SUBSEA CONTROLS DOWN UNDER 2024

SUT Society for Underwater Technology

Protecting the electrical subsea production control system whilst the FPSO is off-station

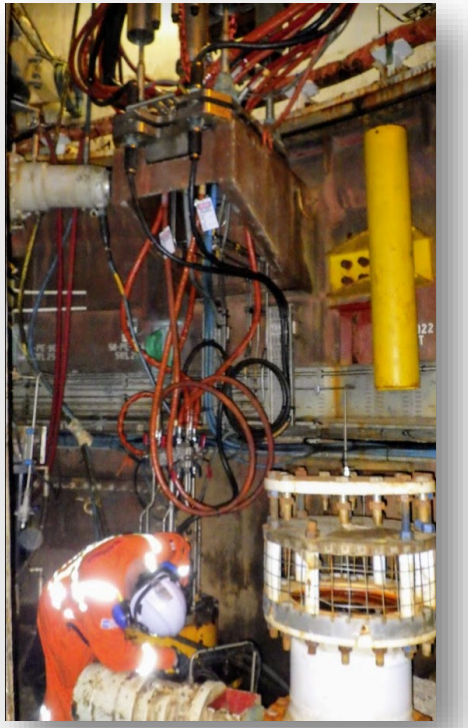
Dr Daniel Denning, Viper Innovations

SUBSEA CONTROLS DOWN UNDER 2024

The Challenge

SUT Society for Underwater Technology

Maintain the **Insulation Resistance** Integrity of the Subsea Production Control System whilst the FPSO was off-station



SUBSEA CONTROLS DOWN UNDER 2024

Companies Involved

SUT Society for Underwater Technology

- **J+S** - experts in design, engineering, operational support, and maintenance of subsea equipment

- **Verlume** - intelligent energy management and subsea power solutions for the energy industry

- **Viper Innovations** - electrical monitoring and protection for global industries including subsea and rail

SUBSEA CONTROLS DOWN UNDER 2024

Project Overview

SUT Society for Underwater Technology

- Design to Deployment in 6-months
  - Purchase Order was raised in July 2023
  - Systems 1 and 2 delivered in December 2023
  - The 3rd system delivered in February 2024
- Repurposing sped up design process
- FPSO off station - January 2024

