



WHITE PAPER

Intelligent maintenance concepts

Creating best practices with user-centric condition monitoring –
demand-oriented & cost-optimized

SIEMENS

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Introduction

Faults in low-voltage power distribution can have serious consequences for industrial plants, infrastructure and buildings. Not only a grid-related power interruption, but even the failure of a single component within the distribution system can bring the system to a complete standstill – and thus quickly stack up the costs. A study by the German Chamber of Industry and Commerce (DIHK) shows the considerable financial impact. For example, 32% of such failures cause additional costs of up to EUR 10,000, 15% from EUR 10,000 to EUR 100,000 and 2% even over EUR 100,000.

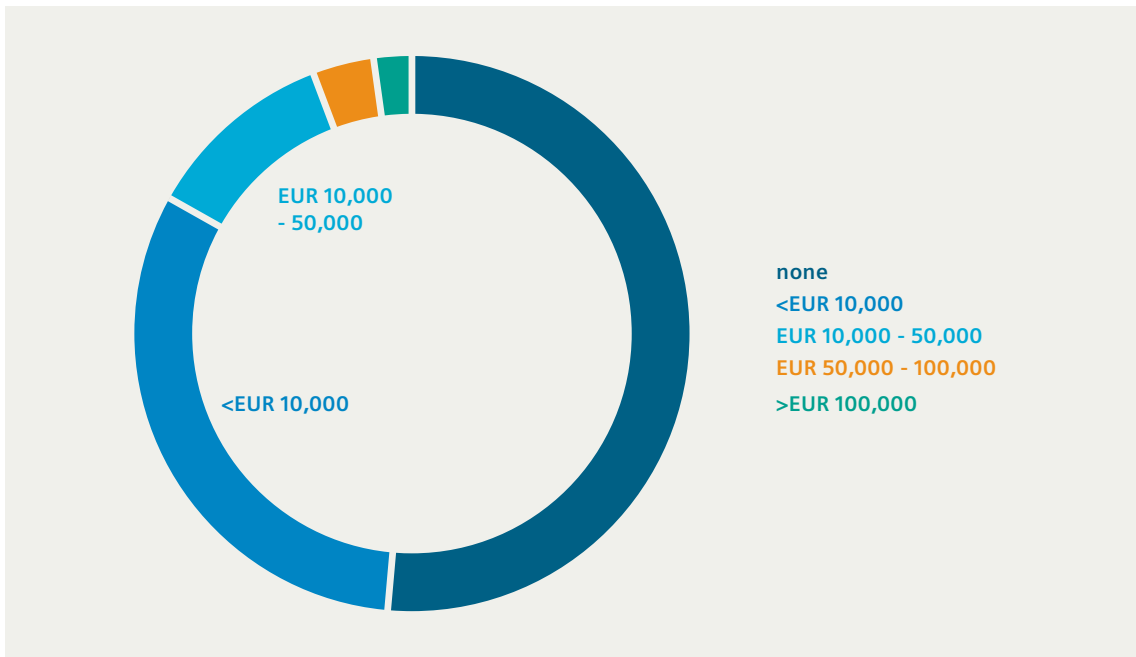


Figure 1: Power outage costs according to DIHK company survey, February 2024

In addition to revenue loss and repair costs, this can also result in data loss, damage to the company's image and even legal consequences. To prevent this and ensure efficient, cost-effective and safe operation, it is important to maximize the reliability and availability of energy distribution by means of suitable maintenance measures. A tried-and-tested way to avoid system failures is to use maintenance concepts that are based on the actual operating status of the system components. With the help of permanent condition monitoring, relevant operating parameters are continuously recorded and analyzed. In this way, the first signs of wear or malfunction can be detected at an early stage. This in turn enables timely and targeted planning and execution of necessary maintenance activities without risking system downtime.

Many planners and operators already rely on condition monitoring as a solution for high system availability. It should be noted, however, that not every condition monitoring concept really promises success.

¹ <https://www.dihk.de/de/themen-und-positionen/wirtschaftspolitik/energie/betriebe-verzeichnen-hohe-zahl-an-stromunterbrechungen-116894>

² Further information on the potential of condition monitoring as an approach to increasing system availability can be found in the [White paper "Enhanced system availability through condition monitoring"](#)

In addition to the functional technology, practical and user-friendly integration into the workflow is particularly important. Only then will condition monitoring actually mean less effort in practice and enable an increase in operational efficiency.

This white paper uses the example of circuit breakers as essential components in energy distribution to show that it is not only the condition monitoring technology itself, but above all its user-friendliness that is the key to success.

Condition monitoring: Knowing rather than assuming

Reactive vs. preventive maintenance concepts

To ensure high system availability, it is essential that all components of the low-voltage power distribution system function reliably. This requires appropriate maintenance and servicing measures. A distinction is made between reactive and preventive measures.

- Reactive maintenance measures are only carried out when defects or component wear already become apparent through limited functionality – a component failure is imminent or has already occurred. This classic maintenance concept prevents the replacement of components that are still functional. However, faulty or obsolete system parts can cause unplanned downtimes and, in the worst case scenario, permanent damage to the system. Therefore, a reactive maintenance concept is not recommended.
- Preventive maintenance measures, on the other hand, are precautionary – in other words, before a system component loses its functionality. This can be done, for example, through regular maintenance work according to defined usage intervals (time-based) or after a defined number of operating hours or load (load-based). However, this does not take into account whether the functionality of the component is actually already compromised at the time. The greatest potential is therefore offered by condition-based maintenance, which takes into account all relevant influencing factors and thus makes the actual condition of the components the decisive criterion.

A preventive and condition-based maintenance concept requires regular inspections during which the actual condition of the components is given a comprehensive check. In order to counteract any functional impairments or damage detected, the respective component is repaired or replaced as part of the maintenance measures. What sounds simple in theory can turn out to be quite difficult in practice. After all, in order to determine the best maintenance time for a device, numerous framework conditions such as the operating duration, number of switching cycles and trips as well as fluctuating loads must be taken into account. Traditionally, the actual data of the device had to be compared and evaluated with the corresponding manufacturer specifications – a complex and time-consuming challenge. It is difficult to determine the exact component condition in this way, meaning that the best it can do is give a realistic estimation. As a result, the maintenance and servicing measures planned rarely coincide with the actual optimal time for device maintenance. However, this can result in components being replaced earlier than necessary, negatively affecting cost efficiency. Or maintenance is carried out too late, which in turn reduces the reliability and safety of the system.

