



RESOLUTION OF COMPLEX CLAIMS

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Lorca Consulting

Lorca Consulting was established in October 2017. As a consulting firm we offer support and expert advice to Clients relating to Scientific investigation and Analysis methods in a variety of Industries.

With 20 years' experience in the Analytical Chemistry industry, we pride ourselves in providing quality Analytical results substantiated by acclaimed international published research papers.

SOP

Lorca Consulting their approach with all assessments on the Scientific method:

“The scientific method is an [empirical](#) method of acquiring [knowledge](#) that has characterized the development of [science](#) since at least the 17th century (with notable practitioners in previous centuries). It involves careful [observation](#), applying rigorous [scepticism](#) about what is observed, given that [cognitive assumptions](#) can distort how one interprets the [observation](#). It involves formulating [hypotheses](#), via [induction](#), based on such observations; [experimental](#) and measurement-based testing of [deductions](#) drawn from the hypotheses; and refinement (or elimination) of the hypotheses based on the experimental findings. These are *principles* of the scientific method, as distinguished from a definitive series of steps applicable to all scientific enterprises.”

Failure Analysis

Failure analysis is a systematic investigative procedure using the scientific method to identify the causes of a failure.

- ASM methodology is applied to conduct failure analysis where appropriate.
- The Failure Analysis Society is the newest affiliate society from ASM International. Founded in 2016, this society is dedicated to advancing the important role failure analysis plays in the materials science industry.
- The Failure Mode and Effect Analysis (FMEA) Process is followed. The FMEA methodology is based on a hierarchical, inductive approach to analysis.

MOTOR

LIGHT

HEAVY

NON MOTOR

ELECTRONICS

FIRE

AGRICULTURE

SOLAR

INLAND MARINE

INVESTIGATION
 On-site
 Photography
 Drone photography
 Electronic measurements

WET CHEMISTRY
 Residue
 Oil Analysis
 Fuel Analysis
 Chemical Identification
 Viscosity, TBN, TAN
 Turbidity, pH
 TOC, COD, BOD
 Melting Point
 Char, Soot and Ash

INSTRUMENTATION
 SEM, TEM
 XRF, XRD
 Microscopy
 FTIR
 Raman
 Thermal analysis
 GC, HPLC
 ICP, ICP-MS

TRAINING
 Hazard ID
 Site Inspection
 Photography
 Reporting
 Big picture approach
 Safety requirements

REPORTING

ENVIRONMENTAL

PRE-LOSS

SALVAGE

FUTURE PROSPECTS

METHODOLOGY

TRAINING

**TEST METHODS FOR RESOLUTION OF
COMPLEX CLAIMS**

Scientific Method
Sampling
Witness statements
Benefits of testing

TYPES OF TESTING

Thermal imaging
Wet Chemistry
Instrument analysis
Transformer testing
Fire Investigation
Lightning vs. Surge
Product failure

PRE- LOSS

INDUSTRY
APPLICATION

REPORTING

Introduction

- Different Scientific disciplines
- Binding factor for Integrated approach
- Scientific method
 - Holistic approach (Outside-In approach)
 - Survey to obtain the big picture = Test plan
 - Record keeping, photographic and video evidence (application to make use of drone technology)
i.e. Conceptual map

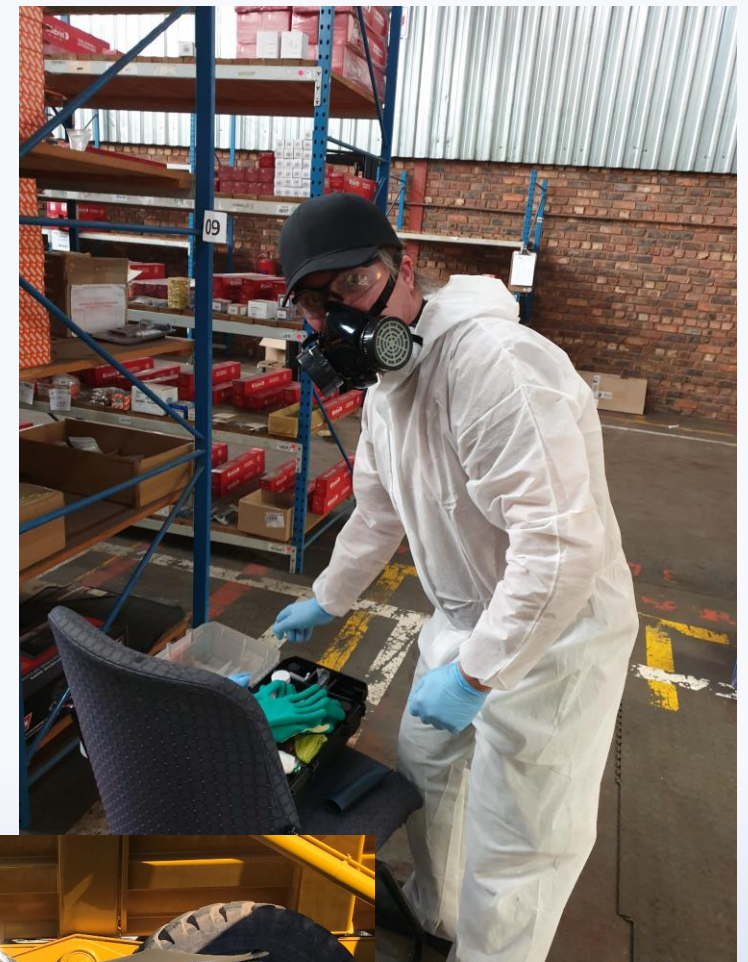


TEST METHODS FOR RESOLUTION
OF COMPLEX CLAIMS

Scientific Method
Sampling
Witness statements
Benefits of testing

- Sampling

- On-site gathering of physical evidence
- Samples are specific to Analytical Techniques
- Correct amount and type of sample for specific application
- Destructive/Non-destructive testing
 - Physical testing
 - Wet Chemistry
 - Instrument analysis



TEST METHODS FOR RESOLUTION
OF COMPLEX CLAIMS

Scientific Method
Sampling
Witness statements
Benefits of testing

- **Witness statements**

- Corroborate with evidence on scene?
- Human error
 - Corruption
 - Error in observation
 - Pre-conceived Bias
 - Stress (traumatic event)



TEST METHODS FOR RESOLUTION
OF COMPLEX CLAIMS

Scientific Method
Sampling
Witness statements
Benefits of testing

- **Benefits of Testing**
 - Physical evidence – Proof
 - Accountable and ethical approach
 - Loss adjusting tool
 - Fair settlement of the claim



Identify factors to consider in pre-loss assessments in future

TYPES OF TESTING

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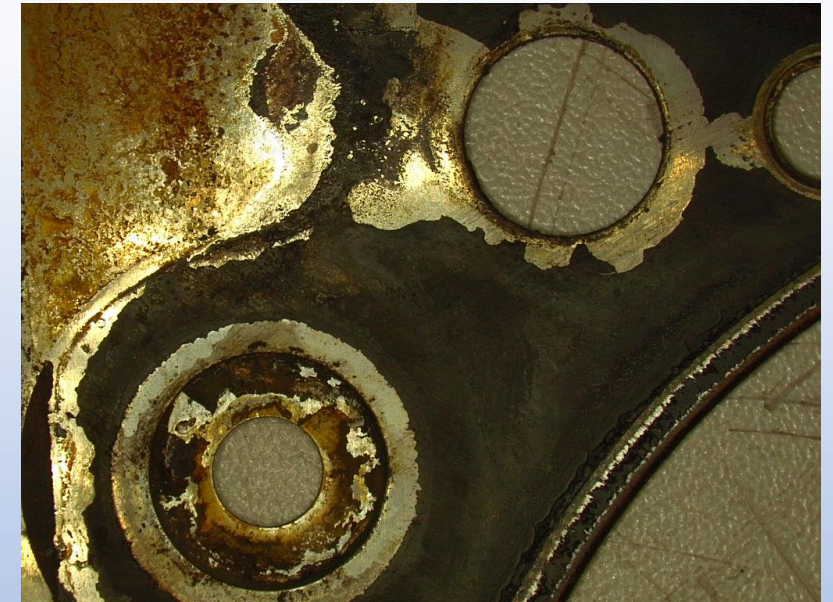
Types of Testing

Non-Destructive methods

- Physical investigation
- Photography, Microscopy
- Thermal Imaging
- RAMAN Spectroscopy (Portable)
- X-Ray Analysis (XRF Hand Held)

Destructive testing

- Electron Microscopy (SEM, TEM, EDX, EDS)
- Spectroscopy (FTIR and Imaging Analysis)
- Organic Contamination (TOC, COD)
- X-Ray Analysis (XRF, XRD)
- Emission Spectroscopy (OES, NMR)
- Oil Analysis

