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Hunting Mighty Milliwatts

The next technology step enables monitoring of these elusive elements, with their potentially catastrophic energy, BEFORE they can cause a major power failure

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7x24 Exchange
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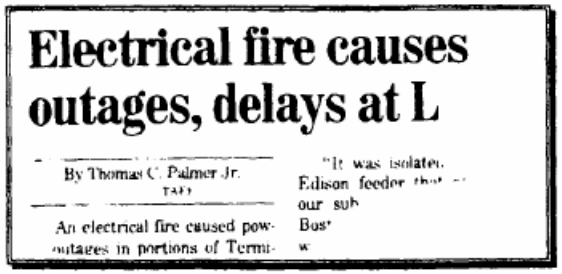
Headlines We Might Avoid



Electrical fire causes outages, delays at L

By Thomas C. Palmer Jr.
STAFF

An electrical fire caused pow- outages in portions of Termi-

"It was isolated. Edison feeder that our sub Bus w

The show goes on after electrical fire quashed

By Desiree French
STAFF

The show almost did not go on last night at the Opera House

Two hours before the Opera Company presented its season premiere, Puccini's "Madama Butterfly," power that had been lost

Opera House's stage door – ex- ploded and burst into flames, spew- ing billows of smoke into the theater and causing a nine-hour power out- age in four buildings along Mason Street.

The fire department battled the electrical blaze with foam for more than two hours and was able to pre- vent it from spreading to adjacent buildings.

when the explosion occurred. No one was injured. But the theater filled with smoke, however, a few DCB staffers fled to the Lafayette Hotel, where they pondered whether open- ing night would indeed take place.

Unsuspecting patrons looking to purchase tickets for the evening's performance were also surprised when they were told that the ticket

working in the area for two days to repair a collapsed sewer line.

executive director of the Water and Sewer Department, said the explosion and the work un- dertaken by his crew, however, were unrelated. "The only involvement we had in it," he said, "is that the explo- sion also blew the cover off one of our manholes and we were asked to be a part of the inspection. No one

Man dies, 1 injured in Garden explosion

By Matthew Brelis
STAFF

An electrician was electrocuted and another critically injured den early yesterday caused a 2,400-volt shoot through th which they

Massive Switch and Data Center Power Outage

Power Outage Knocks Wikipedia Offline

Power Outage Knocks LiveJournal Blogs Offline

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What is a Mighty Milliwatt (MmW)?

- Small amounts of resistive energy losses converted to heat from electrical circuit elements in high power electrical systems, usually at connections, manifested as temperature rise above ambient.

- 0.001 Watt in resitive energy lost by circuits using kiloWatts to megaWatts of power, or less than 0.0001% of the energy transmitted.

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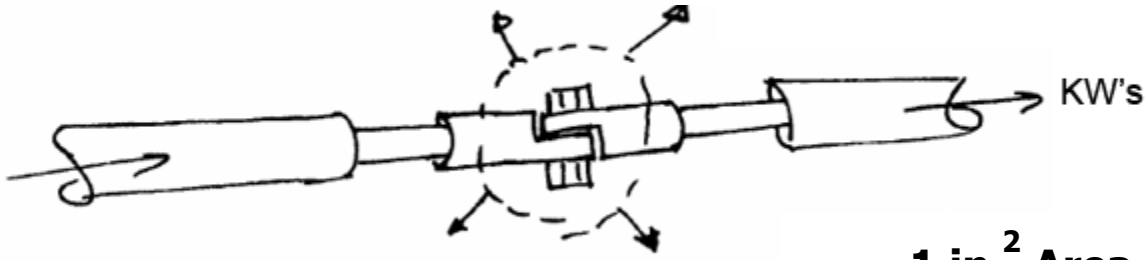
What is a Mighty Milliwatt (MmW)?

Lets Calculate it:

1°F Warmer than Ambient



≃ 1 in ^{2} Area

$$q = h_r \times A \times (T - T_A)$$

$$= 1 \times \frac{1}{144} \times 1 = .007 \quad \text{Btu/hr Ft}^2$$

Convert to Watts $.007 \div 3.4 = .002$ Watts

$= 2$ Milliwatts

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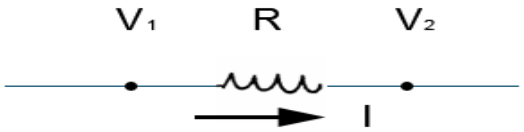
What Creates a Mighty Milliwatt ?