J+S Subsea UNDER CONTROL

SUBSEA CONTROLS DOWN UNDER 2024

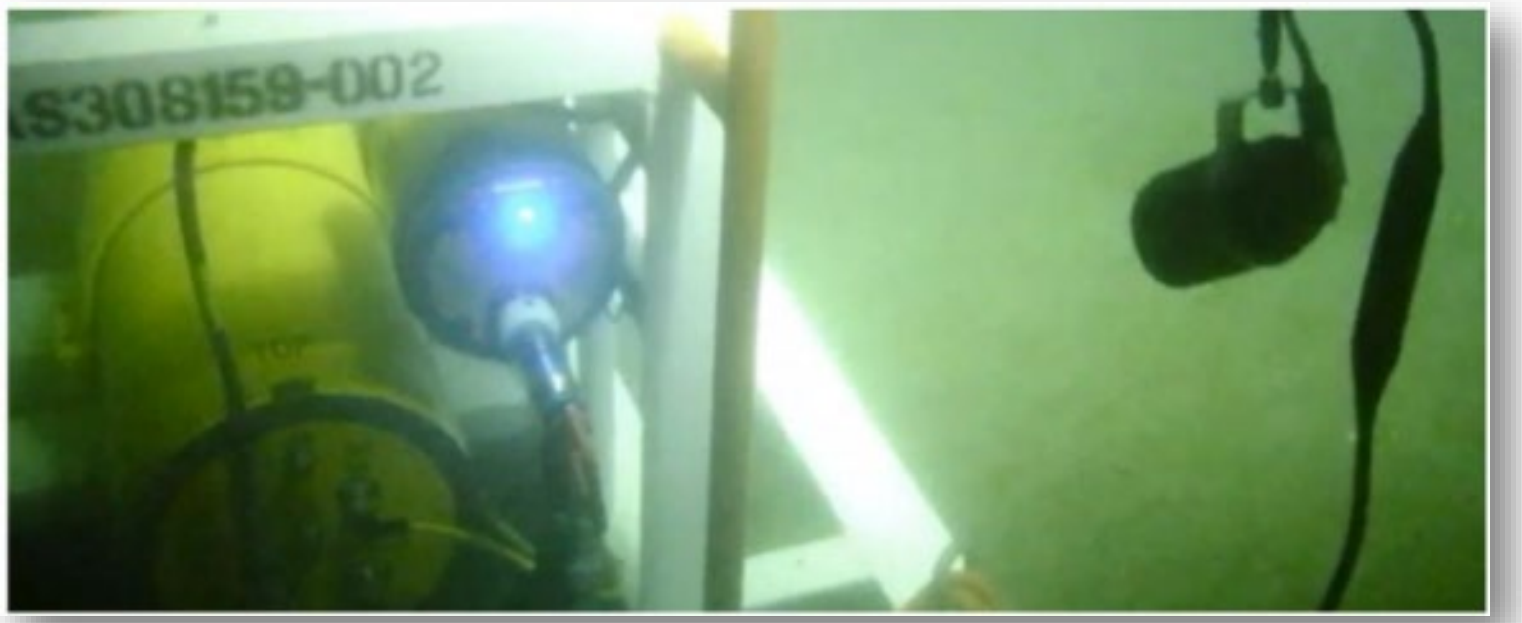
Operating Conditions / Requirements

SUT Society for Underwater Technology

- -25/-30ºC back of the vessel in January - freezing sea spray concern
- Important to have a buffer on the battery to maintain the battery.
- The system was spec'd & tested for 300m and was deployed in 120m.
- Viper's V-SLIM PCBA o/p of ~5W was the primary driver, with 24V DC continuous o/p required from the battery.
- Client's requirements:
  - Visual indication on the control module to confirm the system is operational.
  - To achieve a minimum of 90 days deployment/operation between charges.
- Skid considerations
  - Deployed close to the main drill centre structure in a trench
  - Consider the deployment/recovery and operability by ROV
  - Mid-project variation proposal to deploy in higher sea swell than originally intended

J+S Subsea UNDER CONTROL

System Challenges



- Optical activation
- Data hand-off retrieval

- No live data for 3 months – 90-day recharge
- Could only identity passivation signal

- System
  - Monitoring Modbus output, via microcontroller.
  - Microcontroller for optical activation.

SUBSEA CONTROLS DOWN UNDER 2024

System Challenges

SUT Society for Underwater Technology

Recharge Swap Methods

- Concepts included
  - Semi-permanent frame with recoverable batteries
  - Vertical mounting of battery in the frame,
  - Vertical deployment into a swivel-bucket in the frame to lay the battery flat within the frame,
  - Final design of fully recoverable frame, battery and control module.

- Final design
  - Ease and speed of recovery (reduced vessel time = significant opex savings)
  - Reduced complexity in design and manufacture (reduced capex)
  - Opportunity to easily transport the complete system onshore, for maintenance, if required.