This is precisely where condition monitoring comes in. This involves the use of measurement and communication-capable system components whose actual states are permanently and automatically recorded and analyzed. Both the operating conditions specified for the corresponding component and the actual loads are taken into account as a whole. This allows the current overall status of the component to be fully mapped and monitored. Maintenance measures can be planned on this basis according to actual requirements, therefore ensuring maximum efficiency. Condition monitoring concepts can be customized depending on the area of application, the devices used and their functionality.

Four reasons for condition monitoring in low-voltage energy distribution

Condition monitoring offers many advantages. Essentially, they can be summarized in the four main benefits described below.



Figure 2: Four reasons for condition monitoring in low-voltage energy distribution

Increased data transparency

Condition monitoring enables permanent and automatic recording and analysis of the relevant actual data from devices. This creates a transparent knowledge base that ensures system operators are always informed about the current status of the components used. On the basis of this transparent database, well-founded system-related decisions can be made in a comprehensible manner. Necessary measures can be initiated accordingly to ensure the reliable and safe functionality of the energy supply. The comprehensive data transparency therefore also forms the basis for a predictive maintenance and servicing concept.

Increased system availability

The condition data recorded during condition monitoring allows the need for action to be recognized at an early stage – which is fundamental for avoiding unplanned system downtimes. If faults or errors are detected on the component that could impair the functionality of the system, the need for appropriate measures is seamlessly communicated to the operator by means of automatic alarm messages. For this purpose, limit values can be defined for the performance indicators recorded by the devices, which trigger a corresponding message if exceeded. Multi-stage alarm cascades that signal the urgency of countermeasures depending on the extent to which the limit value has been exceeded have proven very useful. Depending on the alarm level, the operator has a specific period of time to initiate measures before the detected fault actually triggers a failure. Early information about potential disruptive factors and the ability to intervene in good time can significantly increase system availability.

The following illustration shows the principle of a three-stage alarm cascade, whereby the defined limit values with the points P1, P2 and P3 as well as the respective time between the detection of the fault (P) and the occurrence of the malfunction (F) are shown as so-called PF intervals.

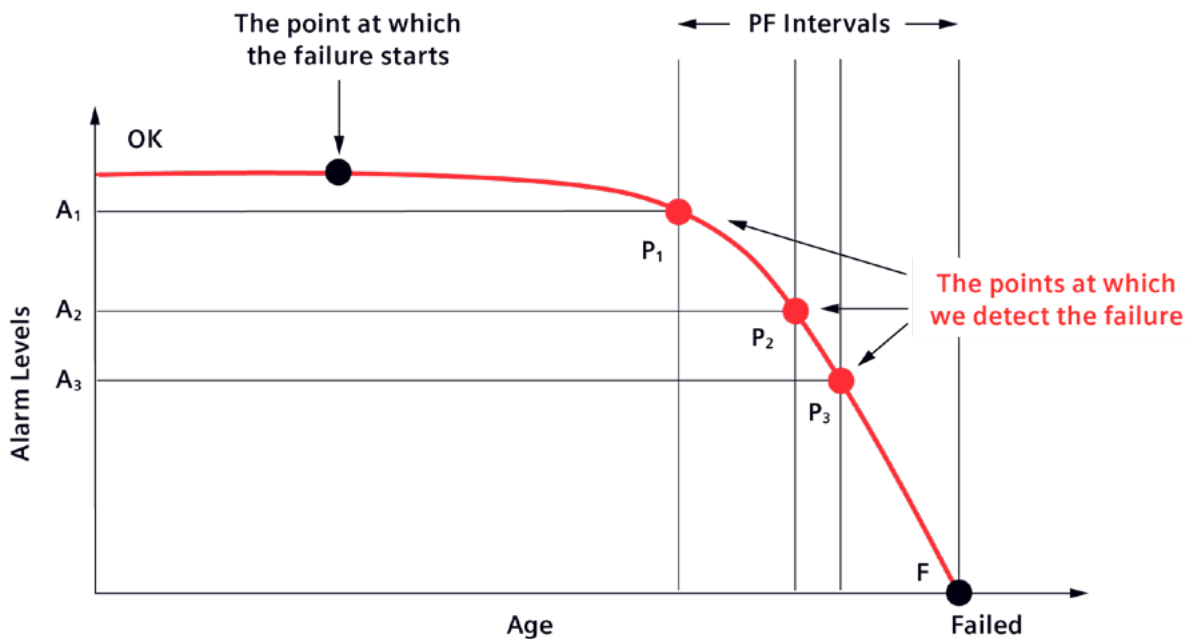


Figure 3: Condition monitoring informs operators about faults in the system before they actually lead to malfunctions. Depending on the defined limit values, operators have a specific length of time to initiate the necessary measures.

Increased servicing efficiency

Normally, the recorded and analyzed condition data is automatically transmitted as status information or warning messages during condition monitoring. With the help of these messages, maintenance and servicing measures can be planned in a targeted, condition-based manner – in other words, only when the condition of the component actually requires it. This allows replacement to take place at exactly the right time, thus maximizing the service life of the component. This ensures more efficient use of both materials and personnel. Maintenance costs can thus be reduced in a targeted manner. The freed resources allow critical system states to be handled more easily.

In its function as a supporting tool, the automatic recording and analysis of device data represents a significant time saving for trained maintenance personnel. In addition, storing the recorded data directly in the device reduces the risk of data loss in the event of personnel or system changes.

Cost optimization

The initial investment for communication-capable devices for the integration of condition monitoring may be higher compared to classic components in reactive maintenance concepts. Maintenance costs might also see a moderate rise, as maintenance and servicing work is carried out more frequently depending on the condition of the system components. On the other hand, however, unplanned downtimes can be consistently prevented, resulting in a disproportionate reduction in downtime-related costs. This significant cost advantage, combined with the more efficient use of materials and personnel, ensures a considerable reduction in overall costs. Any higher investment and maintenance costs can therefore be amortized within a short time.