Resistance and Current! ⟶ the Manywatts



V = Voltage Volts
R = Resistance Ω
I = Current Amps

$P = I^2 \times R$ = Heat Dissipated as MmW

Calculate R for 2MmW (1°F Rise)

For 100 Amp Cable

$P = .002 = I^2R = (100)^2R$

$$R = \frac{.002}{(100)^2} = \frac{.002}{10{,}000} = .0000002\ \Omega$$

$$\frac{2}{10{,}000{,}000}$$

An OHM Meter Won't Work Too Well!!

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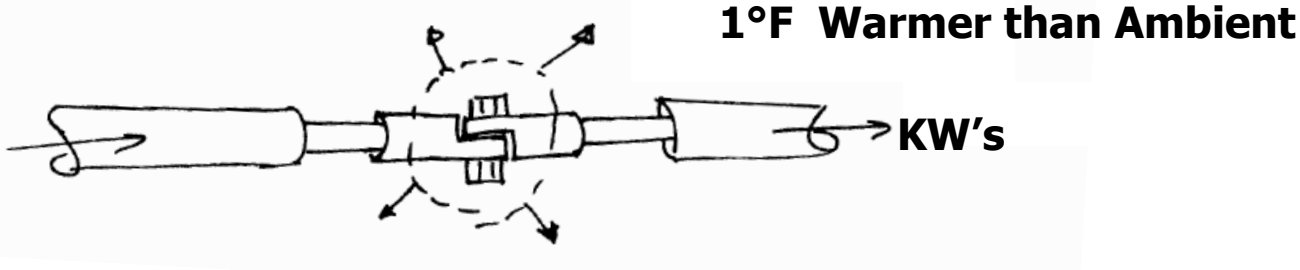
What Can a Mighty Milliwatt Do?



Suppose the connection loosens with time and oxidation to R ⟶ I Ω ?

For 100 Amp Circuit

$$\text{Power} = I^2 R = (100)^2 (1) = 10{,}000 \text{ w}$$

$$= 10\text{kw}$$

Mighty MilliWatt turns into 10 kW, enough energy to melt 1 ounce of copper in 0.6 seconds -> Catastrophic Failure

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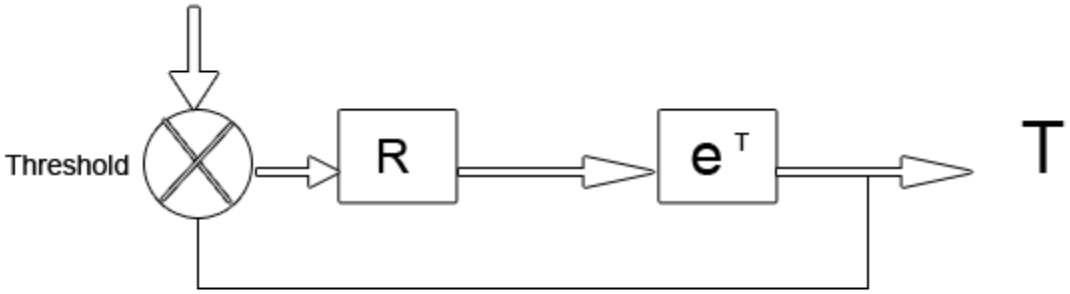
How does that Happen?

When the Resistive Loss exceeds a threshold value, the temperature increase causes rapid and irreversible increase in R, triggering positive feedback system that leads to Complete Failure of the connection.