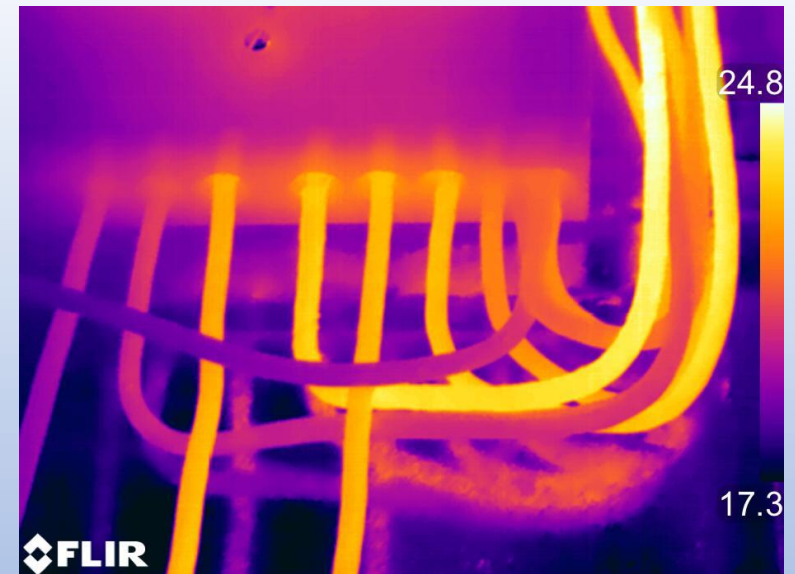
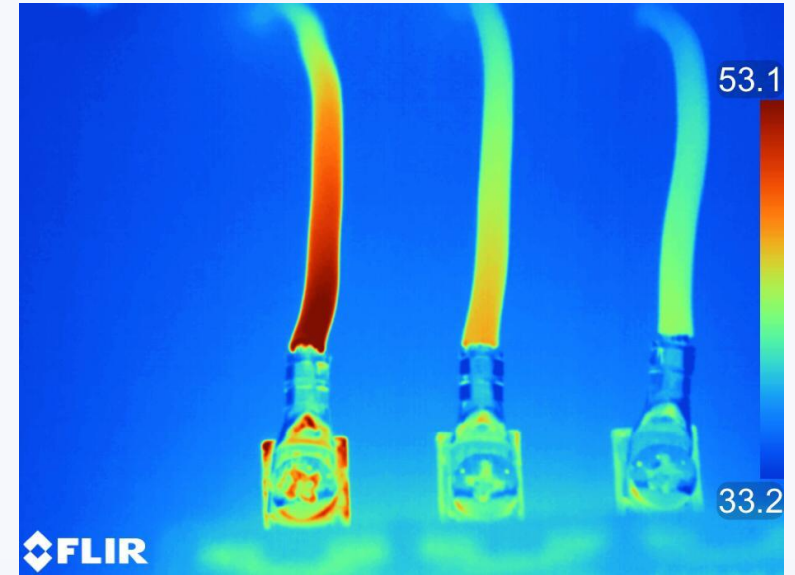


TYPES OF TESTING

Thermal imaging
Wet Chemistry
Instrument analysis
Transformer testing
Fire Investigation
Lightning vs. Surge
Product failure

Thermal Imaging

- Identify thermal anomalies that can indicate possible defects
- Create a baseline - determine a maintenance schedules for fault identification
- Used for electrical, mechanical and building applications, offshore oil and gas platforms as well as detecting leaks and moisture issues
- Non-contact and non-destructive
- Our thermal imaging technicians are all certified ITC thermographers
- Pre-loss tool

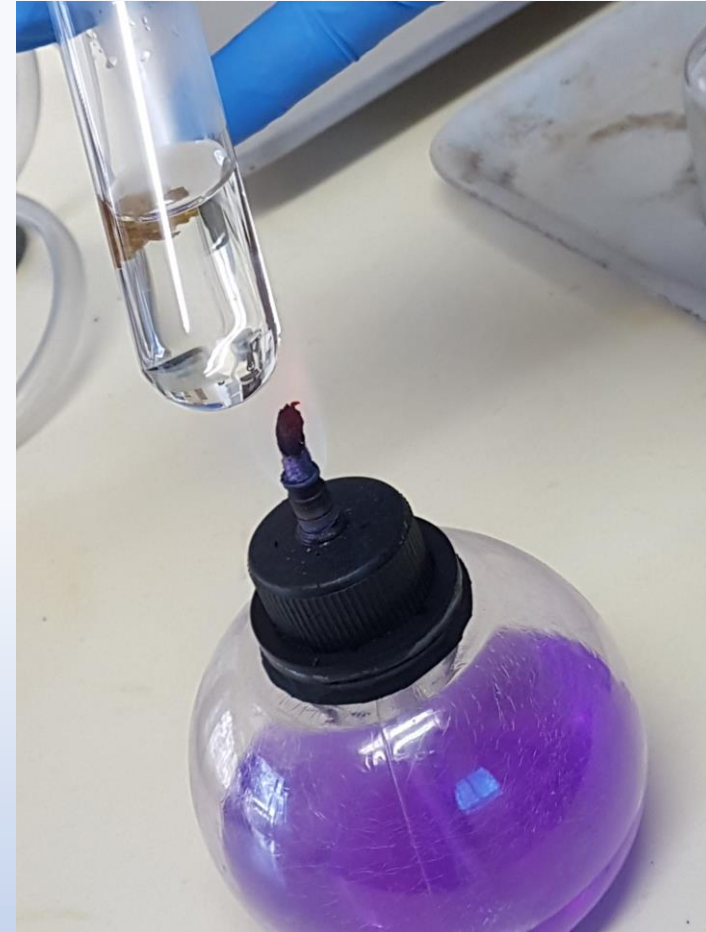


TYPES OF TESTING

Thermal imaging
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Lightning vs. Surge
Product failure

Wet Chemistry

- Residue testing
- Oil Analysis (TBN, TAN)
- Fuel Analysis
- Chemical Identification
- Viscosity, Turbidity, pH
- Melting Point



TYPES OF TESTING

Thermal imaging
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Instrument Analysis

- Microscopy
- Electron Microscopy (SEM, TEM)
- X-Ray Analysis (XRF, XRD)
- Spectroscopy Analysis (FTIR, RAMAN)
- Chromatography (GC, HPLC, Headspace)
- Spectroscopy (ICP, ICP-MS) metal analysis
- Organic Contaminants (TOC, COD, BOD)



TYPES OF TESTING

- Thermal imaging
- Wet Chemistry
- Instrument analysis
- Transformer testing
- Fire Investigation
- Lightning vs. Surge
- Product failure

Transformer testing



Ratio Tests on every tap to see if the turns are balanced and there are no shorts between the turns.



DC Resistance Test to check the resistance between the windings.



Insulation Test to see if the wiring is down to earth and if there are any internal shortages between the windings. This also includes **PI Tests**

TYPES OF TESTING

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Fire Investigation

- Physical observation
- Analysis of hydrocarbons (FTIR) for Wet smoke detection
- Dry smoke detection effect on substances
 - SEM analysis
 - Gas analyser (sniffer probe)
- Effects of heat of combustion
 - Analysis for propellants (FTIR)
 - SEM analysis
 - Melting point of specific metals
- Analysis of char, ash and soot (SEM/EDX and pH)



Nicolet™ iS50 FTIR Spectrometer

TYPES OF TESTING

Thermal imaging
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Product failure

Lightning vs. Surge

- Analysis of damage on PCB's using SEM comparative methods
- Microscopy
- XRF
- Curve Analysis – On-site



TYPES OF TESTING

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Product failure

Metals

- Chemical verification (SEM and ICP MS)
- Contamination analysis (OES, XRF, SEM)
- Corrosion analysis (SEM, Microbiological testing)
- Macro etching (SEM/EDX)
- Micro structure evaluation (SEM/EDS)
- Photo Documentation (Microscopy)
- Physical testing
- Surface contamination and weld evaluation (SEM and FTIR analysis)
- Solder failures and PCB contamination (SEM/EDX and FTIR)

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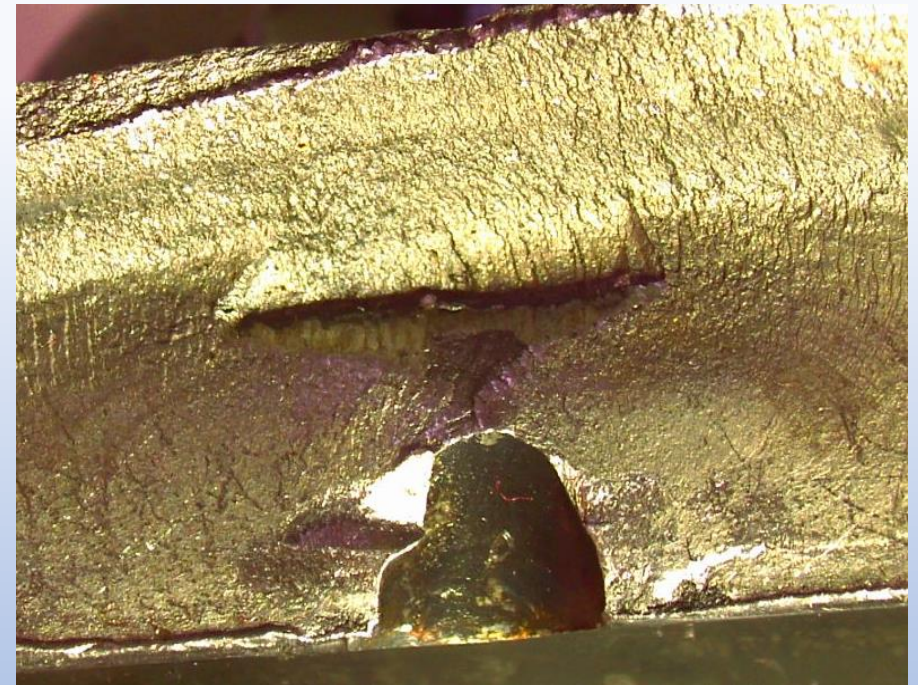
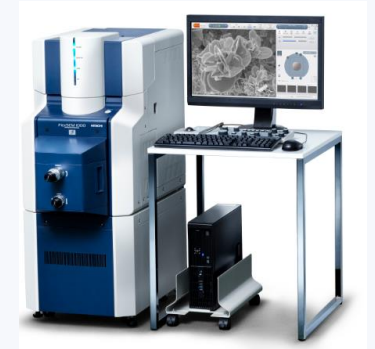
Product failure

Non-Metals (Plastics, Composites, Adhesives, Coatings and Paint)

