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Cable Tie Performance under UV Radiation.

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Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE) releases report on tests commissioned by HellermannTyton.

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UV stabilized cable ties for long-term efficiency and safety

In 2020 Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE) released a report on tests commissioned by HellermannTyton to determine the ageing resistance of selected cable management solutions (including cable ties) under solar irradiance. The following white paper looks at the results of the tests, and the effect of artificial UV irradiance on various plastic material cable ties in a test cabinet in comparison with natural UV irradiance outdoors. It also provides background on how the tests were conducted.

Photovoltaics (PV) is a growing market and plays an important role in reducing the carbon footprint of energy generation. The efficiency of such PV installations has a direct impact on the economic sustainability of this clean energy source.

However, the long-term efficiency of PV installations depends on many different factors, and this includes using the most suitable cable management systems in PV installations. Inefficiencies due to unsuitable cable management systems can lead to increased maintenance and downtime, jeopardize efficiency, and may endanger personnel. The outcome will be higher cost both financially and in terms of safety. It is against this background that HellermannTyton commissioned Fraunhofer ISE to conduct testing to acquire data on cable tie resistance to UV light.

PV installations are today found in a wide range of climate zones. Fraunhofer ISE conducted tests at two outdoor locations. One of these was in the city of Freiburg, located in southwest Germany with a continental Central European climate. The second outdoor test location was in the Negev Desert in Israel, which has a UV intensity approximately twice that of Freiburg. Three years of solar irradiation in the Negev Desert (the duration of the outdoor real-timetest) corresponds to six years in Central Europe, depending on local specific conditions. This has significant implications for the anticipated longevity of a cable tie in terms of exposure to UV radiation.

After only 200 hours in the test cabinet under artificial UV irradiation in Freiburg, natural coloured polyamide 6.6 cable ties showed significant UV damage and the loop tensilestrength of non-UV stabilized material fell to less than 50% of its original value. In contrast, UV-stabilized polyamide 6.6 cable ties showed only negligible degradation to UV exposure. These results are affirmed by real-time testing at the outdoor locations.

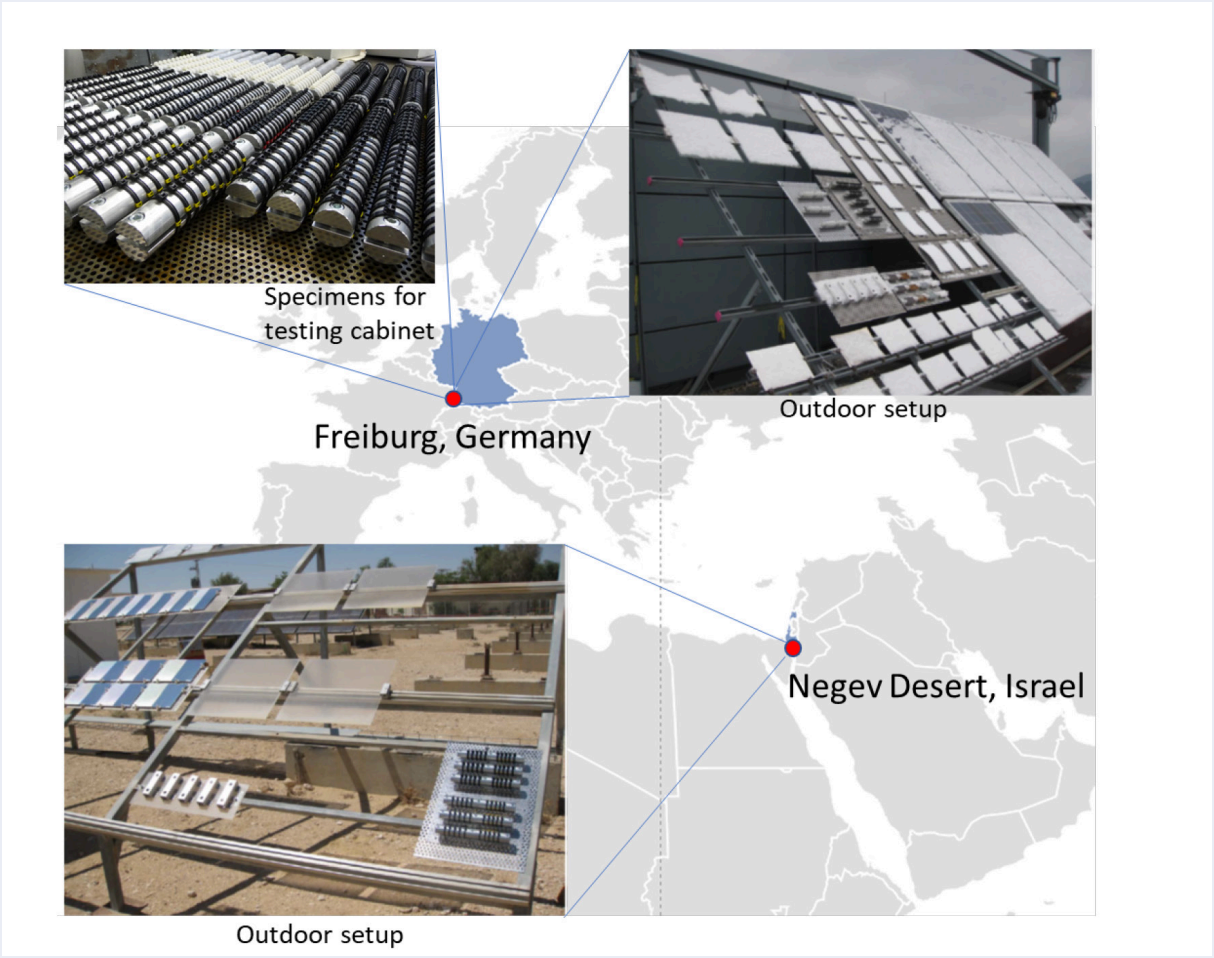
Georg Neureiter
Market Manager Renewable Energies EMEA