The importance of user orientation in the practical application of condition monitoring concepts

Challenges in operation

Continuous condition monitoring of system components has numerous advantages – at least in theory. However, the reality of many projects shows that system operators often face a variety of challenges in the practical implementation despite suitable technology. Depending on the concept, the real benefit may not meet the expectations of a facilitating and efficiency-enhancing instrument.

Possible challenges in operation:

- **Integration difficulties & complexity**
A lack of standardized interfaces or insufficient compatibility of system components can make the integration of measurement and monitoring technology more difficult. In the same way, an overly complex system structure can lead to undesirable additional costs.
- **Data without benefit**
Context-related evaluation and analysis is essential in order to use of the collected data. If this is not done at all or not in the respective use context, no relevant performance indicators can be derived for the specific area of application. Pure data collection is therefore of no benefit to the operator.
- **Lack of transparency**
If the collected and analyzed data is not structured in a suitable, comprehensible and easy-to-understand way by the system, it may be difficult to interpret it correctly. In particular, the lack of clear instructions can lead to no or inappropriate measures being taken despite data availability.
- **Insufficient user orientation**
Factors such as complicated user interfaces, complex data access or high operating effort harbor the risk of incorrect operation and create an inadequate user experience. What is supposed to make work easier can then lead to frustration and a lack of acceptance of the technology.

To ensure that condition monitoring technology can actually create maximum added value in practice, it is important to avoid these obstacles wherever possible. Those who not only value functional technology but also factors such as user-friendliness and practicality when selecting a suitable concept can avoid the risks mentioned and exploit the full potential of continuous condition monitoring.

The good news: In recent years, the usability of the condition monitoring solutions available on the market has significantly improved. The trend in development is moving towards a user-oriented design that processes information in a smart and meaningful way instead of just collecting data.

Criteria for a successful condition monitoring concept

The key to successfully integrating condition monitoring into operations is a concept that combines functional technology and user orientation. The basis is always formed by components with measurement and communication capabilities that can record and transmit relevant operating parameters. To ensure that integration and compatibility problems do not arise in the first place and that data communication functions as efficiently as possible, all components should be ideally coordinated. A holistic and integrated system solution is always preferable to isolated solutions. A suitable overall concept not only includes compatible hardware, but ideally also corresponding software solutions for convenient data aggregation and, if necessary, remote access. One example of a holistic solution concept is the SENTRON portfolio from Siemens, which is presented as an example later in this white paper.

A successful condition monitoring solution starts with simple commissioning and configuration, which can be carried out using existing resources and without specialist knowledge. An intuitive user interface and simple operation of the component displays and the connected software solutions allow a quick and uncomplicated insight into the data acquisition. A particular focus should be on ensuring that the data is not only collected, but also analyzed and aggregated in a meaningful and contextual way. Ideally, the system should provide the user with clear, unambiguous recommendations for action. This can be ensured by clear, comprehensible performance indicators, which should be available both on the device itself and in summarized form via software.

A user-oriented condition monitoring concept that meets the outlined criteria is only as good as its weakest link. For maximum efficiency and effectiveness, all system-relevant components must be taken into account – even those that are often not the focus of operators, but rather work in the background. Circuit breakers are a classic example of this in power distribution systems. Although their work takes place behind the scenes, they play an essential role. Their failure can be fatal and costly. This means that, here too, products should also be selected that have the appropriate functionalities and can be integrated into the condition monitoring concept. The market today offers suitable modern solutions for all relevant components that meet the requirements described. The following section shows what a user-friendly condition monitoring solution could look like, taking suitable circuit breakers into account.

Best practice: User-friendly condition monitoring with SENTRON 3WA and SENTRON 3VA circuit breakers

Digression: What are circuit breakers?

Circuit breakers are fundamental components in power distribution. As switchable protective devices, they are responsible for ensuring that the current flows safely and reliably and for interrupting the circuits in the event of a fault. They protect against overloads or short circuits, for example, by automatically tripping.

Air circuit breakers (ACB): Mostly modular design; suitable for very high switching capacities; mostly used as central nodes in large systems, industrial power distribution systems and power plants

Molded case circuit breakers (MCCB): Compact design in closed housing; suitable for medium to high switching capacities; used in building technology and smaller industrial systems

Assessing the operating status of circuit breakers

For optimal functionality, circuit breakers are designed for operation under certain conditions. Specific values for factors such as temperature range, number of switching cycles and trips as well as operating hours are assumed by the manufacturer. However, the actual conditions do not always match the specified parameters, which is why the actual status can vary greatly in practice. Using modern condition monitoring technology, the actual operating status can be determined automatically and reliably at any time, without the need for a time-consuming and rarely promising manual comparison of the actual data with the manufacturer's specifications. Appropriate measures can be taken to optimize the condition and maximize the service life of the circuit breaker.

Circuit breakers consist of various individual parts. Certain parts, such as the main contacts in air circuit breakers, are usually replaceable and generally have to be replaced several times during the service life of the circuit breaker. Other elements, such as the switch mechanism and the housing, form the fixed, non-replaceable base. At the end of its service life, the circuit breaker itself must be replaced. They therefore determine the overall service life of the device. However, the replaceable parts can also have a significant influence on the service life of a circuit breaker. If they are not replaced in good time, the overall service life of the circuit breaker will also be reduced as a result. The condition of the main contacts has a particular influence on the operational capability and therefore the service life of a circuit breaker.

The following example illustrates the influence of the main contacts on the overall service life: Due to its mechanical design, an air circuit breaker has a maximum service life of 30,000 switching cycles. However, the installed main contacts reach the end of their service life after a maximum of 10,000 switching cycles. They must therefore be replaced twice within the life cycle of the circuit breaker so that it can reach its maximum age. If the switch is not replaced in good time, the overall service life of the switch is reduced to the time at which the main contacts fail.