J+S Subsea UNDER CONTROL

SUBSEA CONTROLS DOWN UNDER 2024

Battery Technology - Charge

SUT Society for Underwater Technology

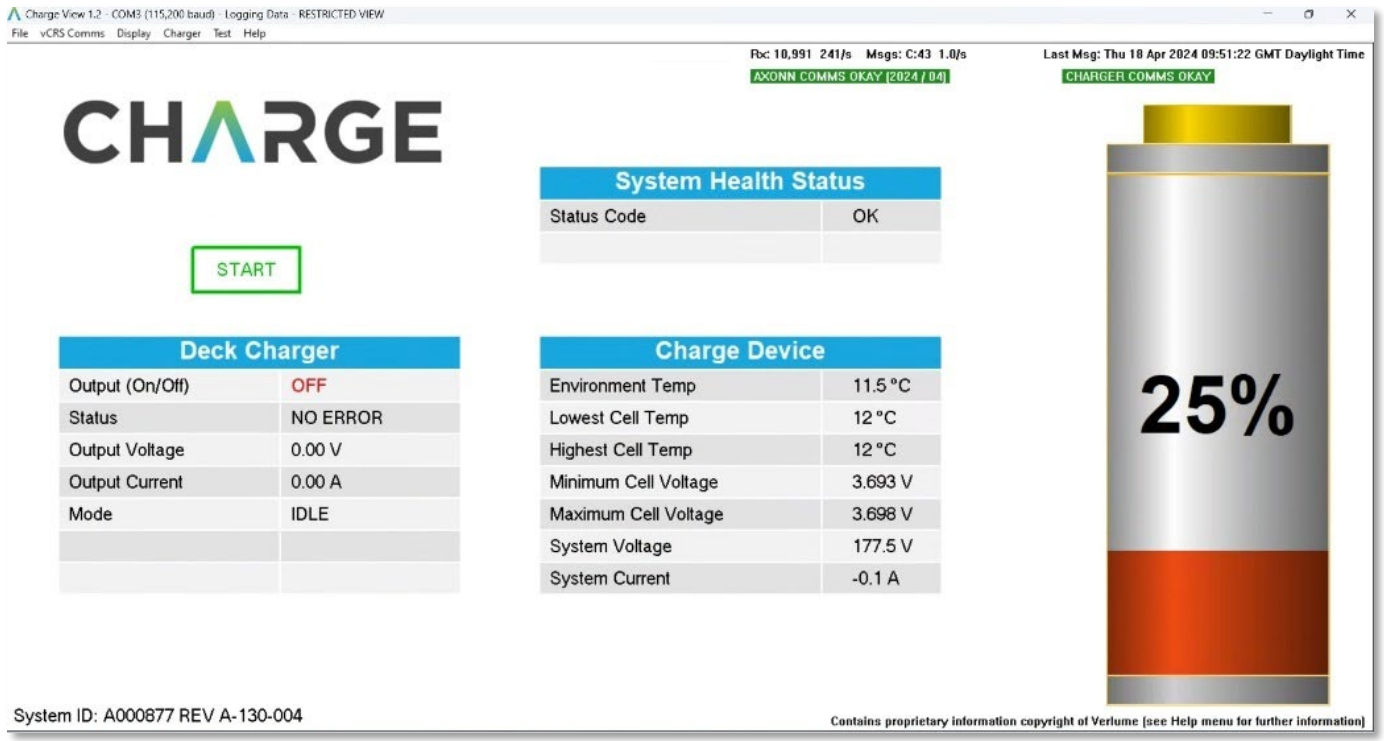
- Verlume's patented Axxon, intelligent energy management system, was important.
- Battery life was estimated on history on real-life data, in different conditions.
- "**Charge**" system:
  - Fully rechargeable, pressure encapsulated.
  - Configurable output and capacity.
  - High energy density using state-of-the-art Lithium-ion battery technology.
  - Integrated battery management system and internal environmental monitoring.
  - UN38.3 certification, API 17F on request.
- Calculated a **55KWh** battery would be suitable for **90 days.**

verlume

SUBSEA CONTROLS DOWN UNDER 2024

Battery Technology - Charge

Society for Underwater Technology



- ChargeView software allows for monitoring and autonomous charging where applicable.
- High level information on battery status including:
  - State of Charge (SoC)
  - Battery State of Health (SoH)
  - Environmental Temperature
  - Output Voltage & Current
  - Battery Status
  - Communication Status (if required)
- Data logs can be retrieved to provide further analysis on battery usage, power draw and overall battery life.