Power α R α e^T

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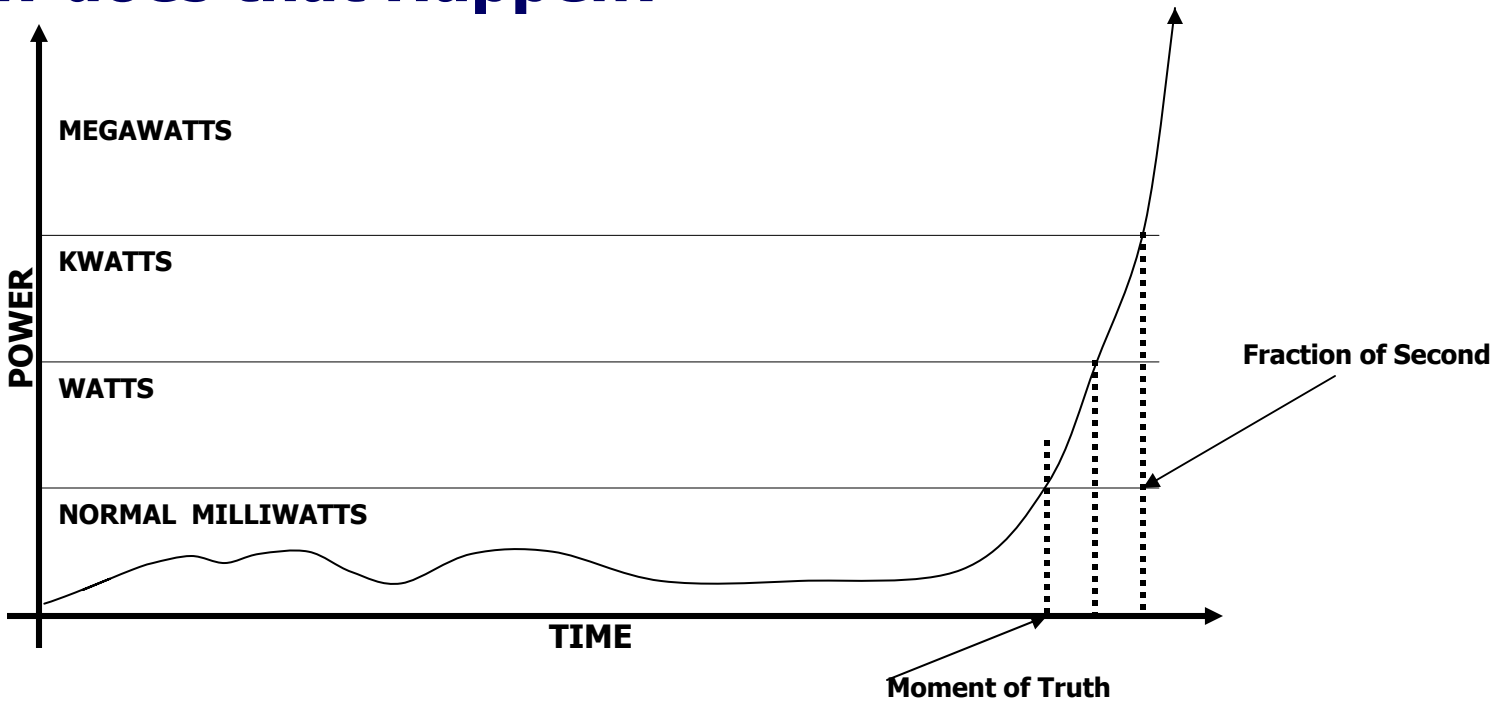
How does that Happen?



If the cause of the resistive loss is not corrected at a safe threshold, there is a risk that the runaway positive feed back will occur.

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How do we find Mighty MilliWatts?

- The resistive energy is lost approximately ½ by radiation and ½ by convection to the local environment.

- The radiation component is detectable by infrared radiation methods of sufficient sensitivity and reliability as temperature rise above ambient.

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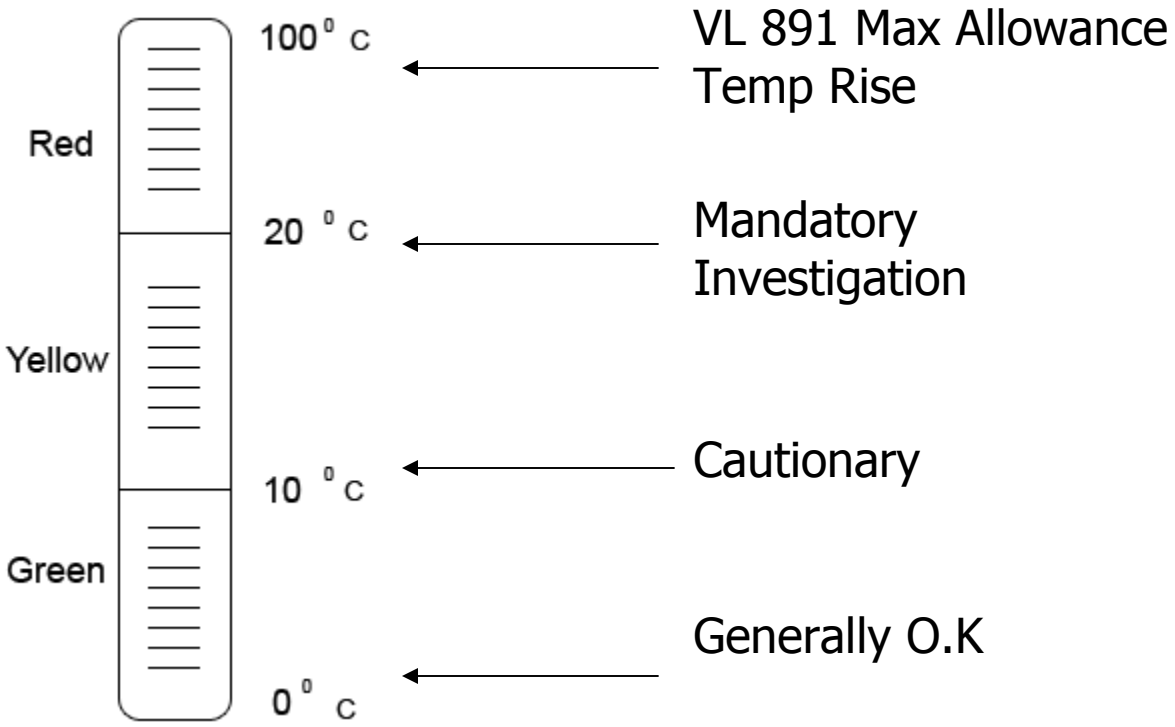
How hot is too hot?



