- **Connection of cells to form batteries**
  On the connection of individual cells to form batteries in a series or parallel configuration, further effects must be taken into account. On charging and discharging accumulators with several cells in a series configuration, checking the voltage at the terminals of batteries operated in hazardous areas is not enough. There is no information available on the state of the individual cells. The cells will change with ageing and the capacity of the individual cells will vary. Inevitably, this situation will mean that the cell with the smallest capacity will reach the end-of charge voltage first. However, the sum of the end-of-charge voltages on all cells will be measured as the shutdown criteria at the terminals on the charger. The individual cells must be monitored for usage in hazardous areas.

Figure 5: Battery boxes for lead gel accumulators in the type of protection increased safety

If the charging voltage is not shut down in good time, some cells may become too hot and, along with damage to the cells, a source of ignition may result. Conversely, during discharge the accumulator provides current until the control system shuts down when the related end-of-discharge voltage is reached. However, as some cells, as described, may discharge quicker, exhaustive discharge and polarity reversal may occur with corresponding damage.

If the cells are connected in parallel, on the other hand, the current in the individual circuits cannot be measured by measuring the total current. Special monitoring devices must also be provided here.

DC UPS in aluminium enclosures ›Ex d‹

The special requirements on the functional safety and long service life of a UPS for use on the Black Sea prompted R. STAHL to prepare a technically logical and reliable overall solution. The central element of the UPS is formed by sea water-resistant aluminium enclosures from the CUBEx system in which the charger and the control system including the battery monitoring are installed (Figure 6).

The connection box in type of protection increased safety contains, apart from the connections and terminals, indicators for the various status and alarm indications:

- charging
- battery operation
- group fault
- overcurrent
- overvoltage
- charger fault
- end-of- discharge voltage reached

Figure 6: Charger and power supply with monitoring devices in CUBEx enclosure

The instruments for measuring the voltage and current on the input and output are also installed in this Ex e enclosure. To ensure the long service life of the batteries, the charging current is pulsed so that thermal overload does not occur. In addition, this technique also prevents possible ›gassing‹, i.e. the release of flammable gases. The UPS installed in the CUBEx enclosure system supplies an output current of 30 A and can be cascaded as required. The output voltage is 24 V DC (Figure 7).

Electrical isolation of the loads connected

Accumulators for operation in hazardous areas must have a device for electrically isolating the loads connected. This feature is implemented using a circuit breaker with isolator characteristics. The circuit breaker has an adapted flameproof enclosure and is installed as an individual component in an enclosure made of glass-fibre reinforced moulded material in type of protection increased safety (Figure 8). The exterior fastenings are made of stainless steel. The clear switch position indication with a two-colour rocker can be read and operated from the outside via a circuit breaker flap.

DC power distribution

The DC power distribution (Figure 9) supplies the power to the loads and provides protection for the circuits connected. The compact design here is also due to the special enclosure concept. The electrical equipment fitted is installed in several mounting planes. The entire area of the cover can be used for the installation of operating elements. The rear mounting plane is easy to access due to hinged DIN-rails.

With this project for an uninterruptible power supply for electrical safety equipment on the high seas, R. STAHL has once again demonstrated its high level of competence and capability in the area of explosion protection for electrical equipment, in accordance with international standards.

Figure 7: Control system in the flameproof enclosure system CUBEx

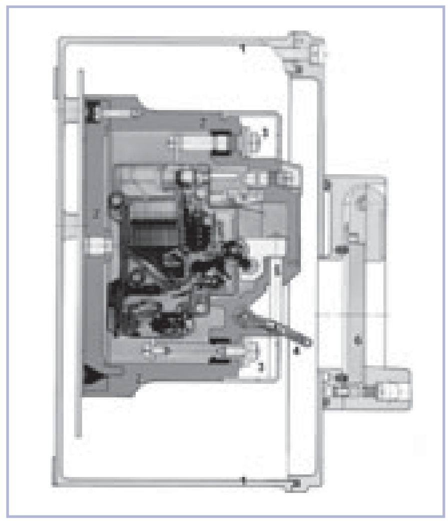

Figure 8: Flameproof circuit breaker in enclosure with increased safety (section)

Figure 9: DC power distribution