verlume

SUBSEA CONTROLS DOWN UNDER 2024

Battery Technology - Challenges

SUT Society for Underwater Technology

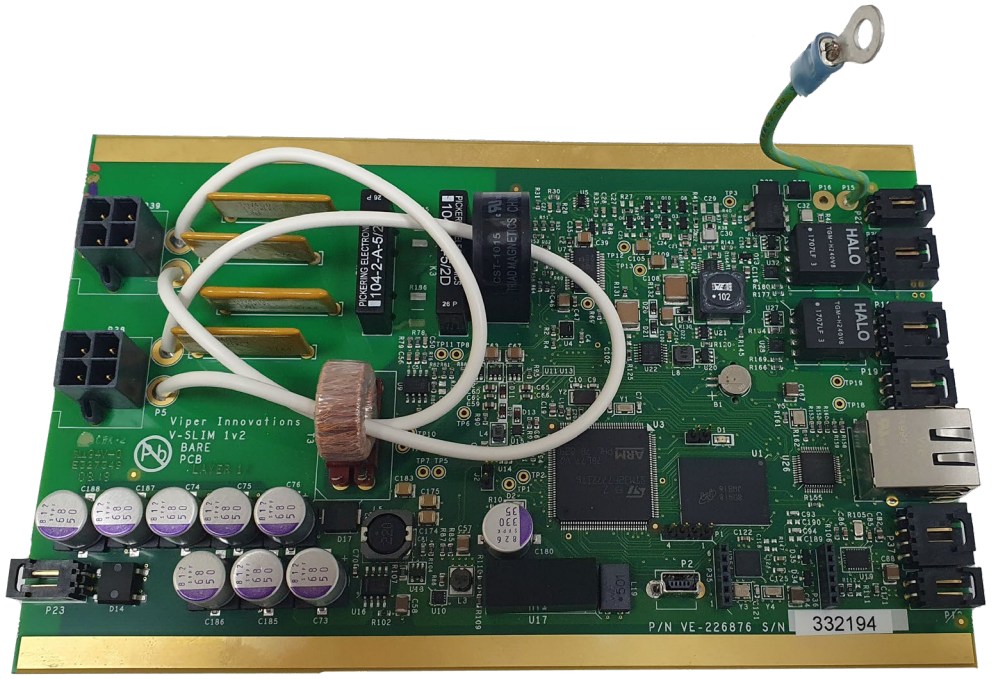
- **Low Temperatures**
  - Operating at low temperatures, e.g., -2 degrees, is achieved by an integrated charging algorithm that provides the appropriate charge rate for environmental conditions.
- **Low Power Overhead**
  - Verlume's Axonn control boards. These boards ensured system compliance with safety specifications, significantly reducing the hotel load.
- **System Integration**
  - Various test beds were created to complete multiple parallel tests of the different subsystems to test the functions of the end solution.
- **Power Calculations**
  - The power calculations were centered around the capability of charging the system within a **12-hour shift period**.
- **Recovery**
  - Charging and then redeployment. This was completed via design and analysis and followed by an intense test programme for verification.