Best general method is setting alarm limits on temperature rise above ambient.

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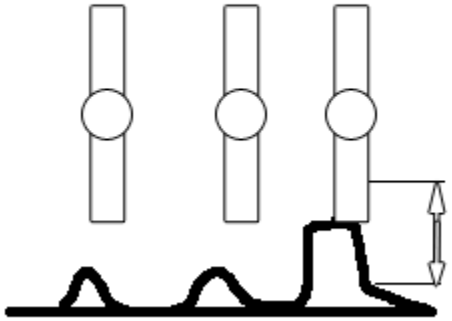
Improvements in detection?

Mighty MilliWatts are lone creatures - they don't normally bunch together



any Lurking

Mighty Milliwatt !

Detection by exception is very effective, since it is very unlikely to have 2 or more faults that appear simultaneously. Also effective is temperature rate of change threshold.

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Continuous monitoring is required

$\triangle T \propto P \propto I^2 R$

Temperature rise is very sensitive to load.
Factor of 3 in Load changes $\triangle T$ by factor of 10

- Scheduled scans will not be at the peak load for all locations.
- Scheduled scans will not detect the "moment of truth".
- Scheduled scans will not provide rate-of-change data.

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Requirements for Continuous Monitoring

A. Small, simple, reliable IR sensors inherently measuring temperature rise above ambient.
   a. Can be placed at a safe distance inside cabinets.
   b. Negligible metallic cross-section.
   c. Self-powered
B. Local signal conditioning outside of electrical panels.
C. Wired or wireless data transmission to monitoring computer.
D. Appropriate software

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Technology Step # 1

Non switch off periodic inspection

The "Joe" Factor

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TECHNOLOGY STEP # 2

Infrared Thermal Imaging

No switch off

No human intervention

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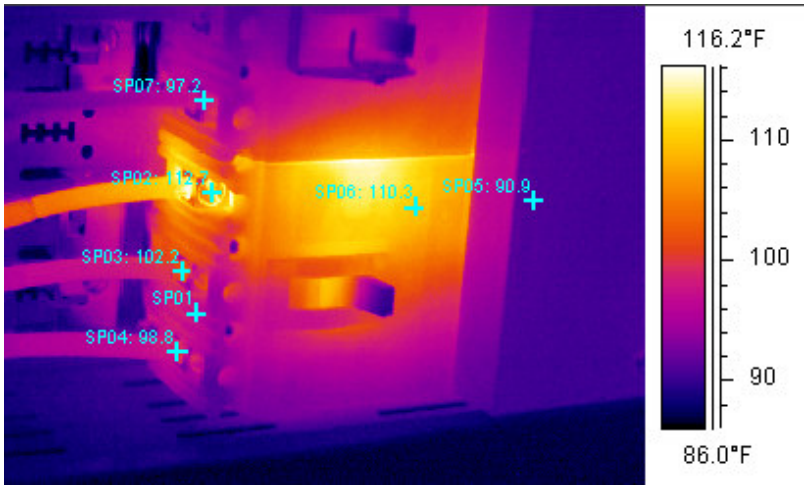

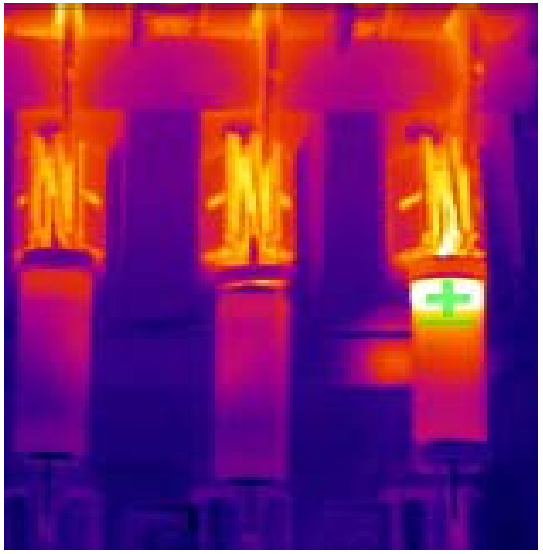

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BUT – not the "Perfect" solution.