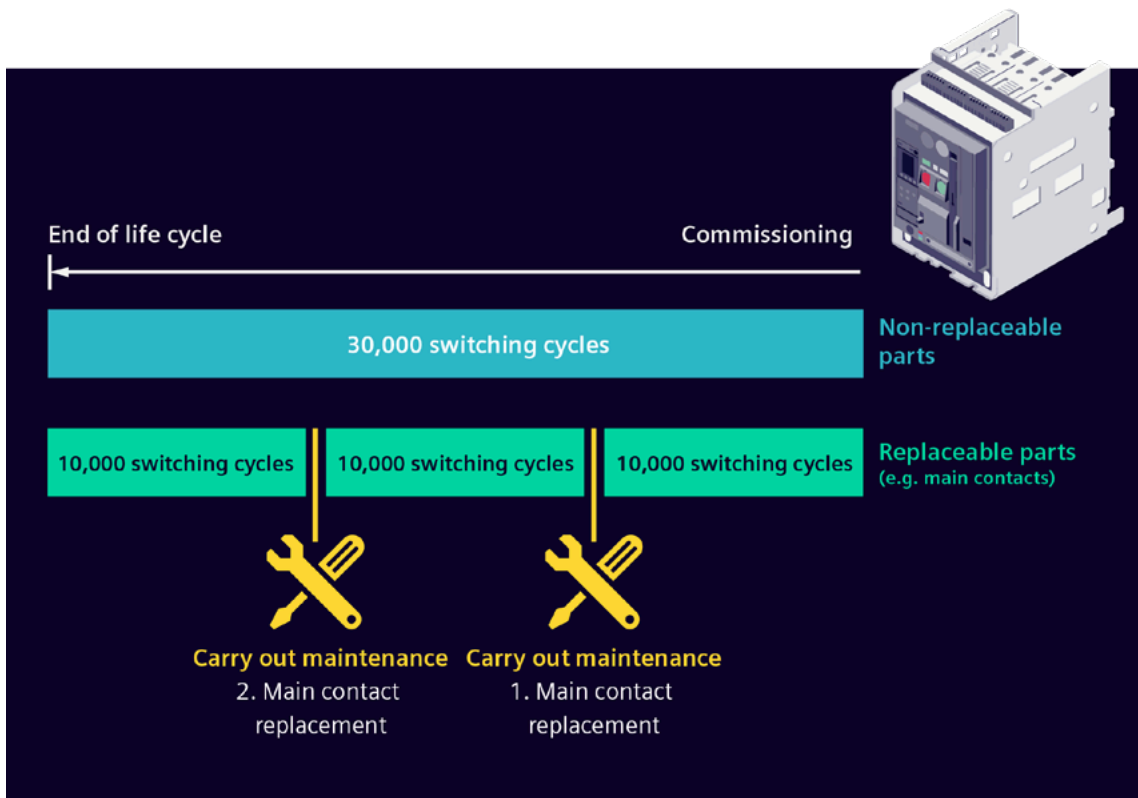


Figure 4: The overall service life of an air circuit breaker largely depends on its replaceable components. If they are replaced in good time, the device can reach its maximum service life.

In order to determine the actual operating status of a circuit breaker, it is therefore important to consider the condition of the individual device components – especially the main contacts – and to evaluate them in an overall analysis. Many modern product solutions with condition monitoring functionality can fulfill this requirement. Circuit breakers such as SENTRON 3WA and SENTRON 3VA from Siemens also offer a particularly user-friendly output of the determined and aggregated analysis results. The insightful health indicator and remaining lifetime provide operators with clear information on the need for action.

SENTRON 3WA air circuit breaker



- Switching and protective devices with expandable communication function
- Can be used in industrial plants, building technology, infrastructures, critical applications with high safety requirements
- Various sizes up to 6300 A
- Certification according to IEC 60947-2, UL 1066 and UL 489
- Serviceable: Service life can be extended thanks to replaceable parts such as main contacts, arcing chambers, arcing chamber cover, accessories, etc.
- Simple functional expansions thanks to standardized accessories for all sizes
- Various ETU application packages, condition monitoring functionality with health indicator and remaining lifetime depending on application package:
 - ETU600-PMF-I ... PMF-III (power monitoring function): Condition monitoring function included
 - ETU600 – ready4COM: Condition monitoring function can be activated retrospectively via license

SENTRON 3VA molded case circuit breakers



- Switching and protective devices with expandable communication function
- Modular, highly variable system
- Can be used in industrial plants, building technology, infrastructures
- Integrated measurement values
- Extensive range of accessories with over 500 parts for flexible functional extensions
- Minimal space requirement due to compact design
- Certification according to IEC 60947 and UL 489
- System protection up to 1600 A (IEC/UL) and 2000 A (UL)
- Condition monitoring functionality with health indicator and remaining lifetime depending on the following requirements:
 - 3VA2 or 3VA6 with series 5 and 8 ETU
 - ETU with firmware V4.4 or higher
 - COM060 communication module with firmware V4.4 or higher
 - COM800 or COM100 data concentrators with firmware V4.4 or higher (commissioning through SENTRON Powerconfig or TIA Portal)

Health indicator

With the health indicator, the SENTRON 3WA and SENTRON 3VA circuit breakers offer an elementary performance indicator that significantly simplifies condition-based monitoring in practice. As an accessible, easy-to-understand percentage value with a color indicator, the respective device status can be intuitively recorded and used as part of a predictive maintenance and servicing concept.

Every switching and tripping of a circuit breaker has an impact on the wear of its main contacts. As their states are decisive for the operational capability of the circuit breaker, the health indicator is based on the analysis of all switching cycles and trips. The current value of the performance indicator is recalculated with each switching operation (on/off or tripping). Triggering for test purposes has no impact. The health indicator is calculated on a device-specific basis depending on the respective switch type and its specific operating parameters such as rated current and switching capacity.

All data collected is stored directly on the device. The current status of the health indicator can be read as a percentage value at any time directly on the display of the circuit breaker electronic trip unit (ETU). For a more detailed insight, the results of the data analysis can be conveniently accessed via connected communication software.