verlume

SUBSEA CONTROLS DOWN UNDER 2024

Electrical Monitoring & Protection

SUT Society for Underwater Technology



V-SLIM

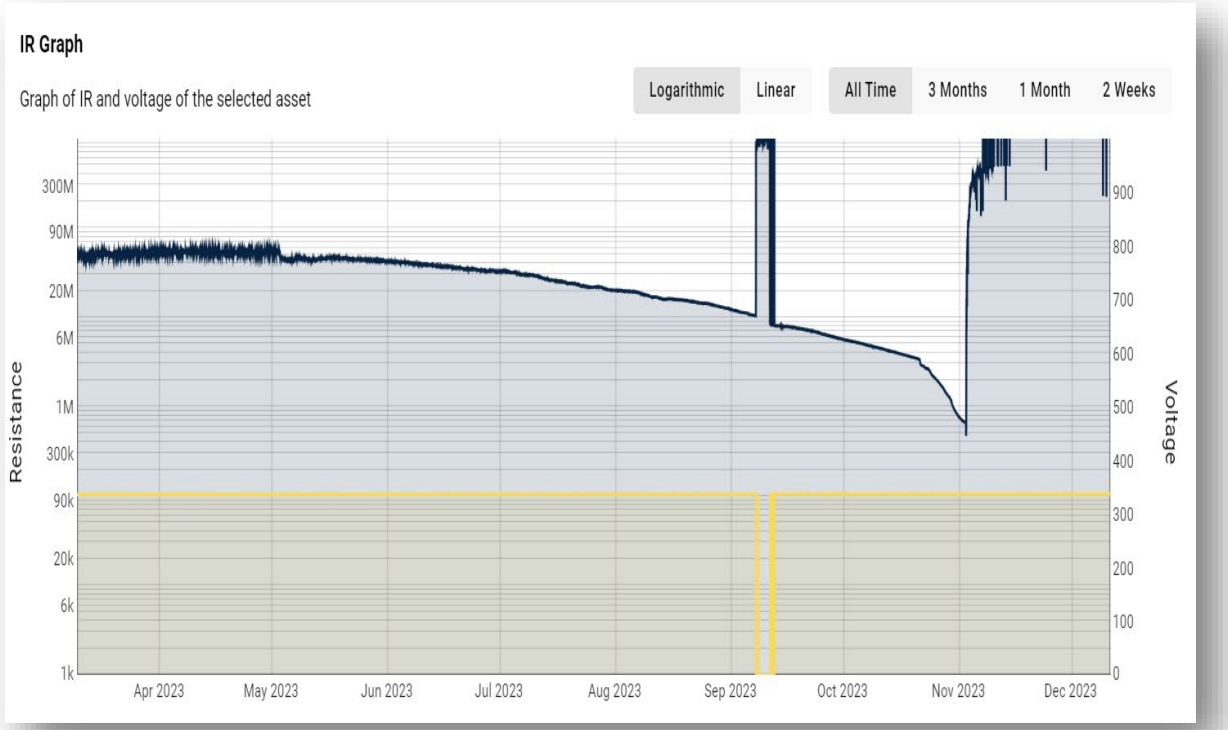
- Monitoring and Protection of Electrical delivered by V-LIFE
- Subsea Insulation Protection and Monitoring Device
  - Accurate 1GΩ Insulation Resistance Measurement
  - 150µF Total Insulation Capacitance Measurement
  - <1000V Line Voltage (direct)

VIPER INNOVATIONS

SUBSEA CONTROLS DOWN UNDER 2024

Electrical Protection – V-LIFE

SUT Society for Underwater Technology



- V-LIFE - Insulation Resistance Protection
- Passivation signal to increase the Insulation Resistance.
- Blocks water-trees with passivation material
- V-LIFE has been activated on this system for 3 years.
- V-LIFE on channels for 10 years.

