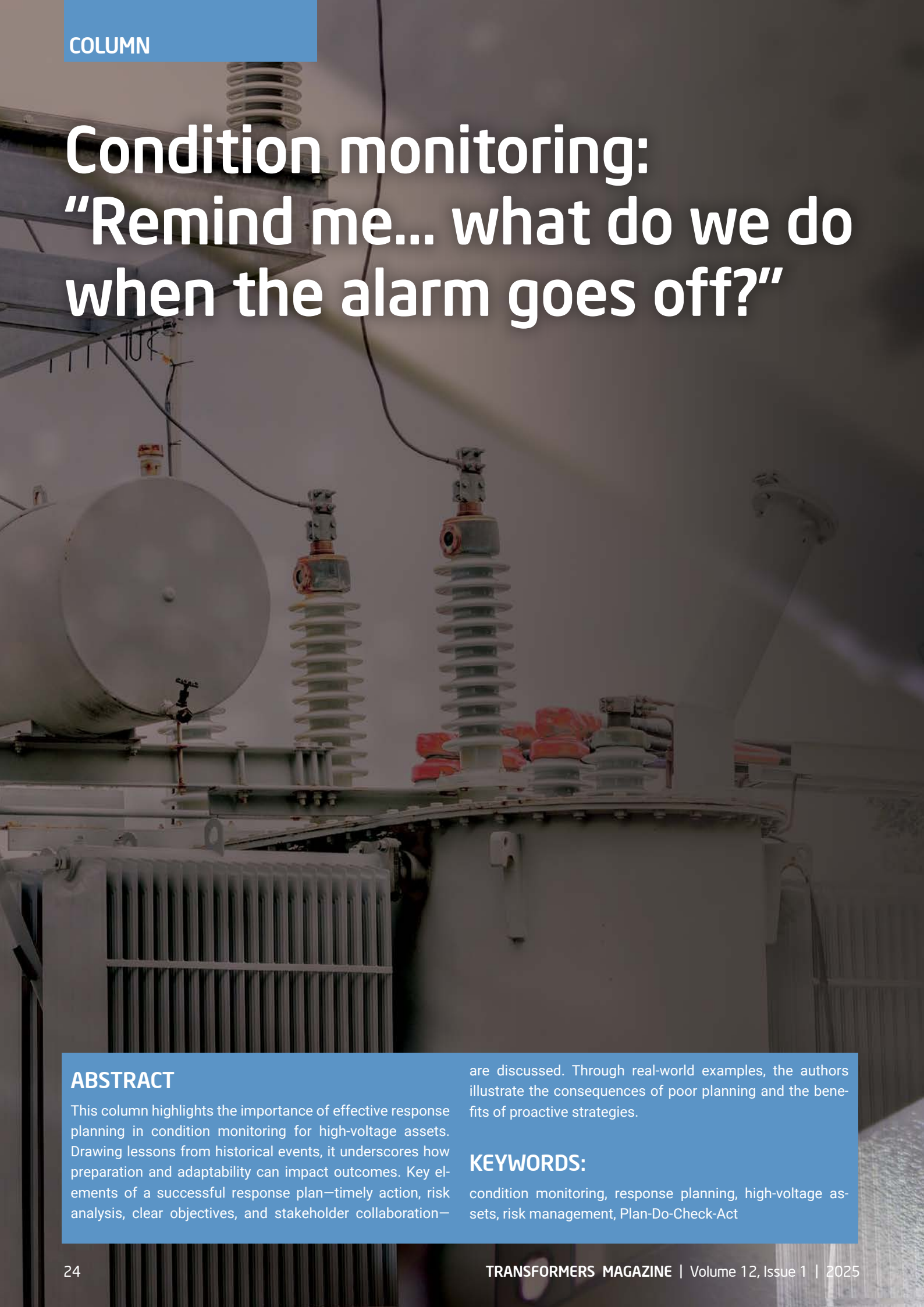
Condition monitoring: "Remind me... what do we do when the alarm goes off?"