- Periodic – 1 or 2 days out of 365 = reliant on a large degree of luck
- Need the problem to have developed to a point where detectable, but not to point of failure
- Inspection is **OUTSIDE** the enclosure, thus not actually inspecting the equipment.
- Can only inspect equipment immediately adjacent to the enclosure wall

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Technology Step # 3

Thermal "Windows"

Mesh/ screen or Crystal

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Technology Step # 4

The Infrared Thermocouple

FOV 1:1 & 3:1 housing

FOV 1:1 & 3:1 housing

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Sensor for Continuous Monitoring

Infrared	Non-contact
No power required	Accurate
Ultra reliability	Small
Low cost	Plastic bodied
Lifetime calibration	Fit & Forget

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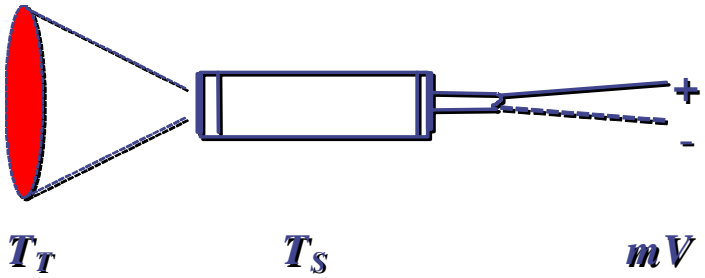
Self-powered intrinsically safe sensor



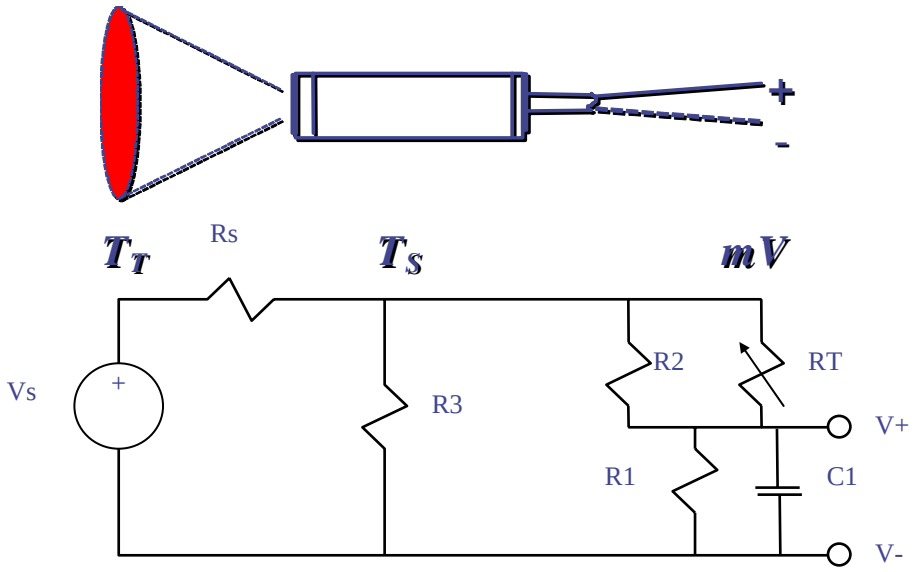
$$mV = c\,(T_T - T_s)$$

$$= c\,(T_T - T_A)$$

$$When\ T_s = T_A$$

Inherently measures the rise above ambient with only the assumption that the sensor body is at the same temperature as the local ambient.

Self-powered intrinsically safe sensor



Drift-free passive electronic components, maintains accuracy over long periods in harsh environments, MBTF ~1000 yrs.

- Sensor provides non-linear mV output
- Data acquisition cards available which both linearise and "condition" the signal
- Making it suitable for "noisy" electrical environments
- Sensors enable a variety of predictive systems

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- Stand alone – proprietary software
- Alarm relay to existing BMS
- Protocol conversion to virtually any protocol
- New data acquisition cards which provide output protocol in Modbus, Profibus, BACnet, DeviceNET – utilise existing bus cable

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- Can be designed into new installations

or

- Retro-fitted to existing installations at next suitable shutdown

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What is normally monitored ?