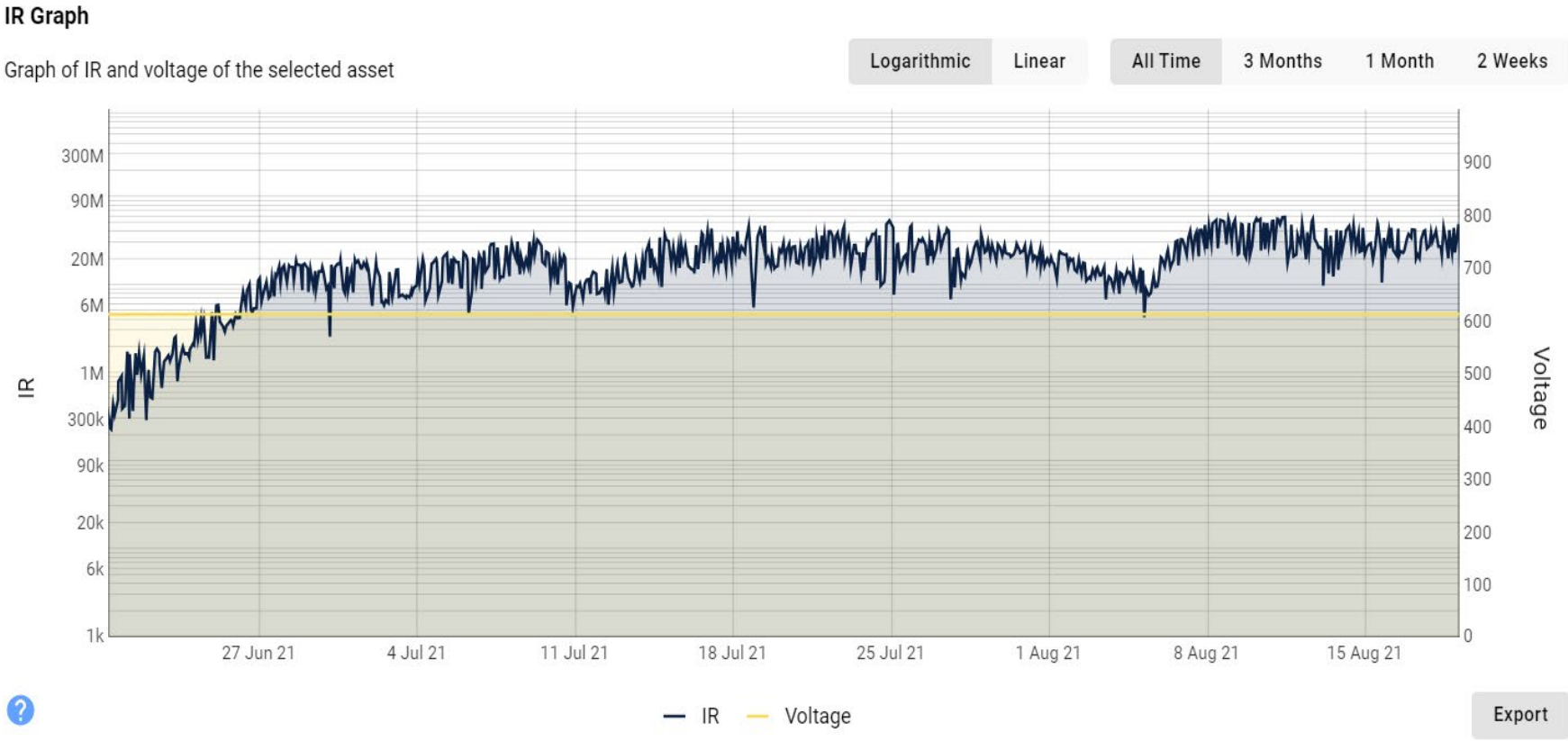
VIPER INNOVATIONS

SUBSEA CONTROLS DOWN UNDER 2024

Electrical Protection – Historical Response

Society for Underwater Technology

Initial Channel Response



- June 21 -> August 21
- IR
  ~ **300kOhms**
- Increased to
  20MOhms

~6500% increase

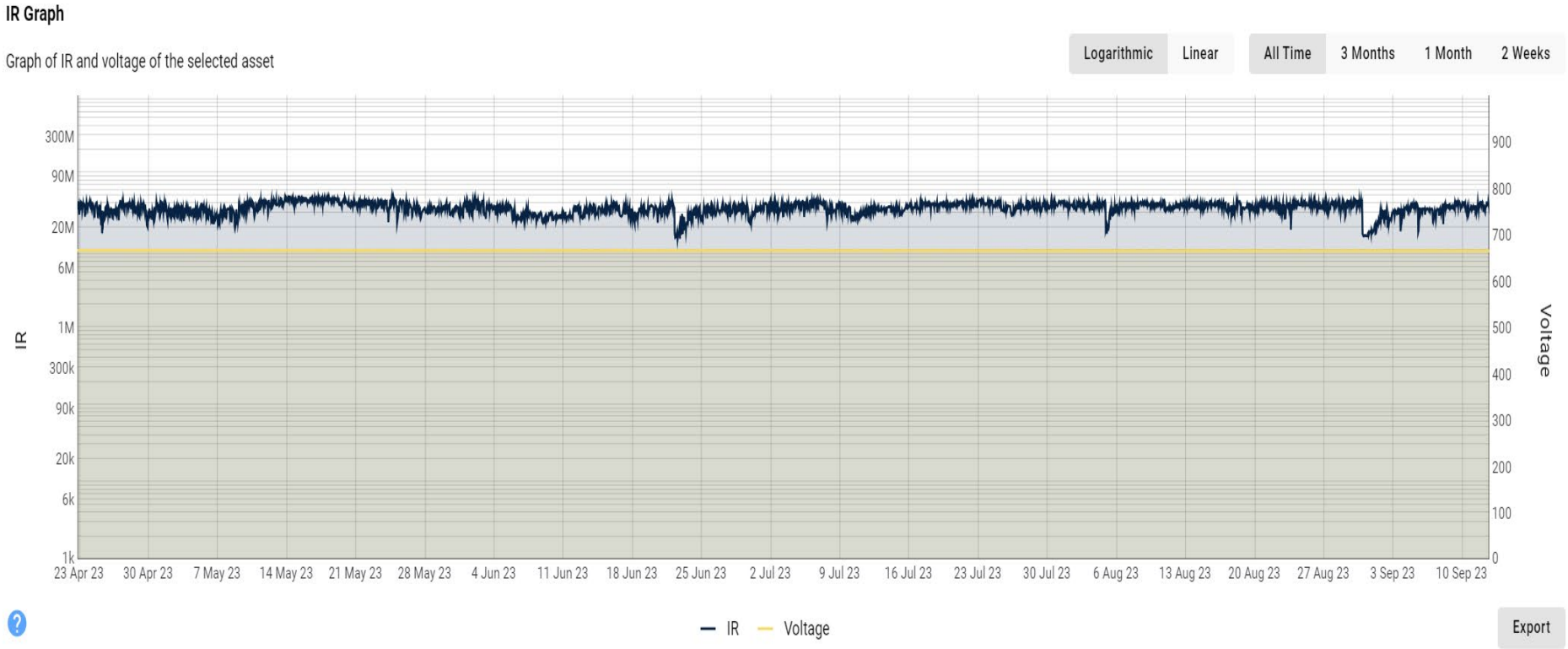
VIPER INNOVATIONS

SUBSEA CONTROLS DOWN UNDER 2024

Electrical Protection – Historical Response

Society for Underwater Technology

Pre-deployment Insulation Resistance Levels



- 2 years on from protection switch on.
- Apr 23 -> Sep 23
- Maintained @

  ~30Mohms

VIPER INNOVATIONS

SUBSEA CONTROLS DOWN UNDER 2024

Testing and Compliance

SUT Society for Underwater Technology

- API-17F qualification
- DNV-ST-E273 2.7-3 Portable offshore units.
- Designed as a subsea electronics module.
- Deployed in 120m.
- Shock, vibration and temperature, completed at Aberdeen University's test facility.
- Witnessed by DNV.

- Pre-qualified a number of boards for spares as well.

SUBSEA CONTROLS DOWN UNDER 2024

Results – The System

Society for Underwater Technology

- Longer than expected operational time.
- After 1st recovery 1 unit still had 50% after 70 days.
- Charging every 90 days -> 100days
- Deployment, recovery and charge **increased** to 100 days.