ABSTRACT

This column highlights the importance of effective response planning in condition monitoring for high-voltage assets. Drawing lessons from historical events, it underscores how preparation and adaptability can impact outcomes. Key elements of a successful response plan—timely action, risk analysis, clear objectives, and stakeholder collaboration—are discussed. Through real-world examples, the authors illustrate the consequences of poor planning and the benefits of proactive strategies.

KEYWORDS:

condition monitoring, response planning, high-voltage assets, risk management, Plan-Do-Check-Act

Planning is about knowing where we are, where we are going, the various scenarios which we may encounter along the way, and how to manage our response to those scenarios

The Race to the South Pole

Norwegian Roald Amundsen and Briton Robert Falcon Scott were in a "race to the south pole" over a hundred years ago. The South Pole is an unhospitable location: gale force winds, extensive storms, minus 40oC temperatures and more. Amundsen and Scott were both famous in their time, and set off on their different >2500 km return journeys within a few days of each other. Some of their differences in planning and preparation are interesting:

- Amundsen spent time with the Inuit people of Northern Canada, learning to cope with the environment he would be in, and learning to dogsled, which is the mode of transport he used at the South Pole; Scott decided on ponies and new, untested motorized sledges, but the ponies died and the motor sledges failed, leaving Scott and his companions to pull their own sleds, slowing them down and exhausting them
- Amundsen and his team of 5 had three tons of supplies which were distributed in "caches" on the outbound journey, clearly marked with flags, for use on the return journey and carried enough with them such that if they missed a cache, it wouldn't be fatal; Scott had one ton of supplies for his team of 17, also distributed along the route, but if they missed one cache, it would likely be the end of them

Amundsen arrived at the South Pole almost exactly on the day he had planned to, and returned to base, reaching it on the precise day planned. As Amundsen reached the pole, Scott was still 360 miles away, taking another 5 weeks to get to the pole, with the team pulling sleds themselves. Amundsen planned and prepared and was, ultimately, well on his way back to Norway when Scott and his team succumbed to starvation and frostbite.

Introduction

"If you fail to plan, then you are planning to fail," is an interesting quotation often attributed to Benjamin Franklin, even though there's no evidence he actually said it. It seems to be a statement of the "obvious" as, without a plan, we could be in trouble not knowing what to do next. The process of planning is key, as per Winston Churchill's statement: "Plans are of very little importance, but planning is everything". Planning is about knowing where we are, where we are going, the various scenarios which we may encounter along the way, and how to manage our response to those scenarios. In terms of condition monitoring, what do we plan to do when the alarm goes off? And how do we come up with a "good" plan? Check 'The Race to the South Pole' box.

Planning doesn't guarantee success, but it does improve your chances: informed decisions, flexibility in response to changing situations, a focus on objectives. One of my managers at a transmission company used to say: "It's just a plan," meaning that we have to have alternatives should the present plan not be sufficient to cope with reality.

Steps toward a "good" condition monitoring response plan

A good response plan is timely, agreed, risk analyzed, appropriate, documented and auditable. In a condition monitoring context:

1. What is the aim of the monitor? Are we looking for incipient failure modes, or to indicate the need for maintenance? Something else? This needs to be clear as even though avoiding failure and initiating maintenance are related, they may have significantly different consequences and urgency for a response plan.
2. Understand the data: what is actually measured, what is derived and what the numbers mean, and that's whether

it's a temperature, a calculated power factor, a dissolved gas ppm level, or whatever. It's very useful to know how raw data is converted into useful data: a set of currents into a set of power factors, for example, so we can understand what may impact that analysis and the result.