- Adhesive identification (FTIR)
- Coating contamination (Lab Analysis and FTIR)
- Paint identification (RAMAN, Physical testing and Photo documentation)
- Filter assemblies
- Fibre identification (SEM)
- Plastic fatigue (Physical testing)
- Visual defects
- Plastic weld failures

Case study – Connecting Rod Failure

- Scenario - Help identify a possible crack vs. fatigue
- Samples were prepared and SEM analysis performed



Case study – Connecting Rod Failure

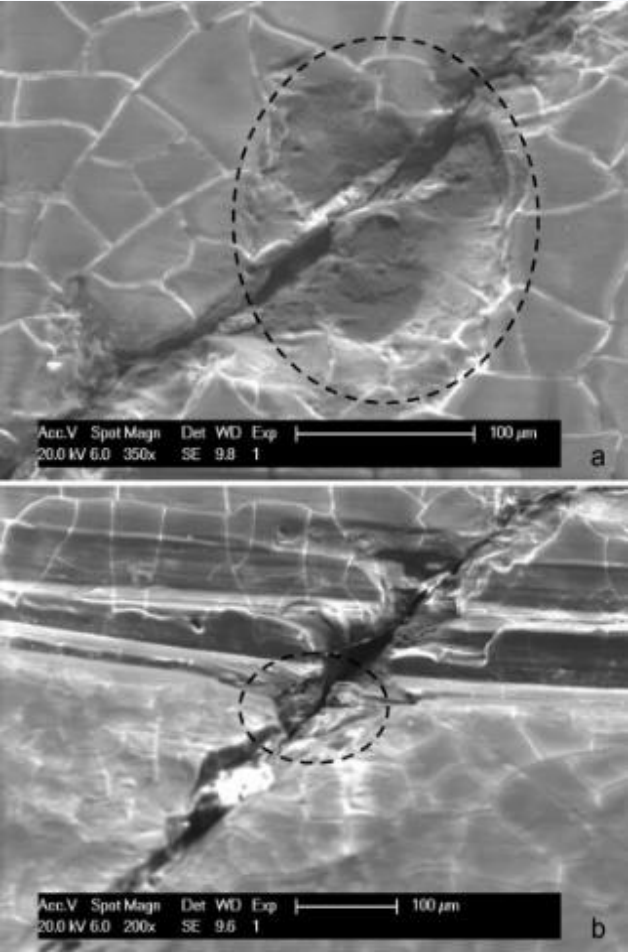


Image typical crack

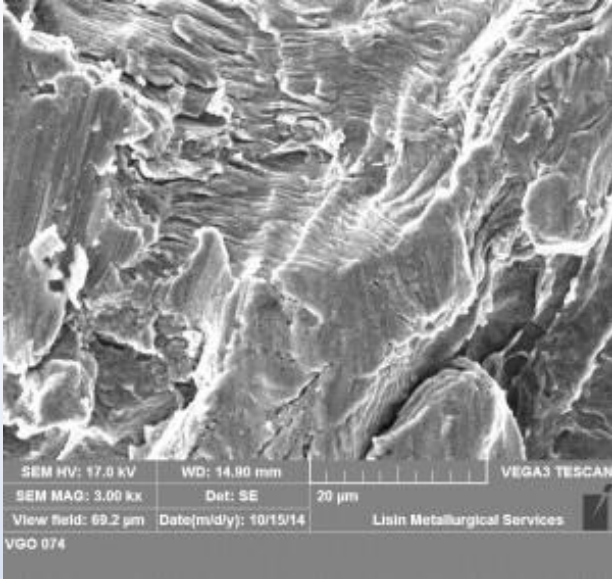
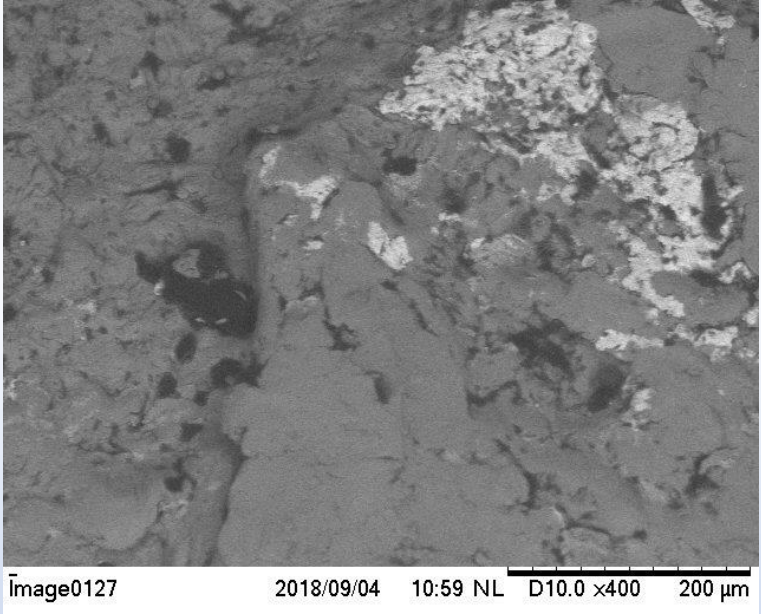
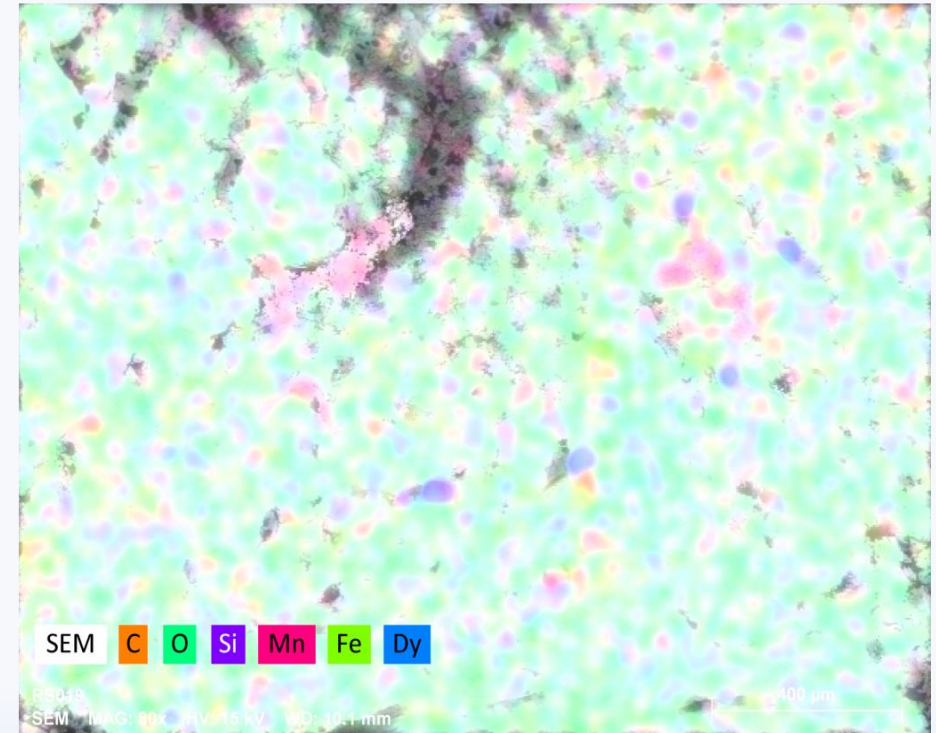
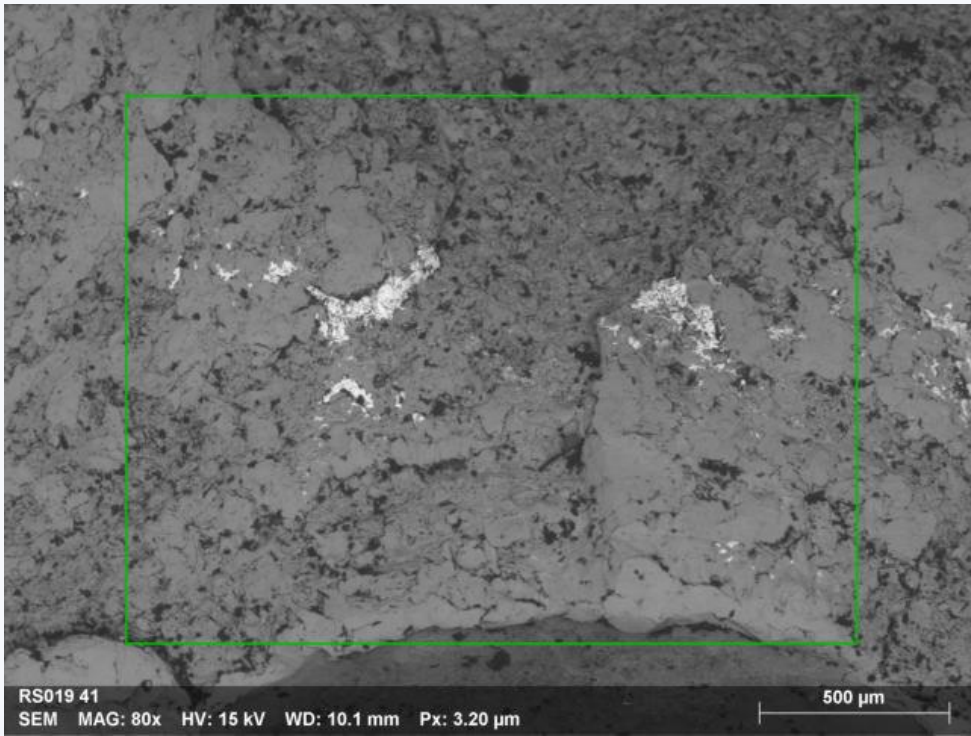


Image typical fatigue



Fatigue striations
(Actual sample)