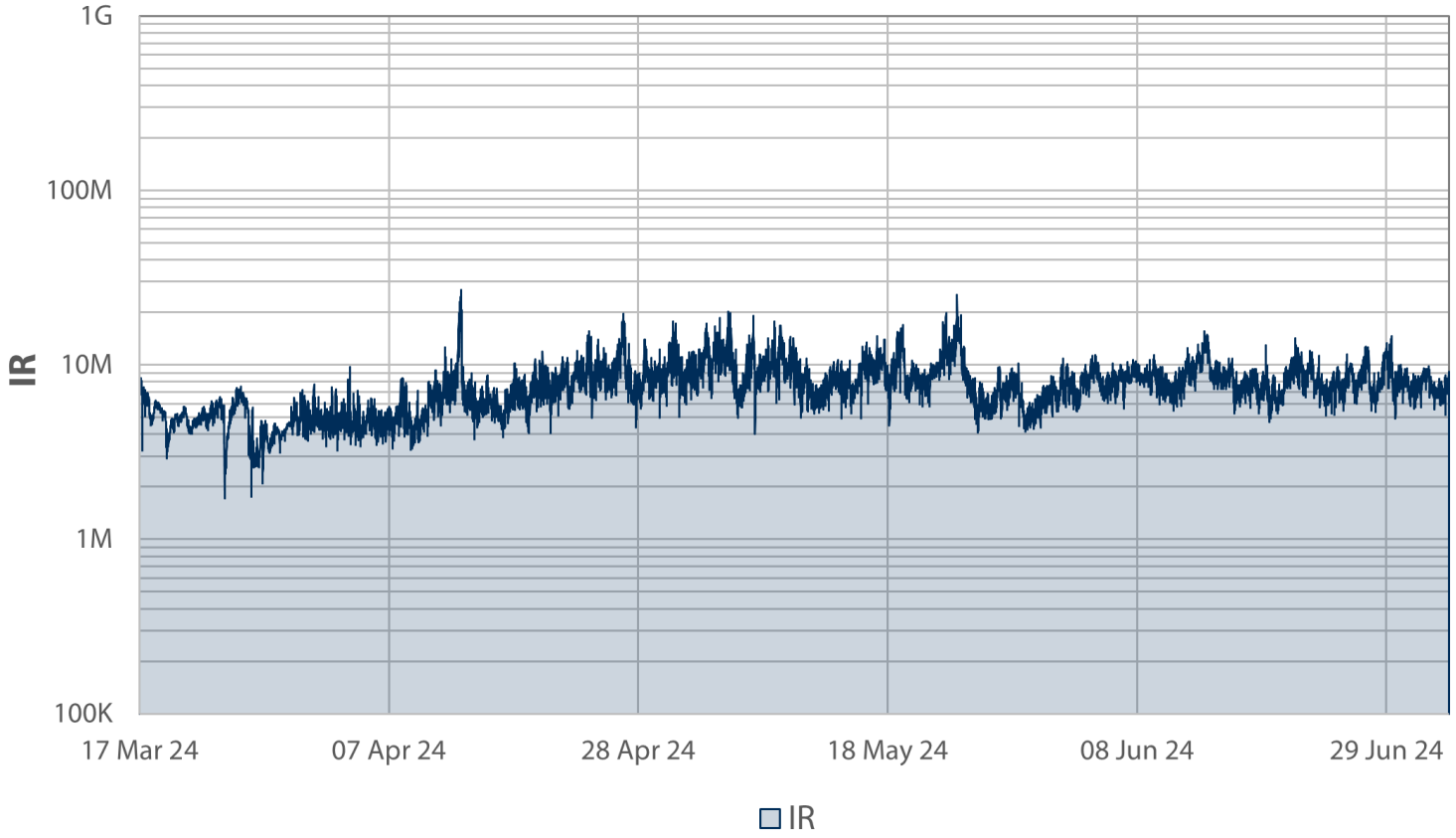
SUBSEA CONTROLS DOWN UNDER 2024

Results – IR Protection

Society for Underwater Technology

IR Graph

Graph of IR of the selected asset



Data

- Insulation Resistance held stable between

  4-10MOhms

- Over 11-months protection has been supported by the battery.

SUBSEA CONTROLS DOWN UNDER 2024

Improvements & Where Next?

SUT Society for Underwater Technology

Improvements

- More details pulled from V-SLIM Modbus Registers
- Visual aid on IR progress
- Data handoff - Flyby buoy communication, without the need to pull skid

Where next?

- FPSO returns November / December

- Battery operated electrical cores monitoring and protection has been proven.
- Inhibits the loss of the passivation material.
- Options now for FPSO wet-parking.
- Other industries that use Dynamic cables and wet parking.

SUBSEA CONTROLS
DOWN UNDER 2024

SUT
Society for
Underwater
Technology

Thank you