"The report on ageing resistance to UV irradiation affects the longevity of cable ties, and UV stabilized wire management solutions are a key contributor to the longterm efficiency and safety of PV solar panel installations. Tests showed that we can expect UV stabilized polyamide 6.6 cable ties to perform for at least six years in a central European climate, and at least three years under UV conditions equivalent to the Negev Desert."

How were the tests performed?

The testing cabinet under artificial accelerated UV exposure located in Freiburg provided a first dataset for a total exposure of 1600hrs. In order to compare and confirm the testing chamber results, two additional outdoor locations has been chosen. One was again in the city of Freiburg, located in southwest Germany with a continental Central European climate. The second outdoor test location was in the Negev Desert in Israel, which has a UV intensity approximately twice that of Freiburg. The testing chamber and both outdoor test sites are operated by Fraunhofer ISE.

Figure 1 Setup of test scenario with test sites



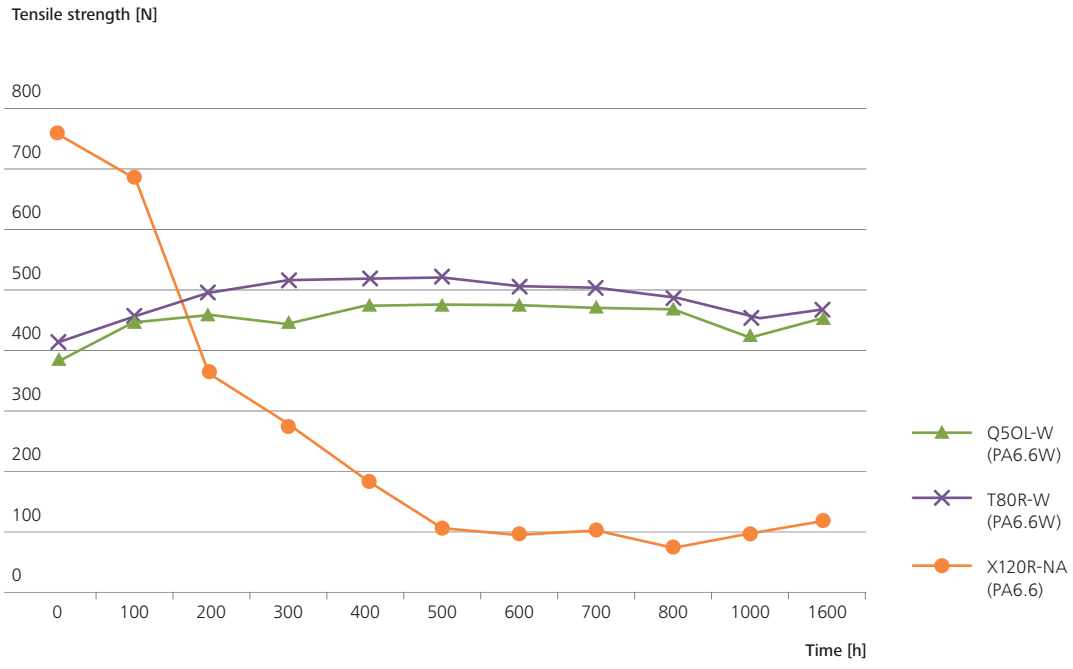
1. Artificial accelerated UV weathering (in test cabinet)