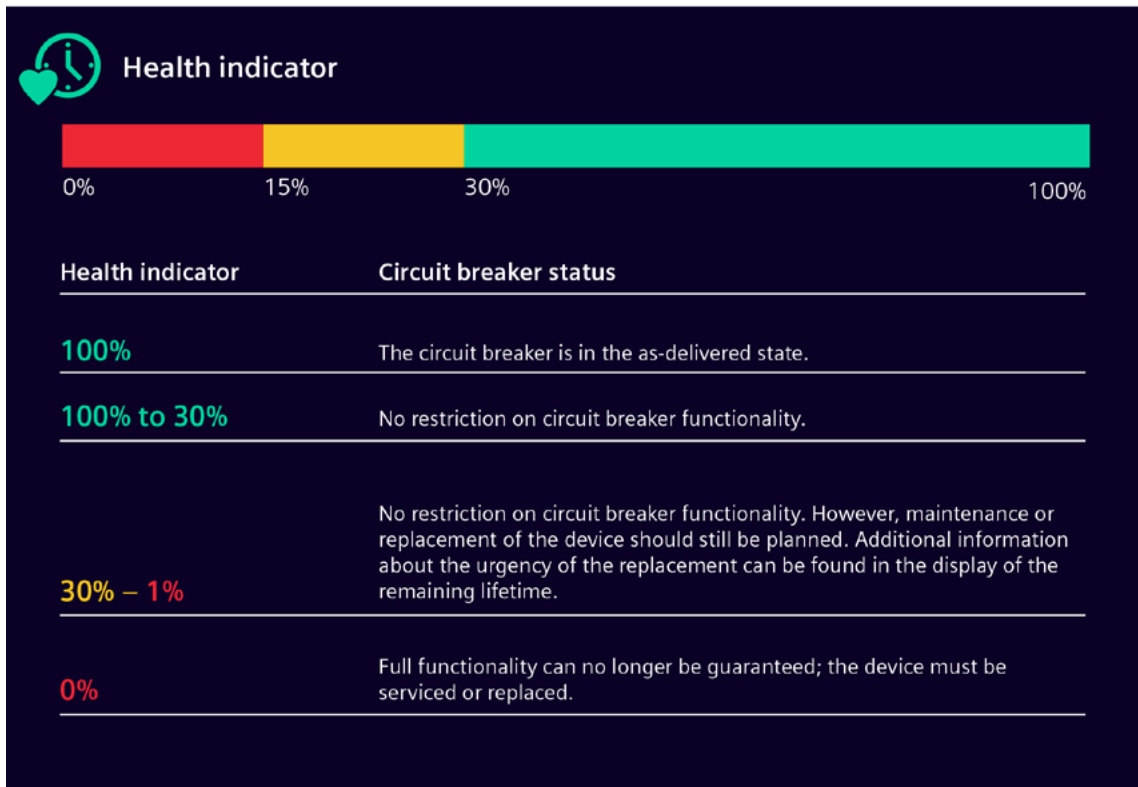


Figure 5: Representation of the health indicator with color indicator and percentage value.

Remaining lifetime

The remaining lifetime indicator adds another important component to the user-oriented monitoring concept of the SENTRON 3WA and SENTRON 3VA circuit breakers. With its convenient time display, it provides a reliable and at-a-glance indication of the remaining time until the device's next necessary maintenance or replacement.

The remaining lifetime is continuously determined in the circuit breakers using a patented, intelligent algorithm. The basis for this is the health indicator. Based on its current value and its historical development, past usage behavior is analyzed and projected into the future. This enables the creation of a forecast for the remaining lifetime. In the event of changes in usage behavior, for example due to unforeseeable triggers that can suddenly reduce the health indicator, the value is automatically and intelligently adjusted.

In addition to the current remaining lifetime, clear statements are given on any condition-based maintenance measures required. If the lifetime of a circuit breaker is deemed to be more than three years, no urgent measures are required. In this case, the remaining lifetime is only estimated to be one year. If the predicted remaining lifetime is less than three years, maintenance or servicing measures may be necessary. In this case, the performance indicator is displayed in more detail, broken down into years, months and weeks. This enables more specific observation and the planning of appropriate steps to be taken.

The remaining lifetime and health indicator can be called up both directly on the device display of the electronic trip unit (ETU) and in more detail in the connected software.

Preventive maintenance with health indicator and remaining lifetime

The information displayed by the health indicator and the remaining lifetime is used in the SENTRON 3WA and SENTRON 3VA circuit breakers for optimal condition monitoring with maximum user-friendliness.

These performance indicators are first calculated separately for all device components in order to subsequently derive the overall status of the circuit breaker. In the SENTRON 3WA maintainable air circuit breaker, this applies both to the replaceable parts such as the main contacts, arcing chambers and arcing chamber cover and to the non-replaceable components, which include the switch mechanism and housing. The lowest specified value determines the corresponding performance indicator for the circuit breaker as a whole.

The current values of the performance indicators – both for the circuit breaker itself and for the individual parts – are simple and clear to view at any time on the device via the display menu of the electronic trip unit (ETU). In addition, system operators are informed when maintenance work or device replacement is required. If action is required based on the health indicator and the remaining lifetime, the system automatically sends warning or error messages. Depending on the type of action required, these are clearly specified by means of appropriate color coding, symbols, detailed notes and instructions.

In the example shown in Figure 6, the maintenance technicians receive a warning message about necessary maintenance work after every 10,000 switching cycles. The messages within the menu structure will clearly show that the main contacts have reached the end of their service life and need to be replaced. The overall service life of the circuit breaker can be extended by replacing it. After a total of 30,000 switching cycles, the circuit breaker itself will have reached the end of its service life due to its non-replaceable parts. The system will report an error message with clear instructions on how to replace the entire device.

The SENTRON 3WA and SENTRON 3VA circuit breakers automatically and intelligently detect the need for action using the health indicator and remaining lifetime indicators. The clear, unambiguous recommendations for action in the system messages can significantly reduce misinterpretations of the device status. In this way, they contribute to the successful implementation of a condition monitoring concept.



Figure 6: The system automatically sends warning and error messages to provide appropriate instructions.

Integration in overall concept

A key success factor for condition monitoring is the integration of the components into a consistent, holistic concept. The SENTRON 3WA and SENTRON 3VA circuit breakers are part of the SENTRON portfolio, which consists of optimally coordinated hardware products, software solutions and additional apps. In addition to circuit breakers, it offers a wide range of other communication-capable measuring, switching and protection devices that enable comprehensive monitoring of the entire system. The recorded status data is stored in the respective system components and can be mapped in aggregated form using various software solutions. With a wide range of options, the portfolio offers an individual solution for every requirement.