Result

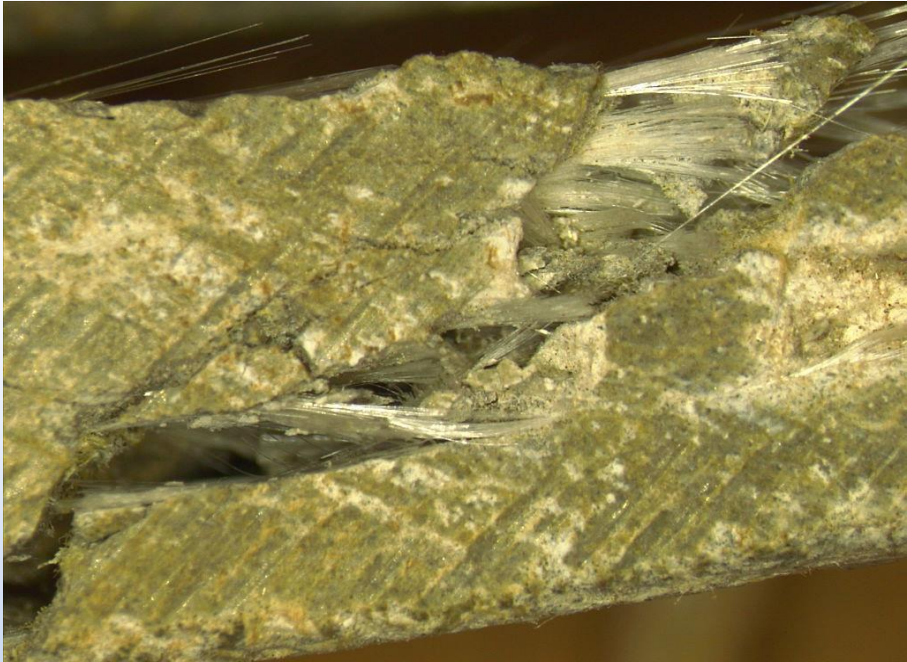
- With the help of SEM analysis metal fatigue and strain became visible
- More fatigue and even burn marks were identified – exact point of strain on chamfer identified
- Fatigue and strain pointed to the cause of the failure
- Determine metal composition and distribution

Case study – Damage in transit vs. Product failure

- Scenario - Identify possible damage in transit
- Microscopy, FTIR and XRD analysis performed



Case study – Damage in transit vs. Product failure



Microscopic/Visual Analysis

Case study – Damage in transit vs. product failure

- Typical Cement composition:
 - CaO , SiO_2 , Al_2O_3 , and Fe_2O_3
- Oxides in smaller quantities:
 - SO_3 , MgO , Na_2O , and K_2O
- Analysis indicated absence of Aluminium Oxides
- Water content ratio incorrect
- Not homogeneous

Result was Manufacturing issue, lack of QC and inferior quality of the product

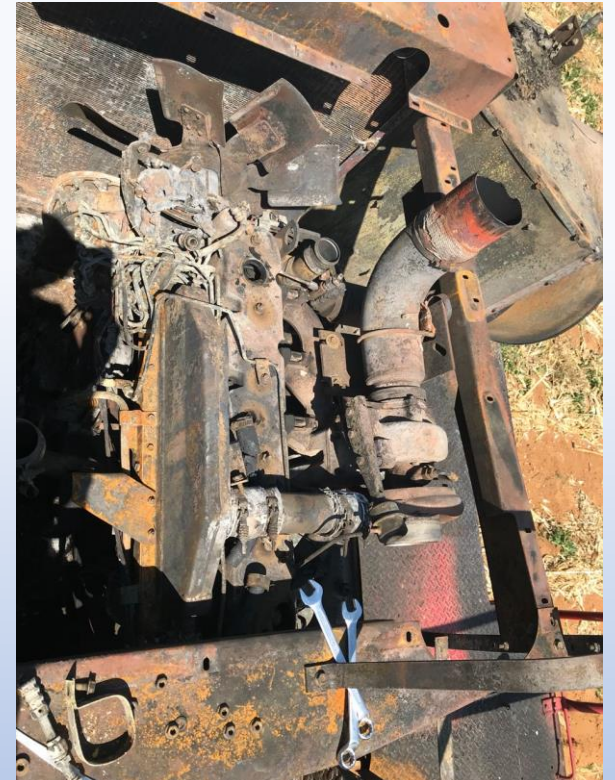
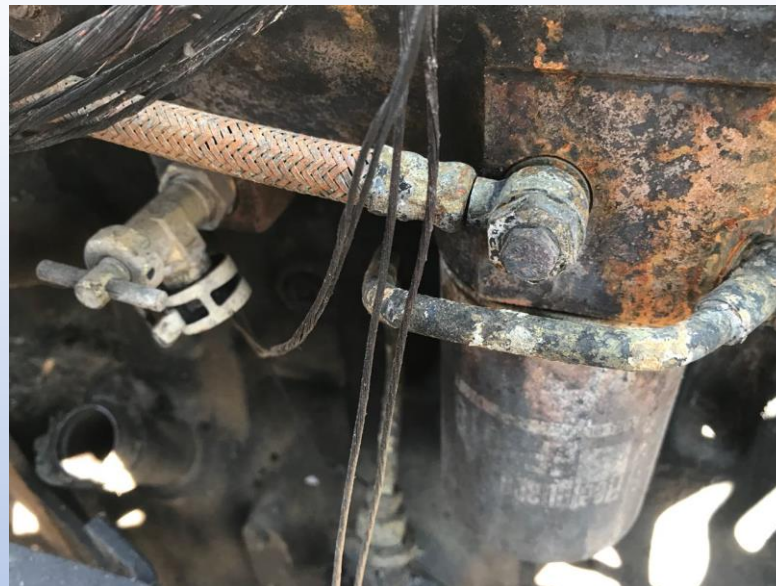


Bruker AXS D8 XRD Instrument

Case study – Harvester Fire

Scenario - Determine possible cause of Harvester Fire

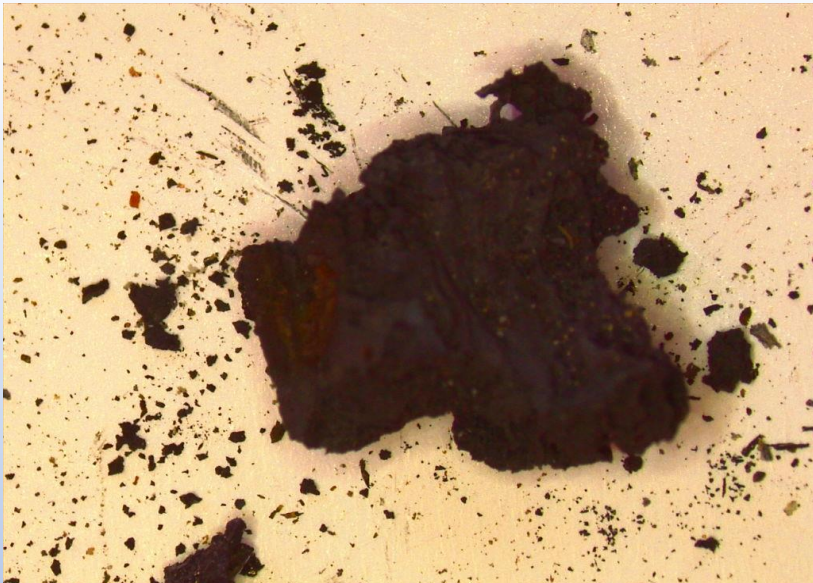
- Spontaneous combustion
- Product failure
- Maintenance Issues



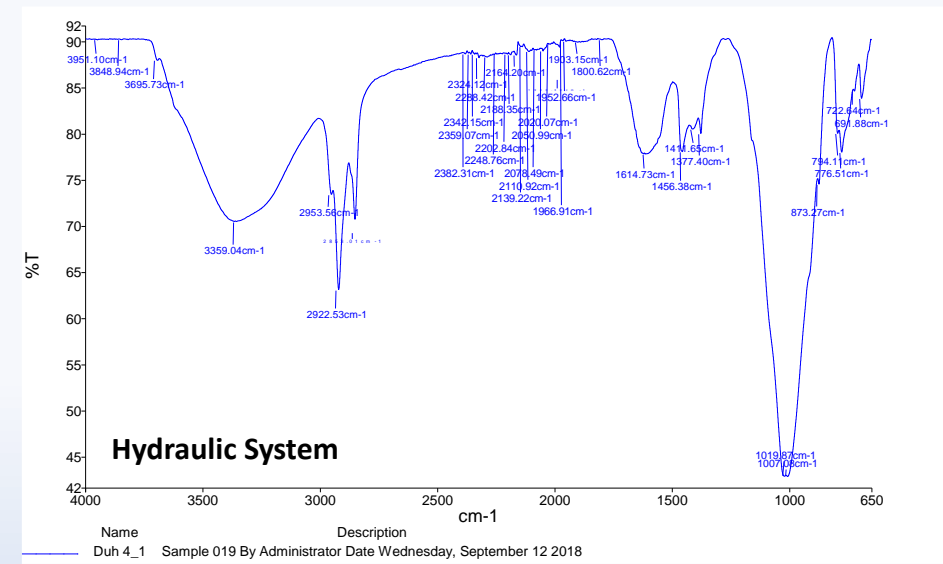
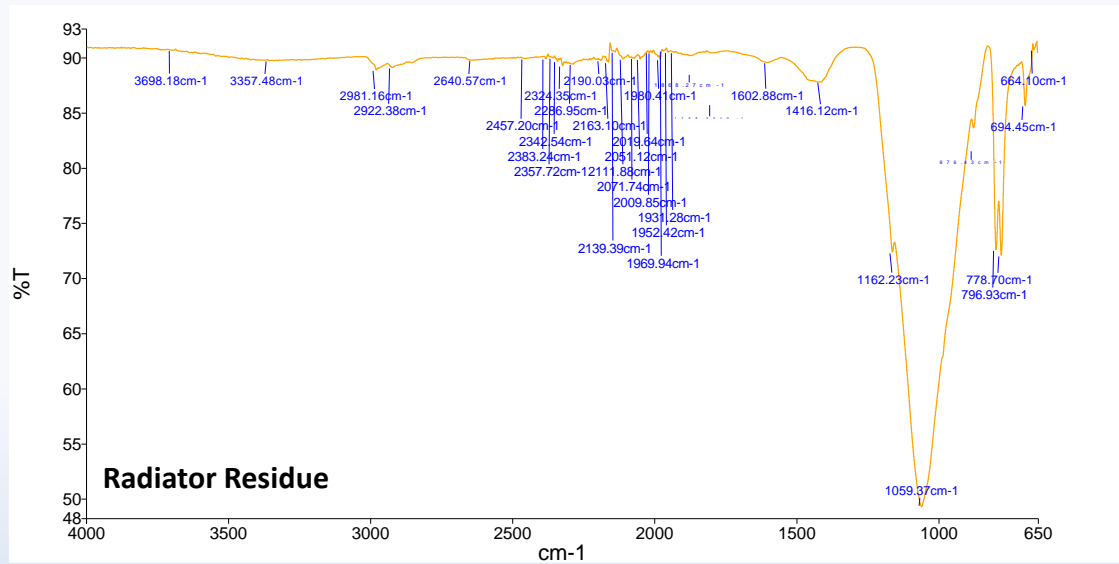
Case study – Harvester Fire