3. How does the data relate to symptoms of asset deterioration and/or failure modes? If we are looking to *detect* an issue that is one thing, but looking to *diagnose* an issue may need a lot more data and analyses: how does what we measure relate to our objectives?
4. Set expectations: what do we think is the raw data going to be – value, range, units of measure nd so on. For example, we may have a bushing nameplate capacitance of 568 pF, what would we expect to see in the measurements we make in an online bushing monitor? Within what range would we say the measurement is acceptable? How do we set alerts for when we leave that range? Are we applying relevant standards and/or guidelines for the industry? Are there any such guidelines for a monitored value?
5. How is the data getting to us, the end user? Do any of the data systems between the sensor and the output impact the quality or value of the data? How does that impact our ability to trust the data?
6. How many alert levels will we have, and what will they represent in terms of urgency? How do we communicate that urgency?
7. For analyses, how do we differentiate between "noise" in the data and a rising trend? PD levels in a transformer main tank can spike when there is a tap changer operation, or a breaker operation – do we need to alert on these, or wait, instead, for a "sustained" PD level rise? What of "chattering alarms" or "alarm fatigue" resulting n an alarm being ignored? These are possibilities and need to be addressed.
8. Understand the risk: if we have a failure, what are the consequences? Our response has to be commensurate with the urgency and impact of an event or a failure to meet our objective.
9. Have we identified all possible scenarios which would cause data to change and how urgent they are? Have we included stakeholders in the discussion, and addressed their concerns and their experiences and expectations?
10. Have we dealt with the "what-ifs?" if our planned response is to take an oil sample, would that be safe? Do we need to de-energize first? How will we prioritize alarms if several are generated simultaneously?
11. How will we audit response plans acted upon? We need to make sure everything went well, and identify areas where we can improve. Have we documented alert communication requirements, selected the relevant individuals for any alert, and checked that communications have been successful: sending an SMS alert is one thing, but noting has been received and activity initiated as a result is something else.

A good response plan is timely, agreed, risk analyzed, appropriate, documented and auditable

So, what makes a good plan? It addresses all the points above through preparation and collaboration within an organization.

The Plan-Do-Check-Act Deming Cycle was developed in the 1940s. The philosophy it presents is still relevant when preparing for an eventual alert on a high voltage asset, though with a few twists. Asset owners need to PLAN for the outcomes we want based on the inputs we receive, we need to be prepared to take and DO specific agreed actions to prevent damage and degradation. Then CHECK to see if our actions were correct and perhaps even follow up with review of the core systems ability to provide reliable indication and then we have to take ACT to improve our response the next time around.

Planning doesn't guarantee success, but it does improve your chances

There can be problems with nuisance alerts, but this requires that the cause of the nuisance is identified and dealt with.

Some examples of poor planning/implementation:

1. If your response to an elevated DGA level from an online oil monitor on a power transformer is to take a sample for lab test, then remember the Dominion Energy story where a transformer failed while the field guys stood next to it, taking a sample for a lab test. Would you want to be the one taking that sample? Dominion Energy now has protocols for de-energization before sampling, depending on the gas levels.
2. Three Mile Island nuclear reactor almost went into melt down due to a stuck valve – the valve indicator light in the control room did not reflect the actual position of the valve but reflected the status of the switch used to operate the valve; the valve had remained open and operators, having only the light for indication, did not realize that there was a 'loss of coolant' event which could have lead to a core meltdown. The valve indicator light needed to be a monitor of the actual valve!
3. A temperature alert from a 660 MVA generator was relayed to the control room but was just one of many alerts they received. The alert was acknowledged but no action taken, and no operational staff informed, leading to the monitor not issuing subsequent alerts and the generator failing some weeks later. Alert management protocols needed to include appropriate staff to ensure the right people can address alerts. And the right people are informed and can follow the previously agreed plan.

And here is an example of good planning/implementation: A generator station in western USA had a bushing monitor issue an alert for elevated power factor some months after it was installed; the transformer was de-energized immediately for offline tests confirming a bushing with advanced deterioration which was removed and replaced successfully. The power factor level at which the transformer would be de-energized was agreed when the monitor was installed, as was the requirement for offline test and subsequent replacement. When the alert came in, the right people were informed and the action plan followed and a successful "save" ensued.

There can be problems with nuisance alerts, but this requires that the cause of the nuisance is identified and dealt with. In PD, for example, to avoid "chatter" we may require that two or three successive readings exceed a threshold before we believe it is a "true" alert. Such denoising is relatively straightforward to implement, but we have to include all stakeholders in order to make sure we don't miss an "important" alert.

So, what do we do when the alarm goes off? We implement the plan we all agreed last time we reviewed our alarm settings.

"Proper planning prevents poor performance" is the motto, but we have to remember that we cannot foresee everything, and we need to follow the plan if possible, but flex our response if required.

So, what do we do when the alarm goes off?

Authors

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