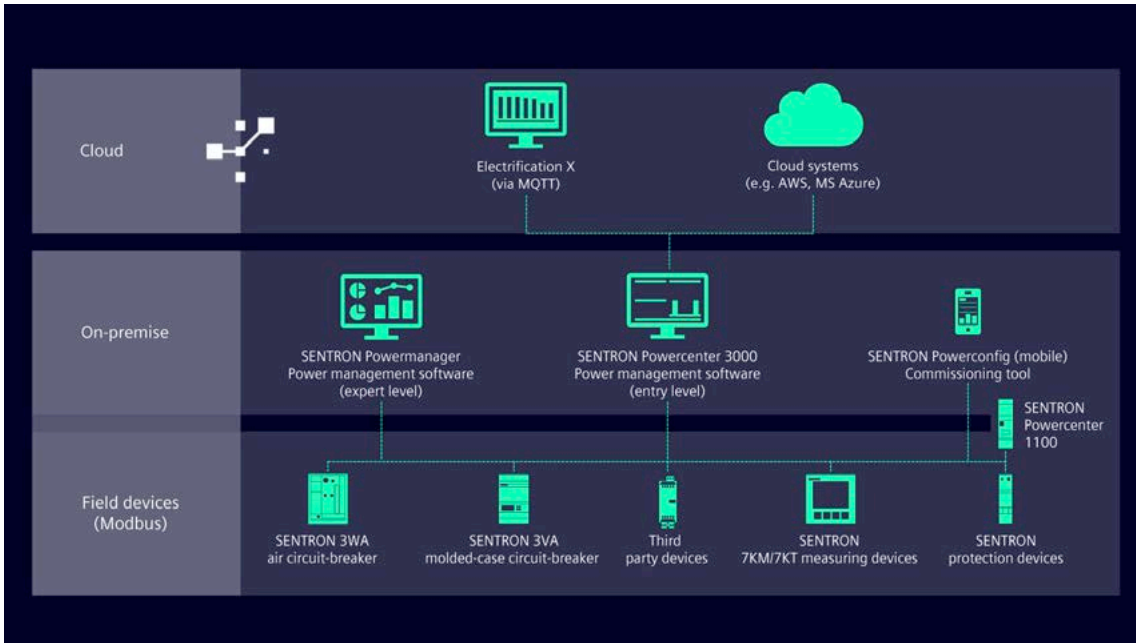


Figure 7: The SENTRON portfolio offers a perfectly coordinated concept of hardware, software and apps for successful condition monitoring.

Simple and time-saving commissioning of the field devices used is possible with the [SENTRON Powerconfig](#) configuration software. In addition, the free commissioning and service tool also enables the convenient operation and monitoring of the devices can also be conveniently operated and monitored during operation. This is made possible by displaying the result values of the health indicator and remaining lifetime per device in an easy-to-read format via the SENTRON Powerconfig user interface.

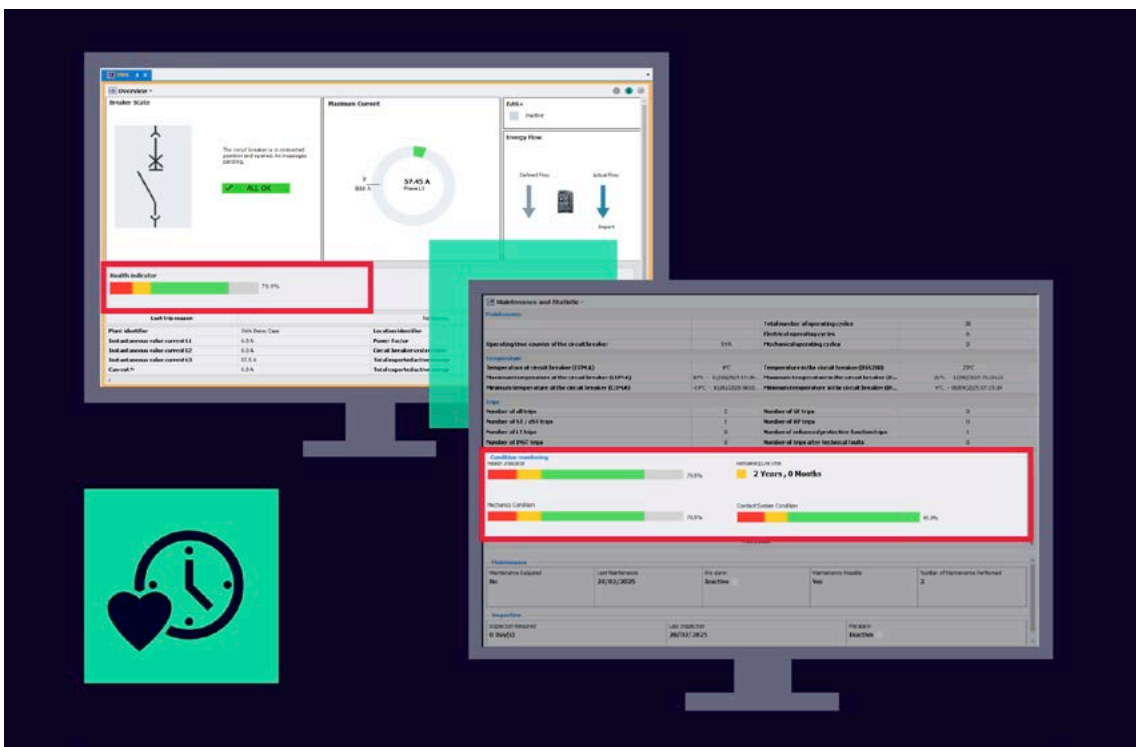


Figure 8: Display of status data in the SENTRON Powerconfig commissioning and service tool.

Comprehensive system overviews of the status values of all integrated components are available to operators in the SENTRON Powermanager and SENTRON Powercenter 3000 energy monitoring software as well as in cloud-based applications of the Siemens Xcelerator platform.