Test plan – Residue identification and Analysis

- Microscopy
- FTIR Analysis



Case study – Harvester Fire



Result – Contamination

- Samples collected from both the Radiator and Hydraulic system indicated the presence of polysaccharides, sugars and plant material
- Engine Contamination

Case study – Underground fuel storage tanks



Scenario – Underground Fuel storage tank failure

- Fuel storage tanker installation failed – fuel line disconnected
- Fuel leak - Environmental contamination
- Preventative measures not in place
- Environmental pollutants could not be contained
- Damage assessment
 - Storage tank inspected
 - Maintenance procedures not followed



What could have been done?

- Preventative measures
- Environmental impact study = Test plan
- Sampling of soil and surrounding water sources

Laboratory testing

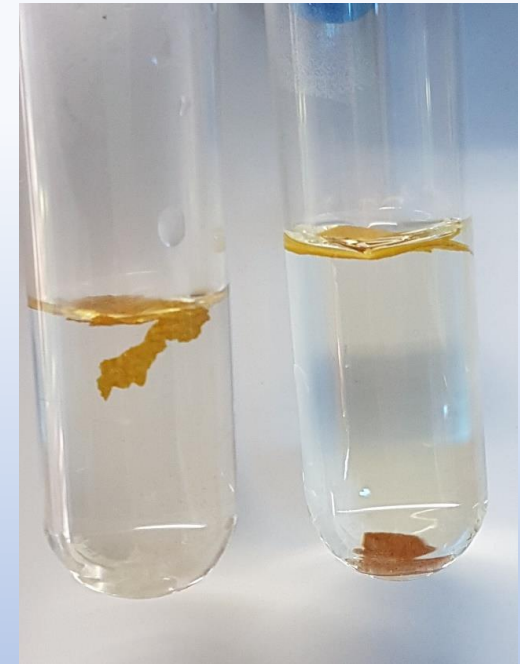
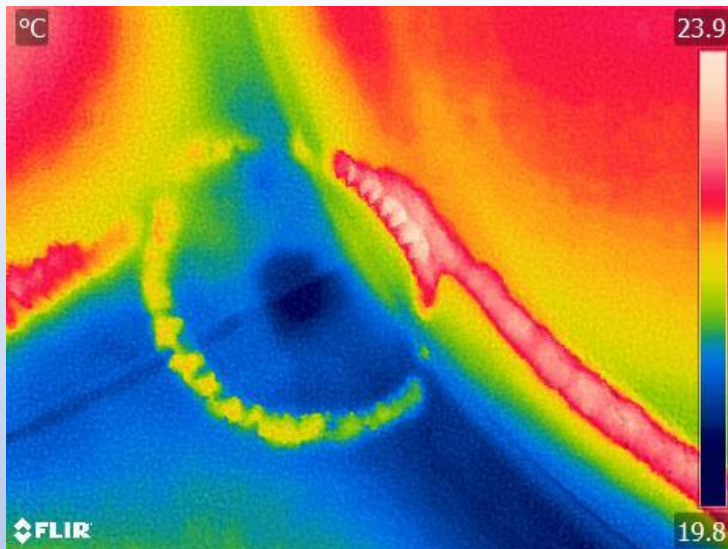
Detectable sources of contamination

- Oil in water
- Ground water contamination (pH, TOC)
- Chemical action
- Lubricants
- Tribology analysis (Petrochemical)
- Metal contaminants (Hg, Cr etc.)



Case study – Acid spill from tanker

- Scenario – Tanker liner failure
- Initial on-site thermal analysis - Identified correct sampling areas
- Sample was removed and analysed using Physical testing



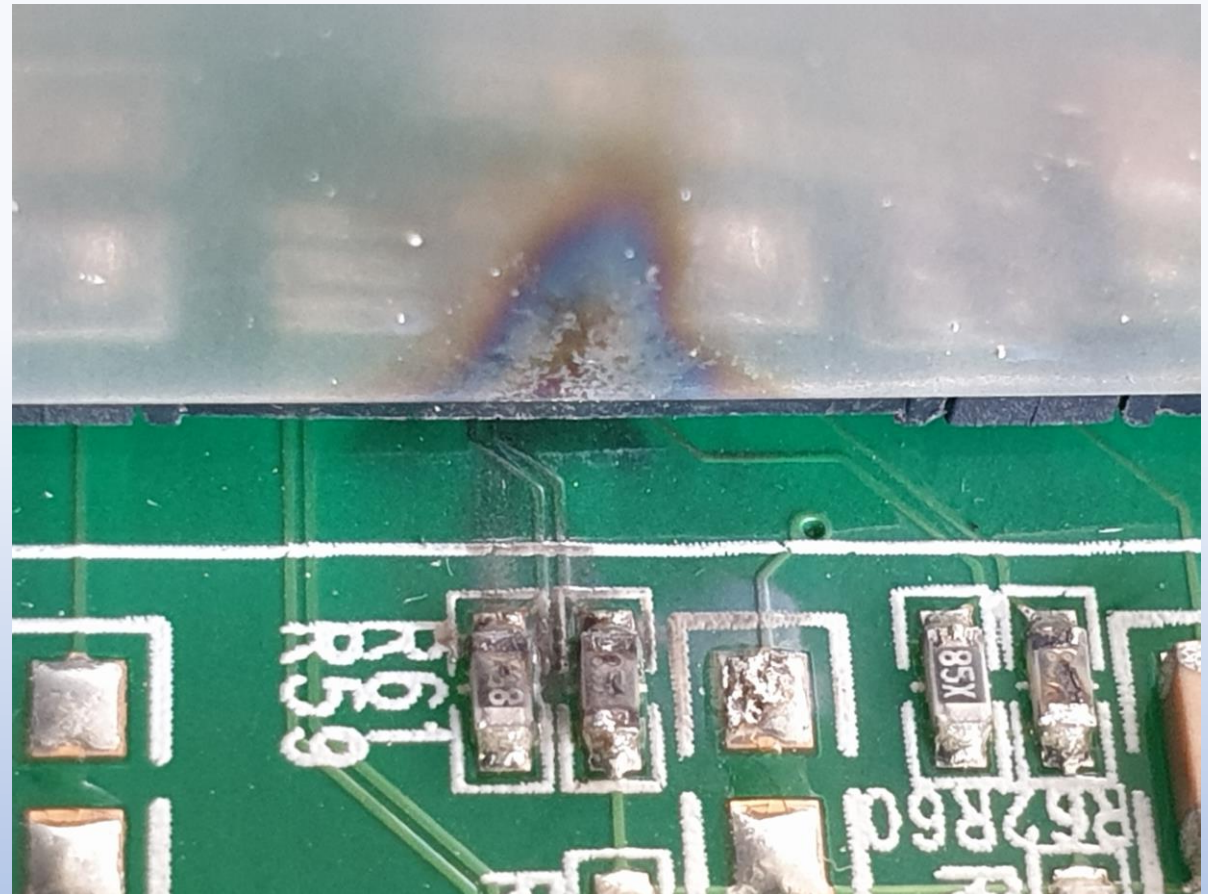
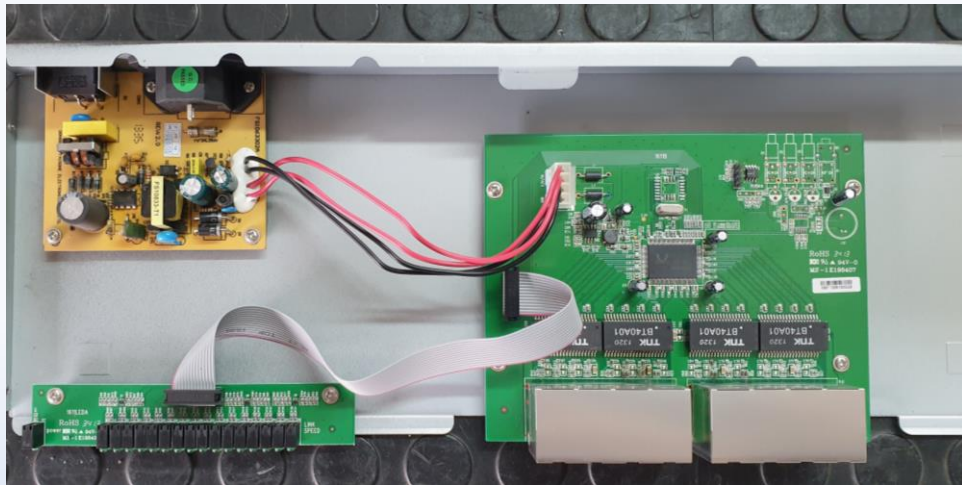
Case study – Acid spill from tanker