The cable ties were pre-fixed and tensioned under load with half of their specified tensile strength to metal cylinders and exposed to 156.78 kWh/m2 of specific UV radiation for a total of 1600 hours at controlled intervals.

The UV test corresponds with IEC 61215, position 10.10 (Terrestrial photovoltaic [PV] modules – Design qualification and type approval). This widely recognized test for solar modules requires a minimum UV dose of 15kWh/m². In this setup, the cable ties have therefore been exposed to 10 times (156.78 kWh/m2) the minimum dose.

Tensile strength testing was conducted according to DIN EN 62275; paragraph 9.5.1. by Association for Electrical, Electronic & Information Technologies (https://www.vde.com/en; Verband der Elektrotechnik Elektronik Informationstechnik e.V., VDE).

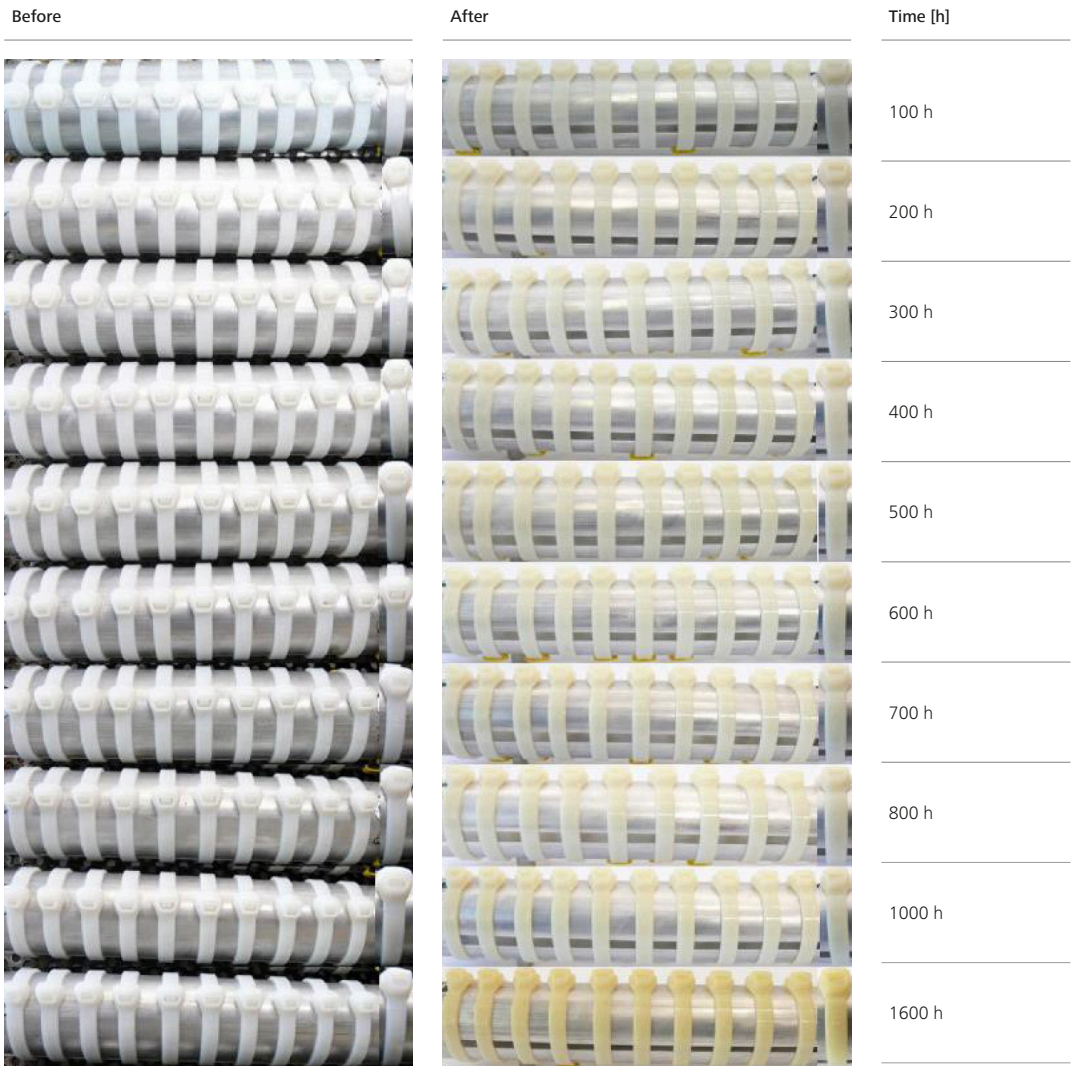
Figure 2 Testing cabinet test results



The initial tensile strength of the X120R-NA cable tie at the start of the test is higher due to a larger cable tie dimension (7.7 mm wide) compared to the Q50L-W and T80R-W (both 4.7 mm wide). The latter two cable ties made of UV stabilized polyamide 6.6 (PA6.6W) show no degradation after exposure in the testing cabinet.

Figure 3 below visually documents the change that took place in the course of 1600 hours when the cable ties were exposed to artificial UV irradiance. Discolouration is apparent even after 100 hours, and the natural coloured X120R-NA cable tie (polyamide 6.6) exhibited a significant loss of tensile strength after 21.0 kWh/m² (200 hours).

Figure 3 "Before" and "After" comparison of the X120R-NA cable ties under artificial UV conditions*



* Discolouration is apparent

2. Outdoor exposure to natural sunlight

Over a period of three years, specimens were tested in outdoor conditions in Freiburg, and in the Negev Desert. Over this three year period, samples were removed, visually inspected, and tested for tensile strength. Testing of tensile strength was again conducted by the independent laboratory of the VDE.