The [SENTRON Powermanager](#) expert software is suitable for monitoring the condition of large and complex switchgear systems. It allows the integration of up to 700 communication-capable field devices. All transmitted status data is collected and stored in the software and made available for further analysis. Since large systems in particular can quickly become confusing, the software is specially designed for demanding requirements to ensure a high degree of clarity in order to make data access simple and user-friendly.

It is also possible to securely expand the data transfer using the [SENTRON Powercenter 3000](#) energy monitoring software and cloud-based applications such as [Building X](#) or [Electrification X](#). The locally stored status data can therefore also be accessed on the move and across locations. A mobile cloud application is particularly useful for distributed systems or multiple properties so that data is available in real time and can be read and processed regardless of location and device.

The comprehensive system overviews for the health indicator and remaining lifetime in SENTRON Powermanager and SENTRON Powercenter 3000 offer operators a decisive advantage: Instead of individual data, the overall status of the system can always be monitored at a glance. In this way, condition-based maintenance activities can be planned and carried out even more easily and efficiently across all systems in terms of material and personnel resources.

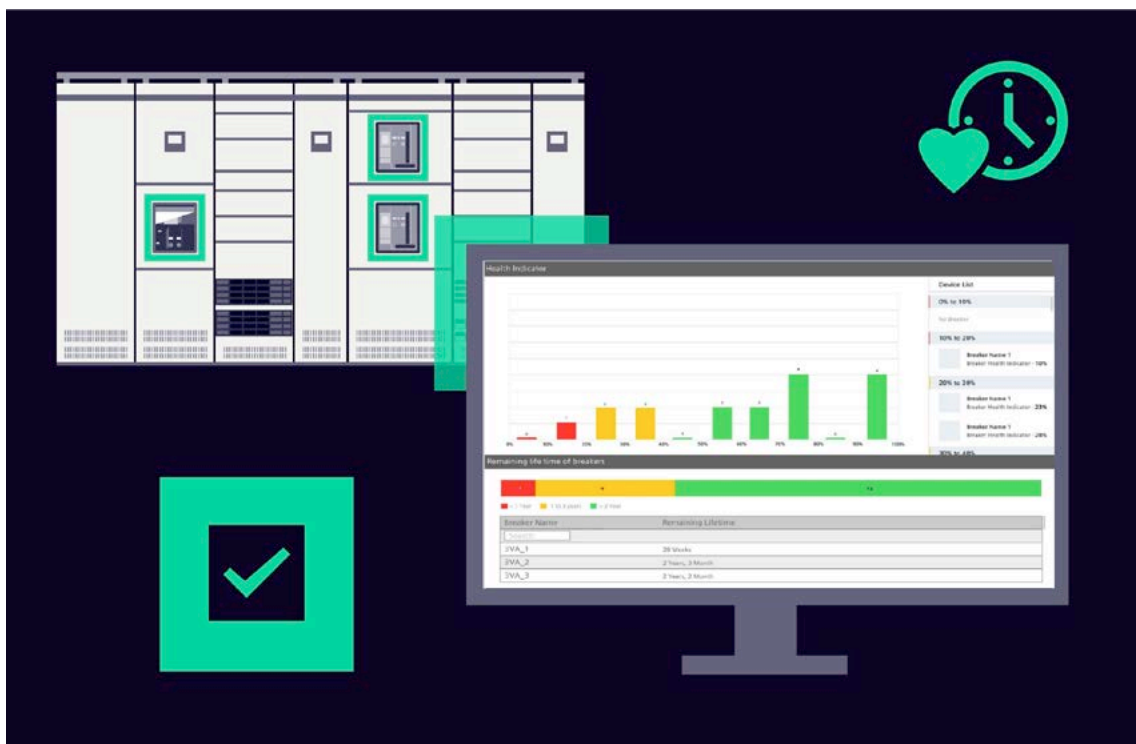


Figure 9: The system overviews in SENTRON Powermanager and SENTRON Powercenter 3000 ensure the clear and simple recording of the overall status of the system through the complete aggregation of the status data of all integrated devices.

In practice: **an application example**

The use of a condition monitoring concept with a focus on high-level user-friendliness pays off in practice in many cases.

Imagine the following scenario:



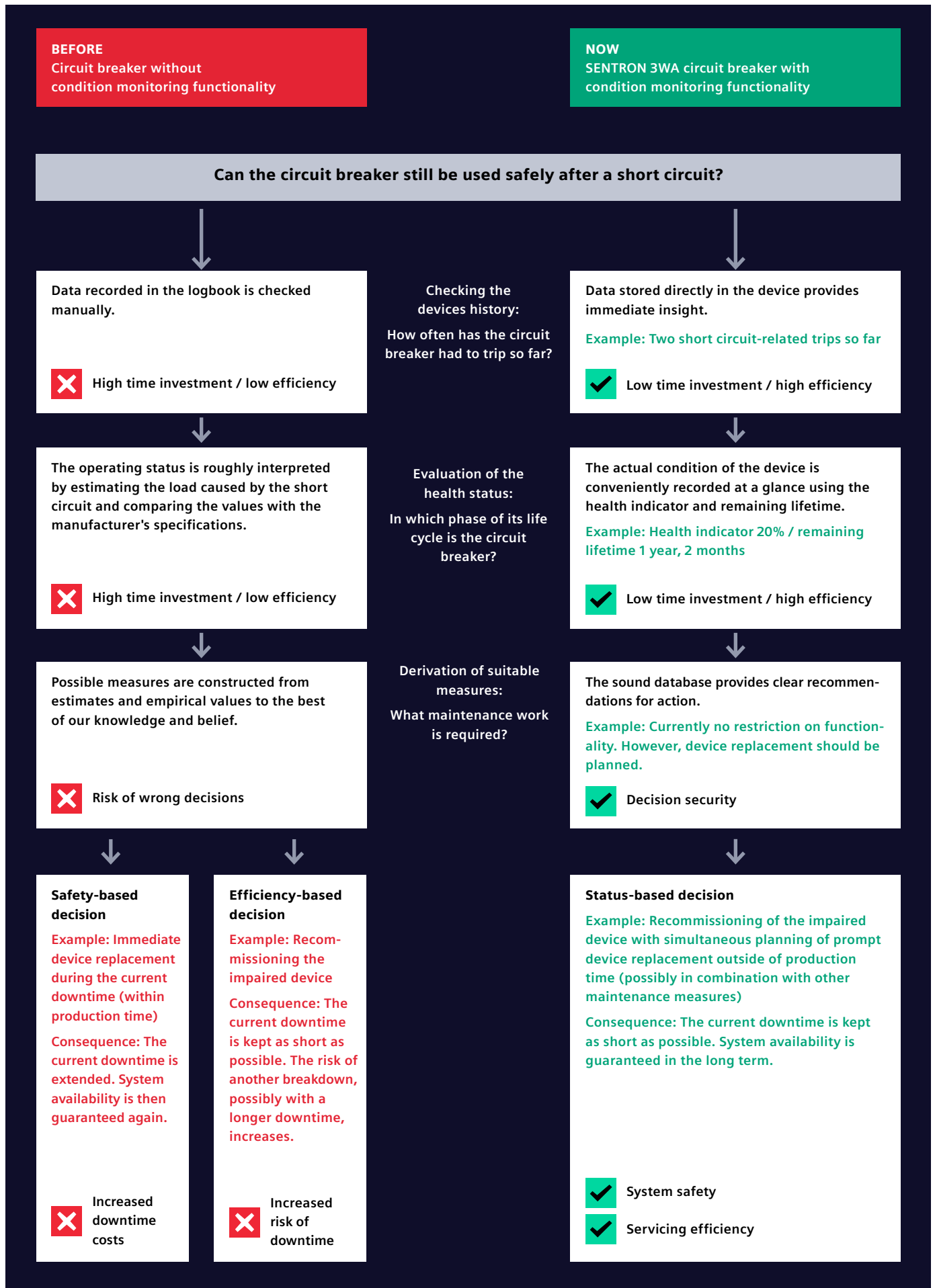
An employee accidentally damages a cable on a machine during a busy day of production. A short circuit is triggered. Fortunately, the circuit breaker responds correctly: It triggers automatically and immediately interrupts the power supply. This reliably protects the system from consequential damage. The service personnel can initiate the usual measures to restore the functionality of the system.

No matter how heroically the circuit breaker acts by absorbing current peaks – which can often be higher than the nominal current – the short circuit itself places a very high load on it. This can result in a sudden reduction in service life.

A single short circuit can abruptly reduce the health status of a circuit breaker by up to 33 percent.

How can system safety and availability be guaranteed in the future? Is the status of the circuit breaker sufficiently stable to continue to function safely and reliably in the event of another incident?

Until now, the current status of the circuit breaker after a short circuit could only be roughly estimated by service personnel after investing a great deal of effort. Today's modern, user-friendly solutions such as SENTRON 3WA and SENTRON 3VA offer meaningful performance indicators with clear recommendations for action. This significantly increases system safety and maintenance efficiency.



Summary: Six criteria for a successful condition monitoring concept

High system availability is essential for efficient and safe operation in low-voltage power distribution systems. The best way to achieve this is through preventive, condition-based maintenance. It therefore makes sense to integrate a suitable condition monitoring concept into the entire system. To maximize potential, it is advisable to focus primarily on user-centric concepts. Condition monitoring can only unfold its true value when it is not just technically convincing, but also provides specific support in use. In particular, clear and unambiguous performance indicators that provide specific recommendations for action offer great added value. What such practical added value can look like was demonstrated in the best practice solution presented with the health indicator and remaining lifetime of the SENTRON portfolio as well as in the practical application example described.

User-centered condition monitoring concepts bring considerable advantages for system operators: simple operating options without the need for additional specialist knowledge, reduced risk of misinterpretation, simple and efficient maintenance planning. Planners benefit in many ways, too. Clear and simple operating options provide useful arguments when advising customers, while a consistent overall concept with coordinated hardware and software increases planning reliability.

When planning and integrating a successful condition monitoring concept with a user-oriented focus, it is advisable to consider the following basic criteria:

1. The right basis

Only select components that have suitable measurement and communication functionality. The investment costs may be slightly higher, but they will quickly pay for themselves.

2. Overall concept instead of isolated solution

Opt for an integrated system with coordinated hardware and software. This ensures simple integration and full compatibility. Ideally, choose system solutions that offer a wide range of application options. This means that your concept can be expanded at a later date if required.

3. Clear performance indicators

Only the meaningful and context-related evaluation of device data creates a usable database. Place value on the availability of relevant and clear performance indicators – such as the health indicator and the remaining lifetime in the SENTRON portfolio. These allow the clear derivation of necessary measures.

4. Clear recommendations for action

Clear performance indicators are good; clear recommendations for action are even better. Successful condition monitoring solutions leave no room for interpretation when deriving the necessary measures. For the greatest possible success, choose solutions that communicate the identified need for action in a specific, unequivocal way.

5. Intuitive operation

Ensure easy data access as well as clear and comprehensible navigation in the system to make it as convenient as possible to use. This prevents frustration or operating errors by service staff. What's more, user-friendliness starts with commissioning and configuration. Bear in mind that this can also be implemented with existing resources and without specialist knowledge.

6. Complete transparency

Pay attention to ALL relevant system components – even those that mainly operate in the background. It is often the “hidden champions”, such as circuit breakers, whose failure can have a particularly critical impact. It is therefore essential that you also include these components in your condition monitoring concept.

Additional information

Websites

Condition monitoring for low-voltage power distribution

[Condition monitoring – Siemens](#)

Products

SENTRON 3VA molded case circuit breaker – sophisticated, modular, highly variable

[SENTRON 3VA molded case circuit breaker – Siemens](#)

SENTRON 3WA air circuit breaker – the basis for greater efficiency in switchgear

[SENTRON 3WA air circuit breaker – Siemens](#)

Software

SENTRON Powermanager – energy monitoring for smart infrastructures

[SENTRON Powermanager – Siemens](#)

SENTRON Powercenter 3000 – the simple solution for transparent power distribution

[SENTRON Powercenter 3000 – Siemens](#)

Publisher:

Siemens AG
Smart Infrastructure
Electrical Products
Siemensstraße 10
93055 Regensburg, Germany

Order number: SIEP-T10466-00-7600

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