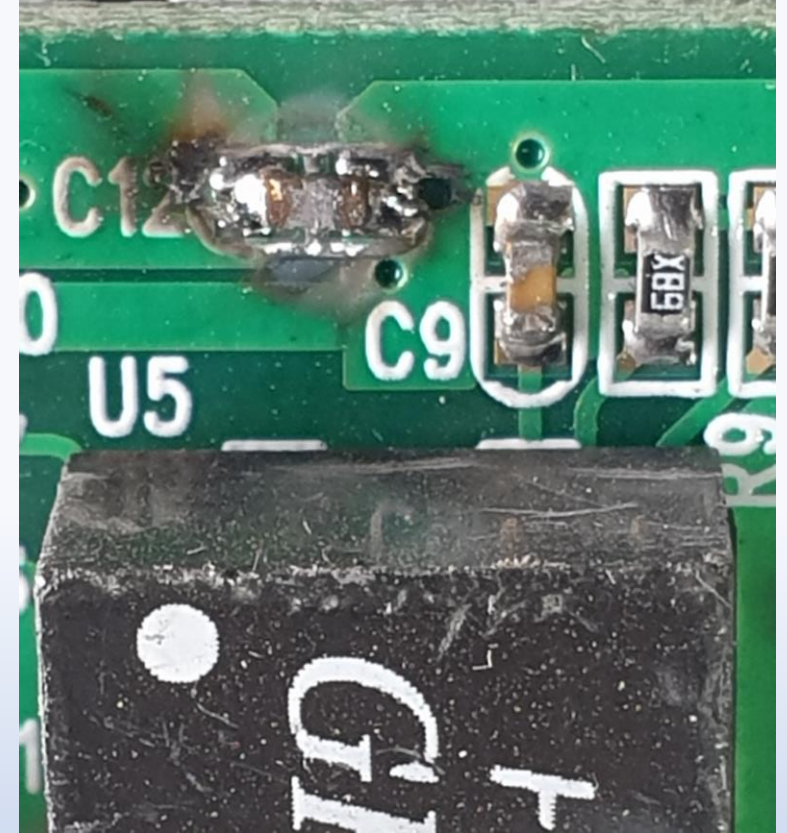
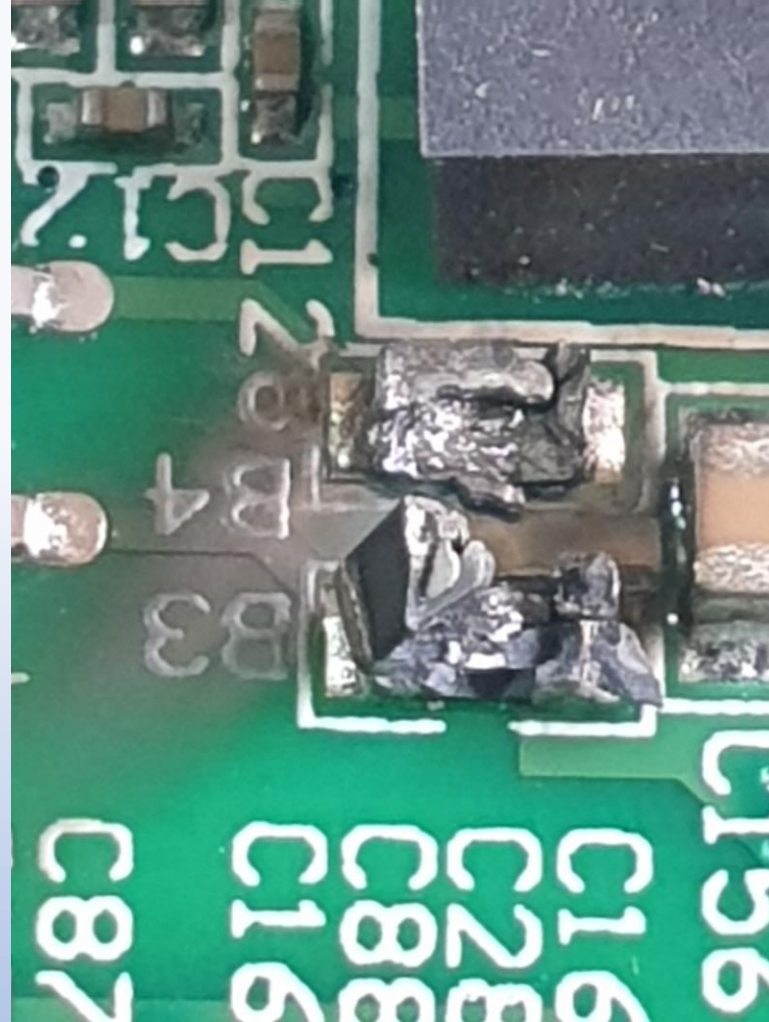
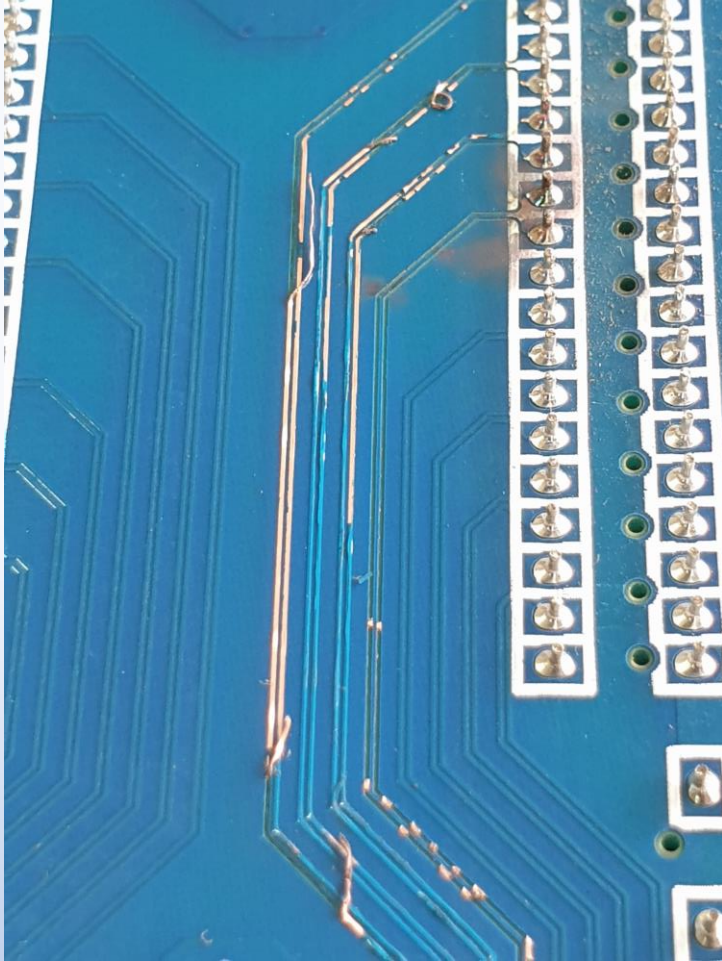
- Coating was not soluble in HCl
- Microscopic investigation indicated four distinct and uneven layers
- Polymerisation inefficient
- Product application was done incorrectly

Case study – PCB Failure

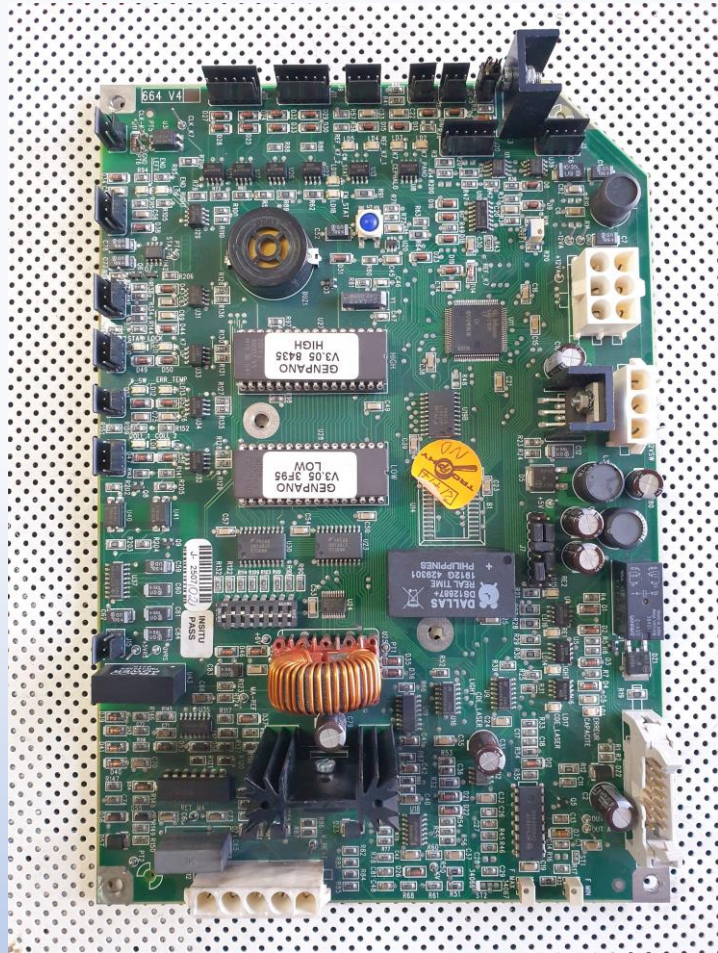
- Scenario - Claim for lightning damage
- Visual investigation – PCB visibly damaged