- Basically, what do you periodically thermally image?
- Critical joints & connections i.e. ACB's, MCCB's, PDU's, shipping breaks, bus bar sections (not every joint)
- Key word is critical

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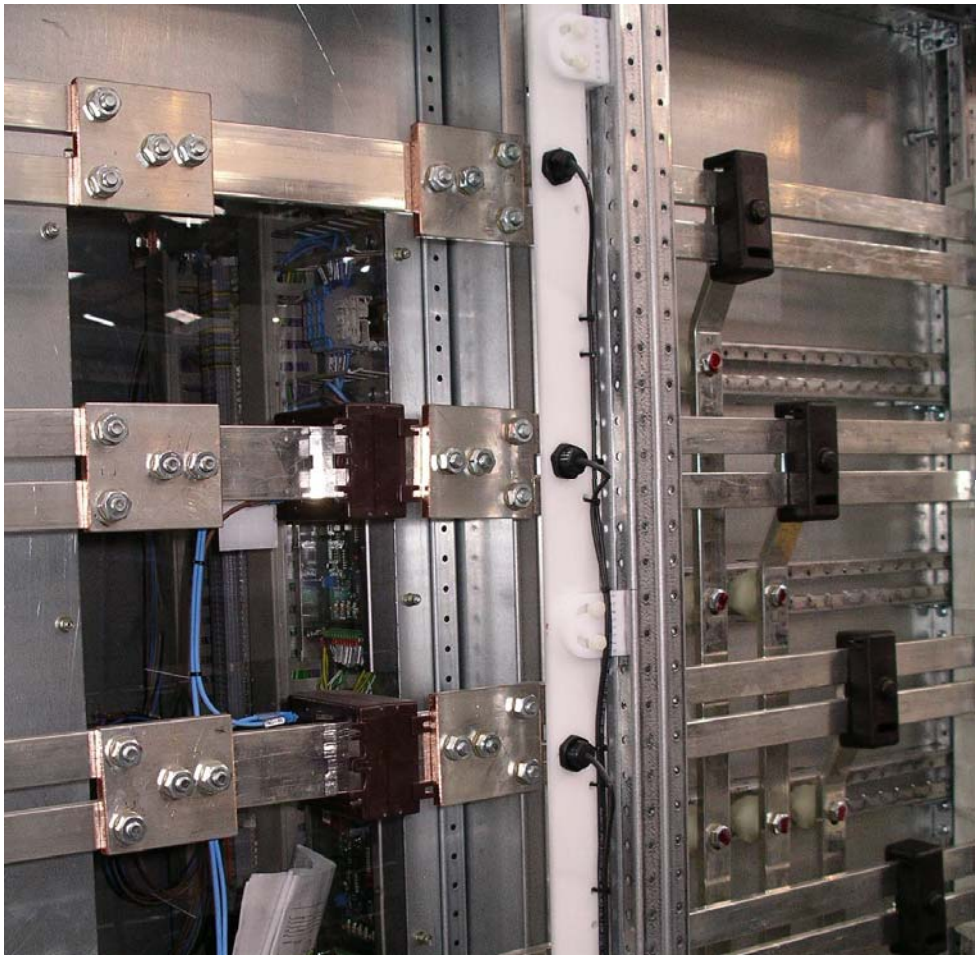
Monitoring shipping joints on PDU, utilising the plastic bracket system