Figure 4 T120R-W outdoor Freiburg exposure test

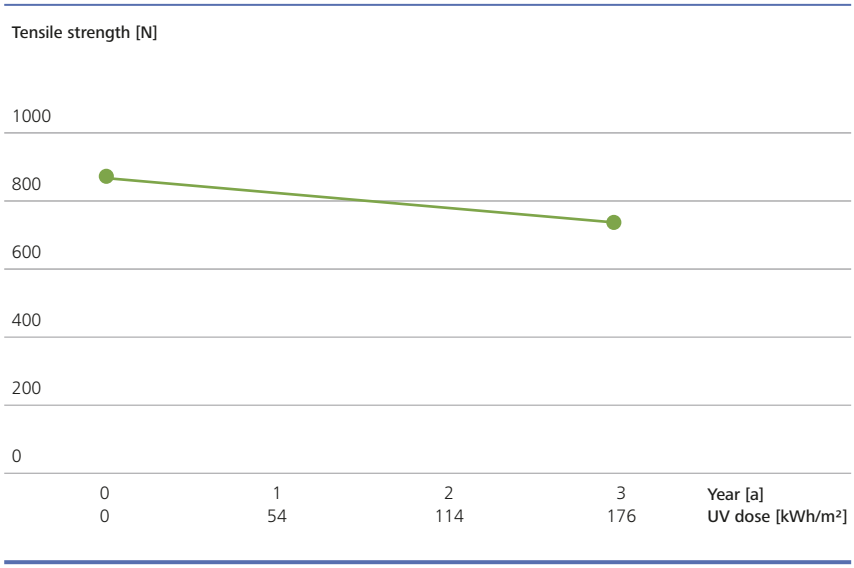


Figure 5 T80R-W Negev Desert exposure test results

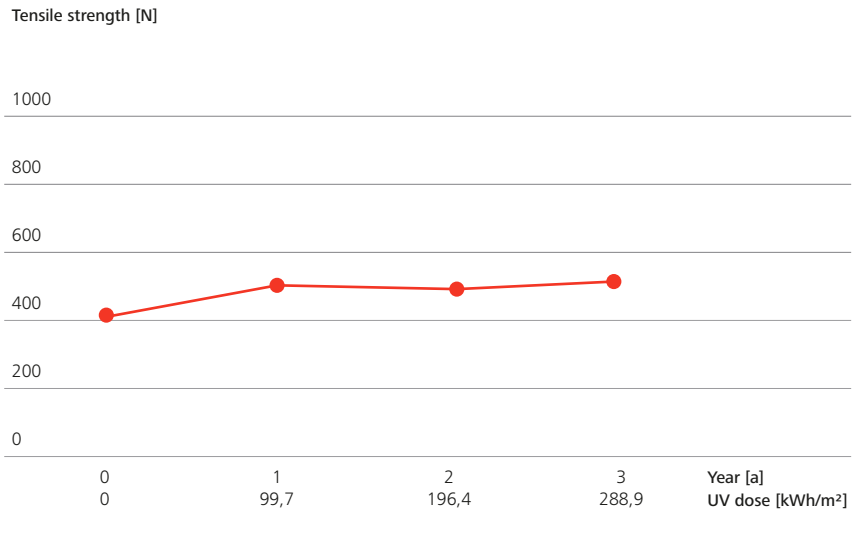
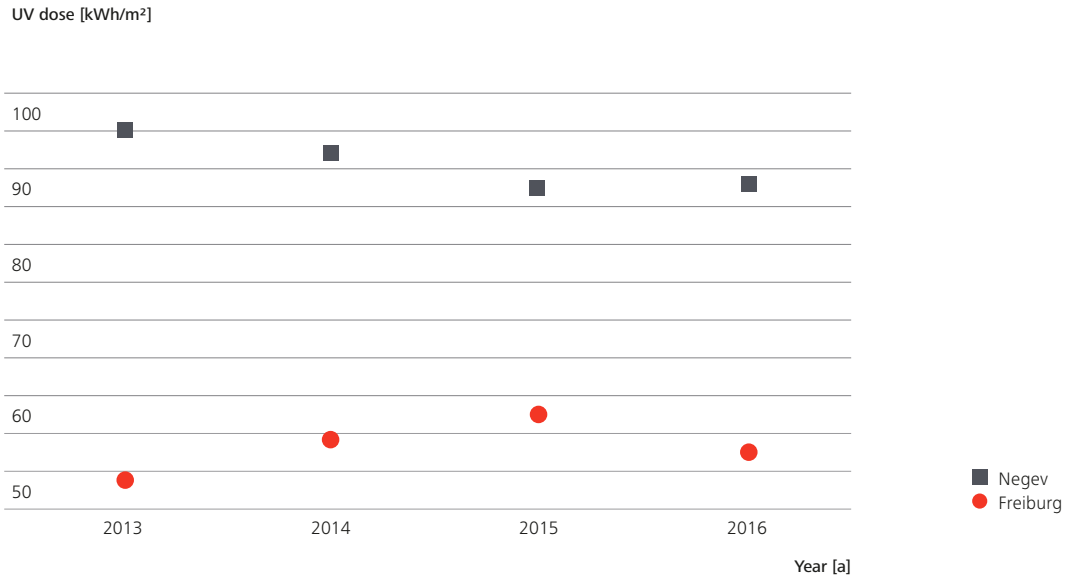


Figure 6 below depicts the UV dose outdoors in Freiburg compared to the Negev Desert. This is important as it shows that Freiburg receives approximately half the dose of Negev, which has implications for comparing ageing resistance between Freiburg and the Negev Desert. It should also be noted that due to the nature and local weather conditions, UV irradiation is not constant and varies from year to year.