Case study – PCB Failure

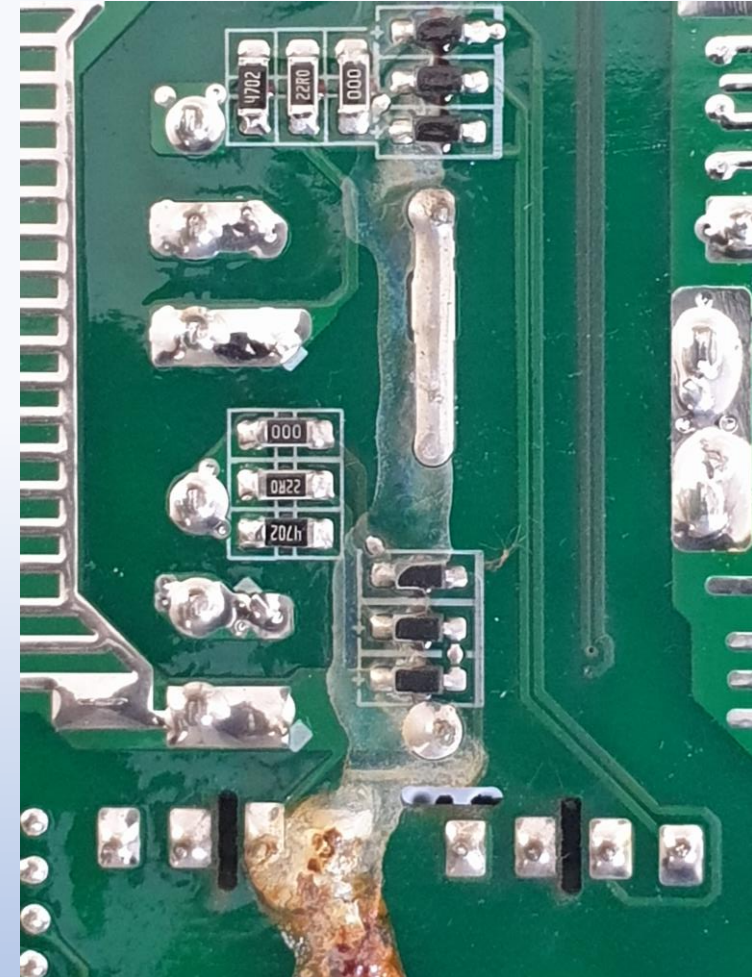
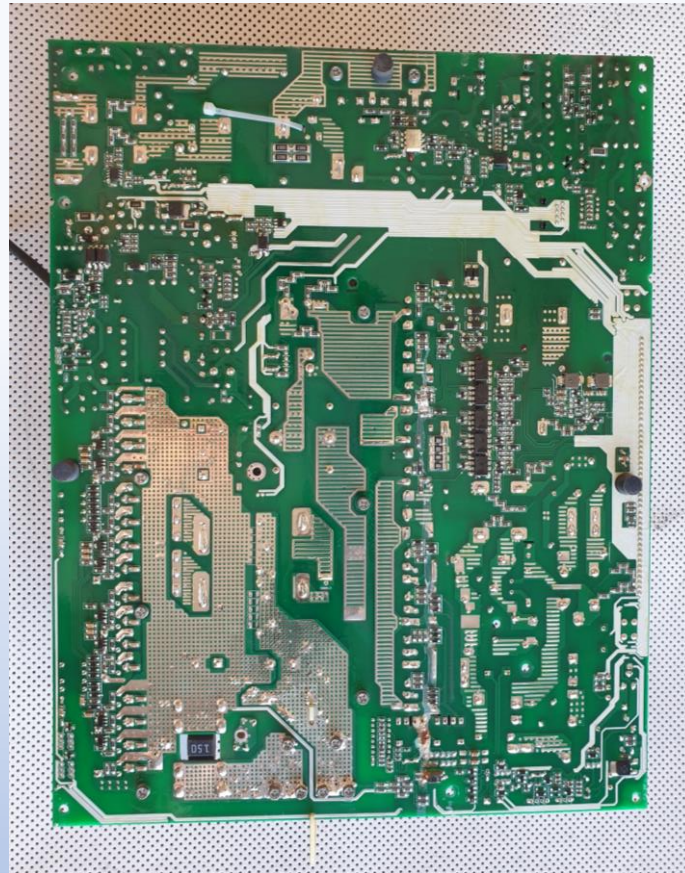


Case study – PCB Failure (Lightning)



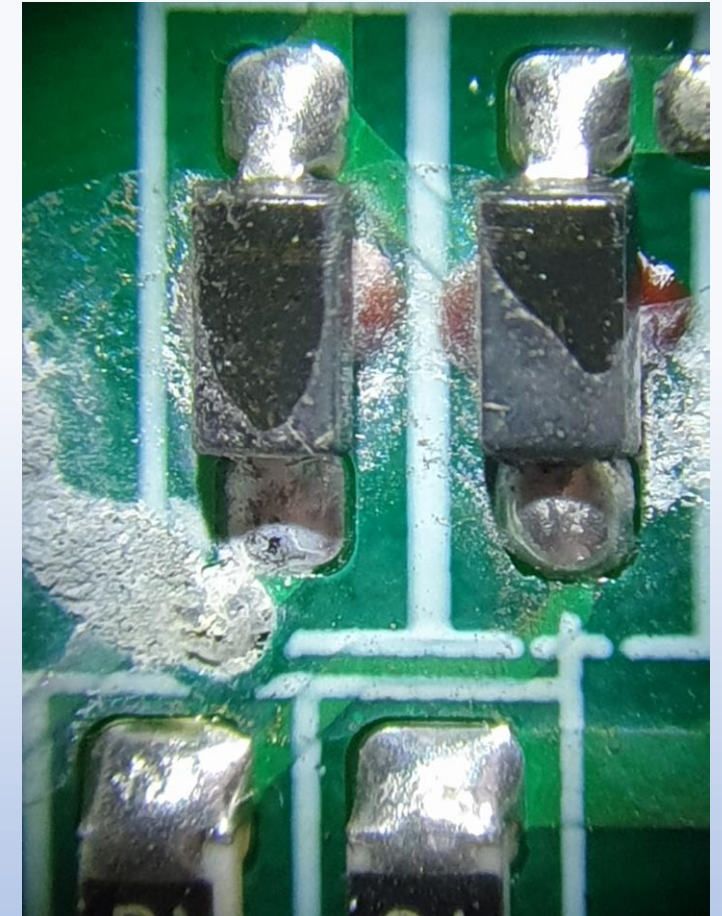
Case study – PCB Failure

- Scenario - Claim for lightning damage on Inverter
- Visual investigation – Ingress



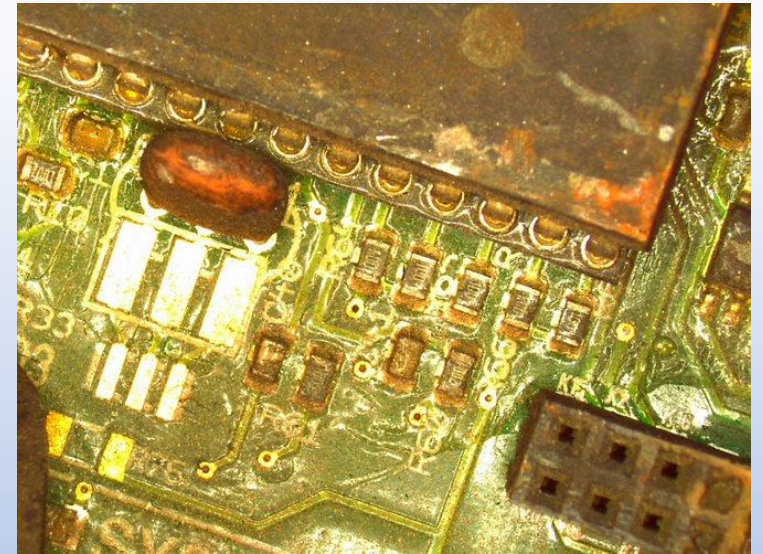
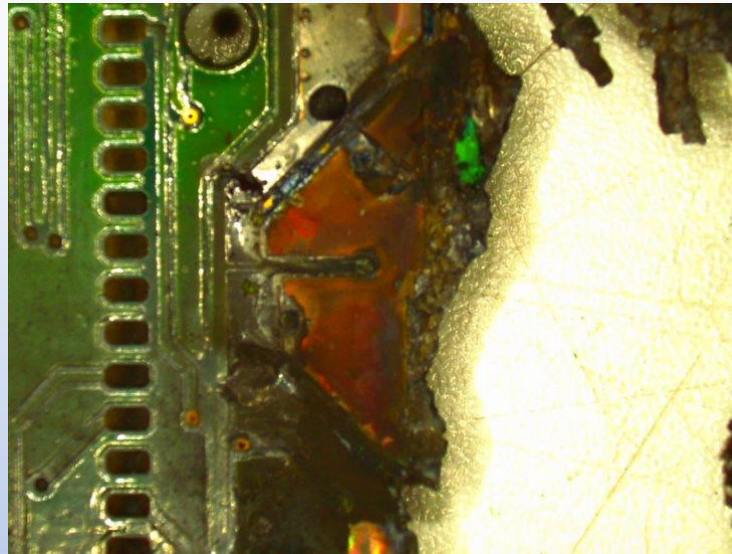
Case study – PCB Failure

- Scenario - Claim for lightning damage on Inverter
- Visual investigation – Ingress