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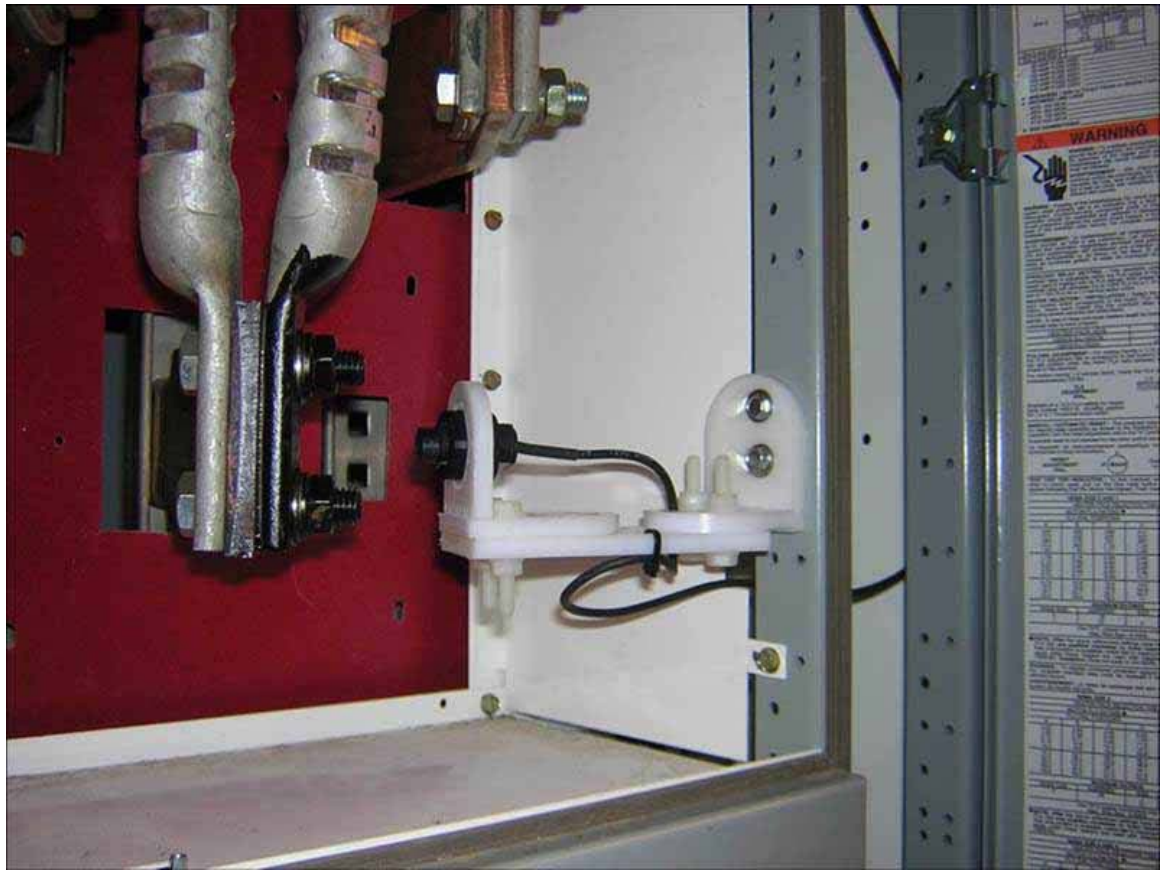

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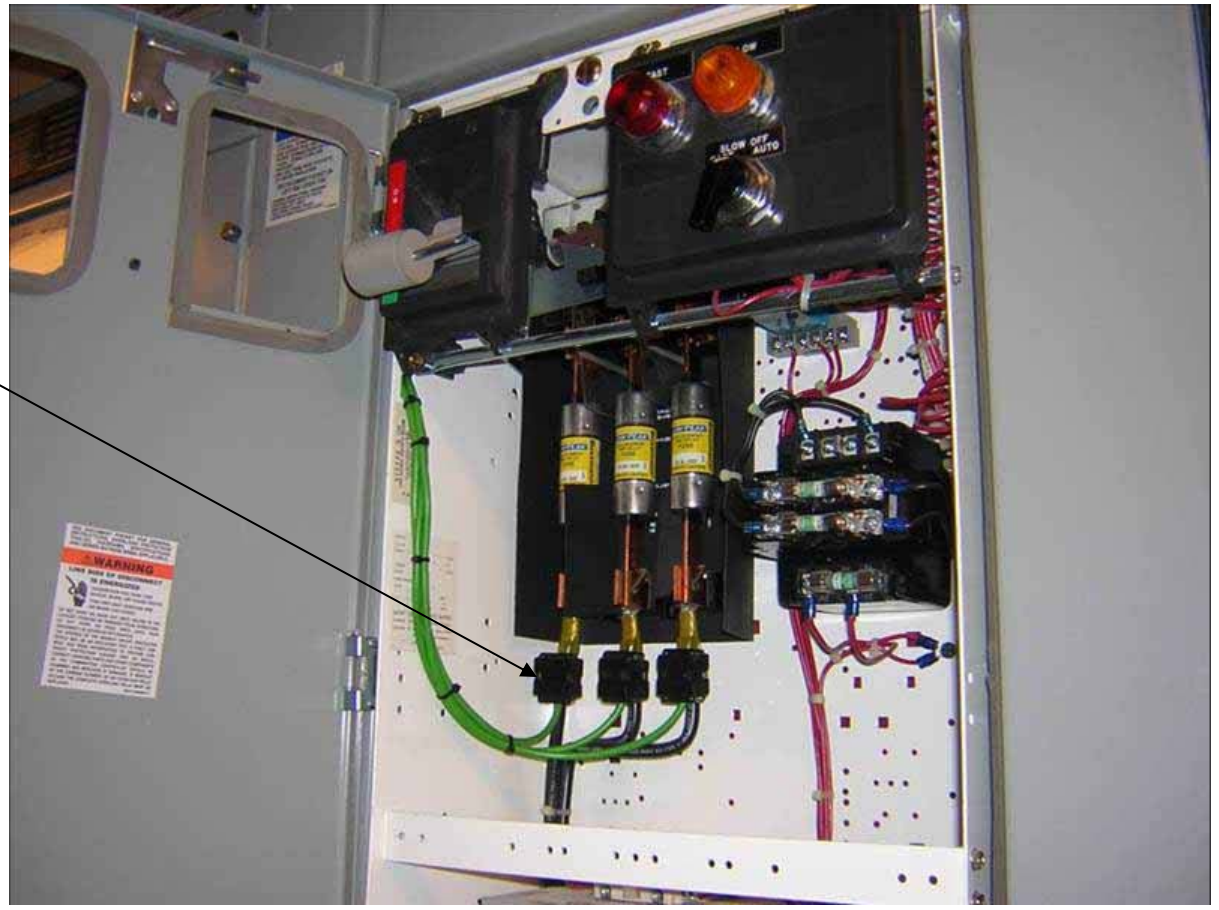
Cable sensors