Figure 6 Performance of Materials



Results of UV Radiation

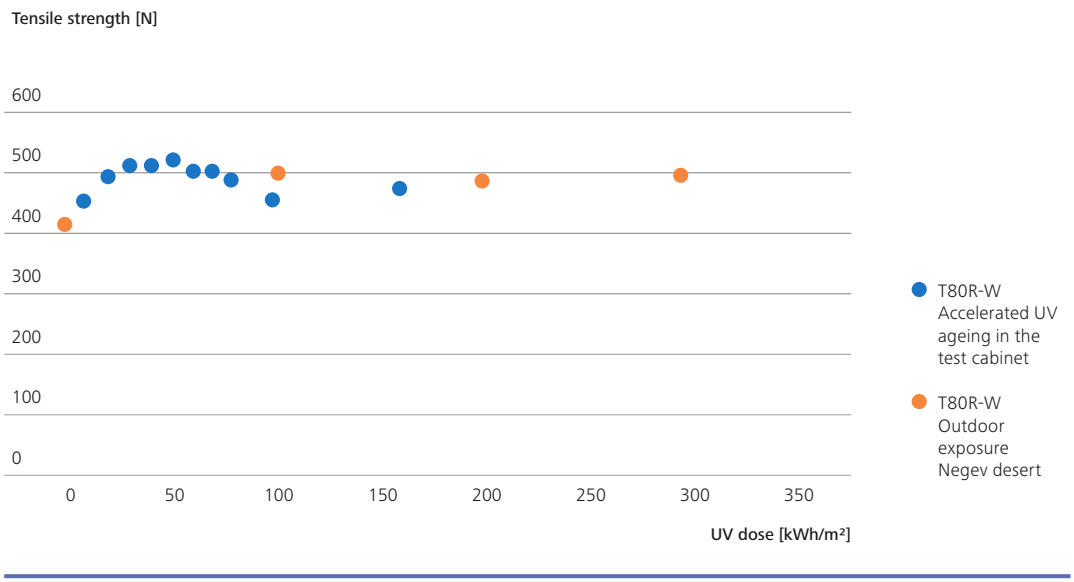
A feature of the test was that UV intensity in the cabinet was higher than in natural sunlight in the UV spectrum wavelength range of 280-390 nm. It was therefore an "accelerated exposure test". There are clear and obvious limits to comparing accelerated chamber exposure tests to those conducted under real conditions outdoors. However, if we assume that solar radiation in Freiburg is approximately 1000 kWh/m² per year, and around 5% of this is UV radiation, then the 1600 hours of artificial UV radiation in the cabinet corresponds to approximately three years of UV radiation outdoors in Freiburg, but only 1.5 years in Negev (due to the higher amount of UV radiation in Negev).

"When conducting the tests, it was important to work for comparable results under artificial UV conditions and real conditions outdoors in the Negev Desert. However, exposing cable ties to excessive UV irradiance under artificial conditions provides very useful results but is unlikely to provide a complete picture of weathering for these types of plastic material."

Dr. Karl-Anders Weiß
Business Developer Service Life and Sustainability,
Fraunhofer-Institut für Solare Energiesysteme ISE

In Figure 7 below, the T80R-W tie made of UV stabilized polyamide 6.6 material shows a correlation of tensile strength values after exposure to equivalent artificial UV radiation in the testing cabinet and real light conditions outdoors.

Figure 7 Comparison of T80R-W performance in the test cabinet and outdoors in the Negev Desert



The important conclusion we can draw from testing performed by Fraunhofer ISE is that three years of UV exposure in Negev (the duration of testing outdoors) demonstrates there would be no significant loss in tensile strength for a period of 6 years (possibly longer) in Freiburg in a Central European location for a UV stabilized polyamide 6.6 cable tie.

In terms of lifespan of cable ties, although UV exposure is a significant factor, it is of course not the only reason why cable ties lose tensile strength or fail. Other factors in solar PV installations such as movement due to wind or trackers, local climatic conditions, and chemical reactions (e.g. salt in maritime climates, or chemicals used in agrivoltaic) also affect the condition of a cable tie over time.

In conclusion, the report provides an extremely valuable insight into a major factor affecting cable tie performance, and results align with the expectations of HellermannTyton in regard to performance, UV exposure and the significantly greater ageing resistance of UV-stabilized cable ties. In the meantime, HellermannTyton is continuing to acquire even more data on cable ties by establishing a test site in Morocco, where the company will conduct long–term testing over a period of 30 years.

Contact

If you have any questions on specific solutions or would just like to receive more information, we are happy to help – with all our experience and with technical know-how.

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