Case study PCB - lightning vs. surge

- Scenario – lightning or surge
- Microscopy and Scanning Electron Microscope (SEM) was used to investigate the board



Case study PCB - lightning vs. surge

- Characteristic lightning patterns was absent and damage consistent with control sample, where power surge caused boards to ignite

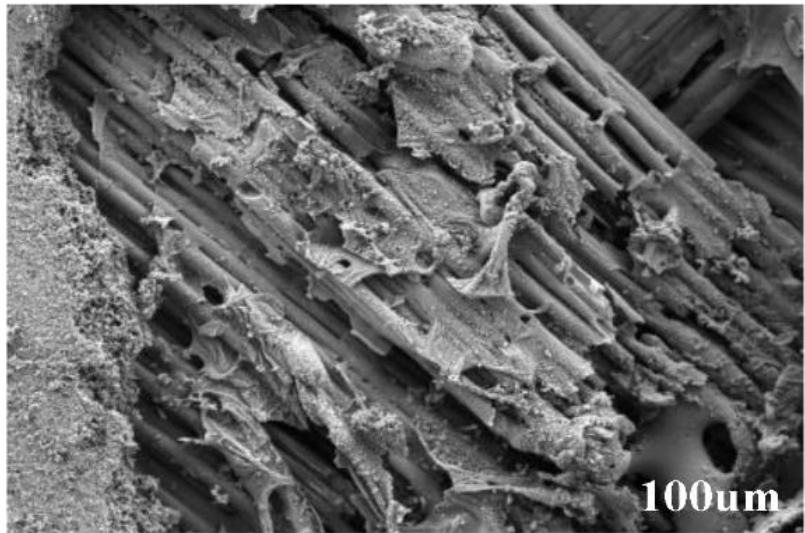


Image0110 2018/06/28 11:50 HL D10.4 x40 2 mm

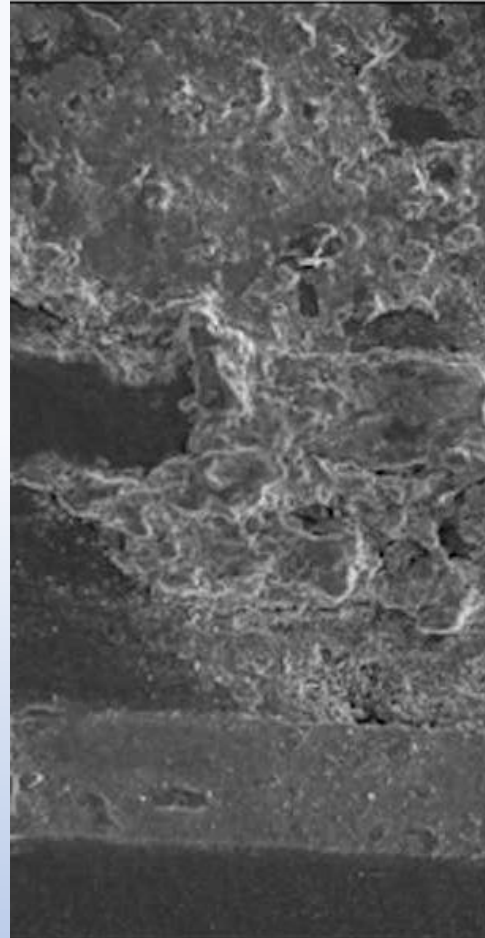


Image0115 2018/06/28 12:51 NL D5.2 x80 1 mm

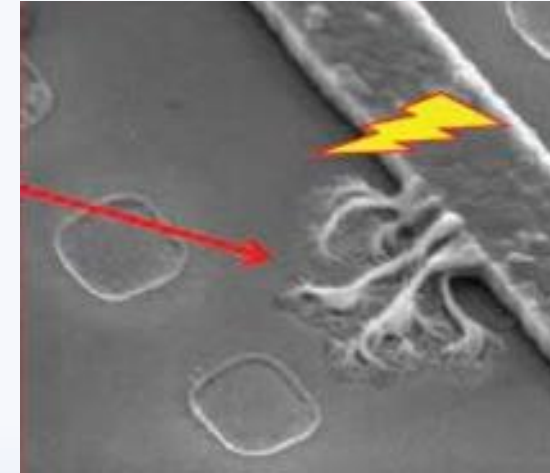
Case study PCB - lightning vs. surge



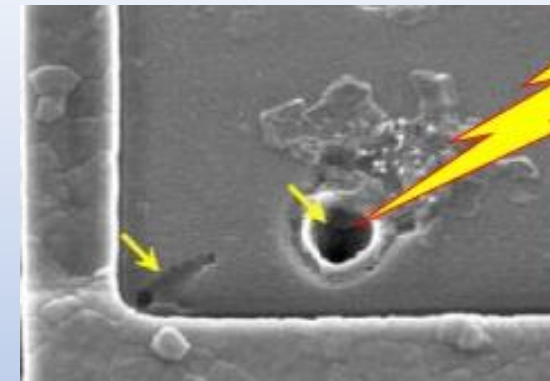
Surge/failure typical pattern



Corrosion pattern

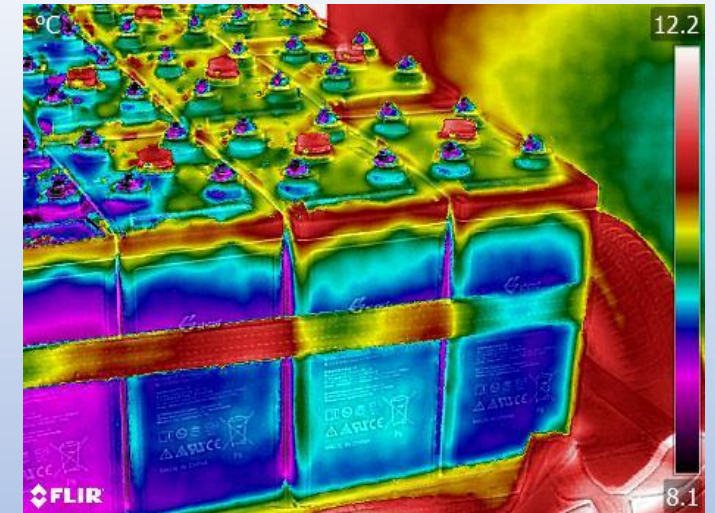
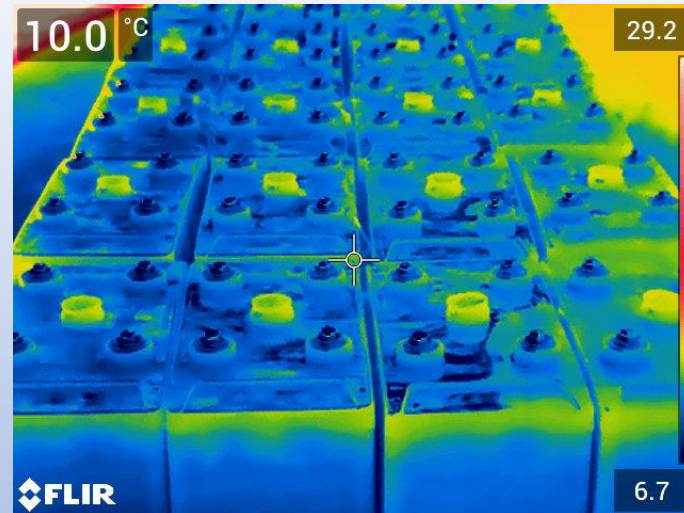
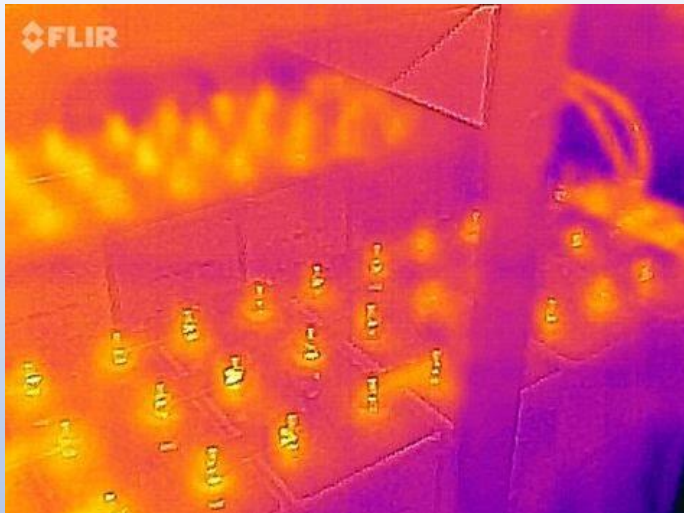


Lightning pattern



Solar Battery Installation- Investigation

- Thermal imaging
- Electronic investigation



Solar Battery Installation- Battery assessment

- Postmortem assessment



Solar Battery Installation- Battery assessment

- Postmortem assessment



Solar Battery Installation- Battery assessment

- Laboratory assessment
 - Specific gravity
 - pH
 - Ionic composition



Reporting – Factual evidence

- **Preliminary assessment**
- **Recommendation on the correct procedure and initial testing**
- Advanced Laboratory testing
- A **formal report** will be compiled stating all the Analytical results and facts (approved by an Analytical Chemist)
- Possible cause and **conclusion will be highlighted**
- Short summary of outcome with photographic evidence will be supplied
- **Record keeping** for future reference and evidence (as per requirement)

Pre-Loss (Risk assessments)

We assist by helping to identify potential faults before they become problems

- Lightning and power surge protection
- PV (Solar) installation verification
- Surveys for laboratories and businesses



Lorca Consulting

- Where we are
 - Solid network of professionals in the relevant industries
 - Skilled team able to offer a complete solution
 - Scientific facts to back up our assessments and reports



Thank you!