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SUMMARY:

- New ExerTherm IR technology has provided the **NEXT TECHNOLOGY STEP**

- Continuous 24/7 thermal monitoring, Inside the enclosure to **Predict** failures **BEFORE** they happen

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Why take a

Snapshot

when you can now have the

Whole Picture ?

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Wireless Transmission of data

- ExerTherm System used with M2M transfers monitoring data to almost any location in the world
- Data transfer via network, internet, wireless, cell phone
- State of the art M2M communication
- One central location monitors key equipment at all your sites, un-manned, off-shore, tankers, large processing plant - even inter-continental!
- No unnecessary engineers' visits
- Fully integrates with BMS/Bus Systems

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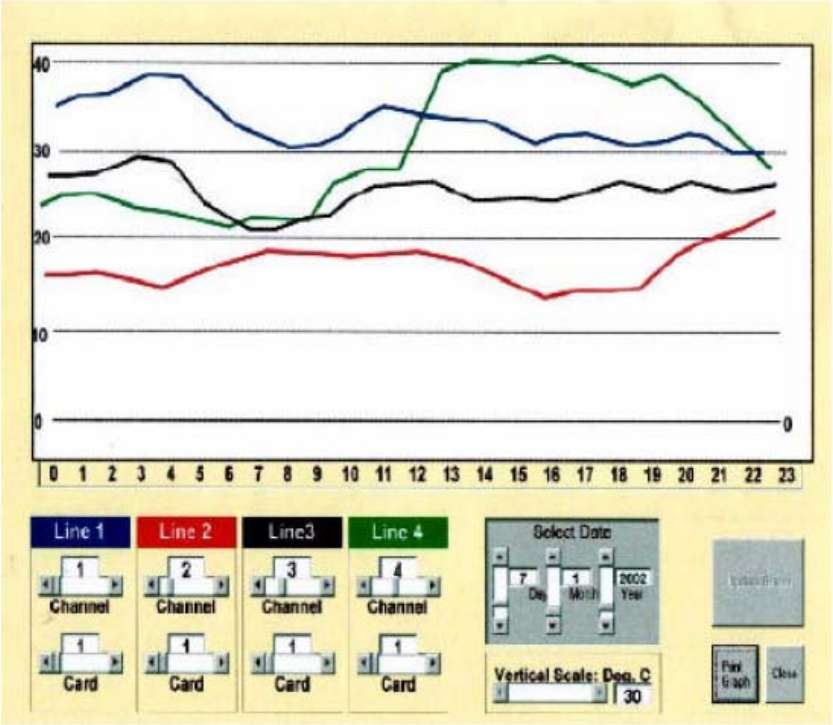
Interface for Continuous Monitoring



The sensors constantly measure the temperature of key components in relation to ambient, feeding back signals to PC. The automatic data logging gives instant on-screen trend graphs. Two separate alarm levels per sensor automatically activate if your preset temperature levels are exceeded. Clear screen displays show which sensor triggered alarm, easily locating potential problem component before it fails.

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Company Information

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