Underwater Diving Remote Monitoring Implementation

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ISOE Seminar

Agenda

- ✓ **Initiating Event**
- ✓ **Corrective Actions Identified**
- ✓ **Vendor Selected**
- ✓ **Technician and Diver Classroom Training**
- ✓ **Implementation**
- ✓ **Diving Mock-up Training**
- ✓ **Industry Lessons Learned**

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Background

- ✓ Kernkraftwerk Leibstadt (KKL)
- ✓ August 31st 2010 RFO26
- ✓ Diver Performing Planned Maintenance
- ✓ Diver Identified an object
  - Dive supervisor authorized diver to retrieve item
  - Item dose rate was in excess of 10,000 rem/hr (100Sv/h)
  - Exposure individual received
    - 2.800 rem (28 mSv) WB
    - 750 rem (7500 mSv) extremity

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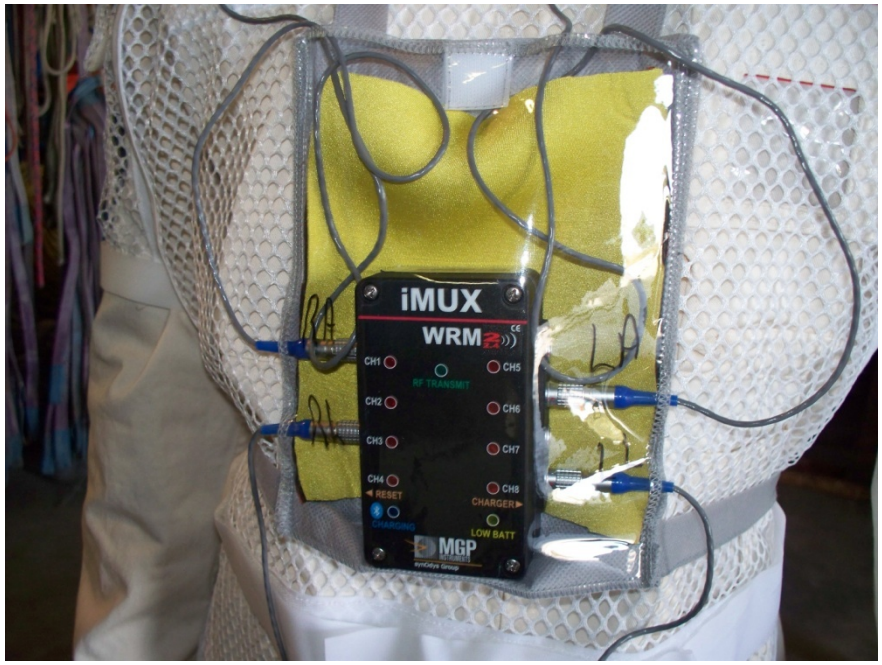
Corrective Actions/Lessons Learned

- ✓ Lessons Learned
  - Historical loss of highly active material (dry tube)
  - No radiation survey performed during the dive
  - EPD alarm was not heard because of dive suit air flow
  - Did not use remote telemetry on the diver
- ✓ Corrective Actions
  - Dry tubes will be contained prior to movement
  - A formal procedure for material removal developed
  - Dive procedure rewritten with regulator approval
  - Survey requirements enhanced
  - Requirement for underwater Telemetry instituted

Dosimetry Vendor Selected

- ✓ Mirion Technologies (MGPI) Inc.
  - Integrated package Implemented
  - Remote monitoring software: WinWRM2
  - 2 IMUX Transmitters: up to 8 dosimeters
  - 4 iPAM alarming vibrating units
  - 12 DMC-2000S electronic dosimeters
  - Hard wired active dive antenna
  - Classroom training for technicians and technical staff
  - Dive mock-up training at diving company's facility

Components



- ✓ iMUX Transmitter
- ✓ Supports up to 8 dosimeter to extremity locations
- ✓ iMUX Transmits to Active Dive Antenna

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Components

- ✓ WinWRM2 software
- ✓ Technician interface
- ✓ Real time dose and dose rate monitoring
- ✓ Visual and audio alarms

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Components

- ✓ DMC-2000 electronic dosimeters connect to the iMUX Transmitter

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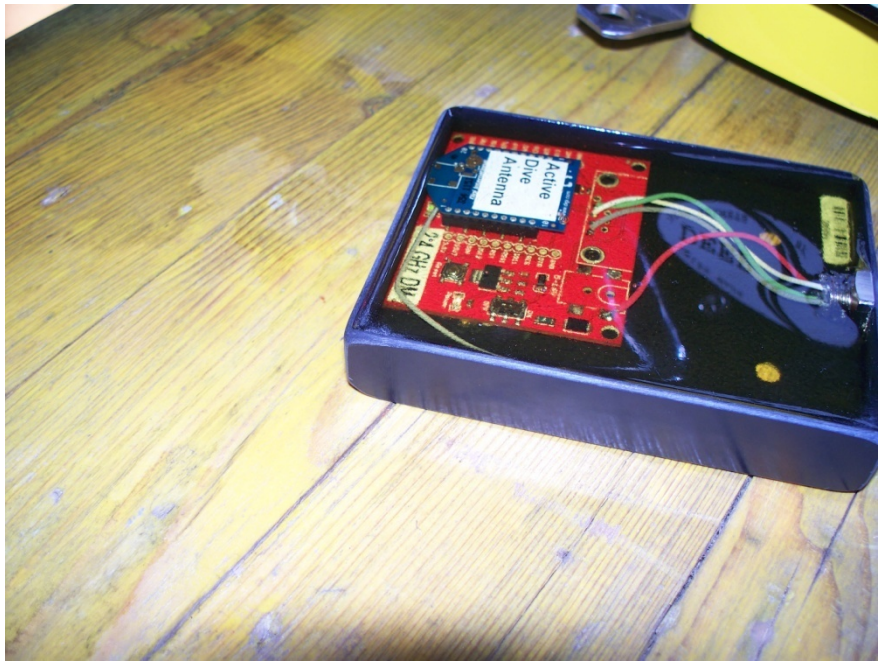
Components



- ✓ Active Dive Antenna (ADA)
- ✓ iMUX Transmits to ADA
- ✓ 100’ dive cable to connected to Active Dive Repeater, powers ADA.

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Components

- ✓ iPAM-Tx transmitter
- ✓ Secondary backup
- ✓ Vibrating Personal Module

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Components

- ✓ Active Dive Repeater
- ✓ Receives signal from Active Dive Antenna
- ✓ Provides input to the WinWRM2 remote monitoring software

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Class Room Training

- ✓ Vendor Led Instruction
  - Component familiarization and operation
  - Software training: WinWRM2
  - Plant dive procedure
  - Dosimetry Set-up
  - Diver Information input to remote monitoring software
  - Initial diver dress-out
  - Troubleshooting

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Dive mock up training

- ✓ Equipment set-up
- ✓ Final instruction
- ✓ System testing prior to dive vest placement

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Dive mock up training

- ✓ Initial diver dressout
  - iMUX with comfort lanyard

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Dive Mock Up Training

- ✓ Diver dress out
  - iMUX transmitter
  - 5 dosimeter locations
  - Right and left arm
  - Right and left leg
  - Chest

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Dive Mock Up Training

- ✓ Divemaster preparing diver

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Dive Mock Up Training

- ✓ Dive helmet
- ✓ Final dry checks of dosimetry transmissons

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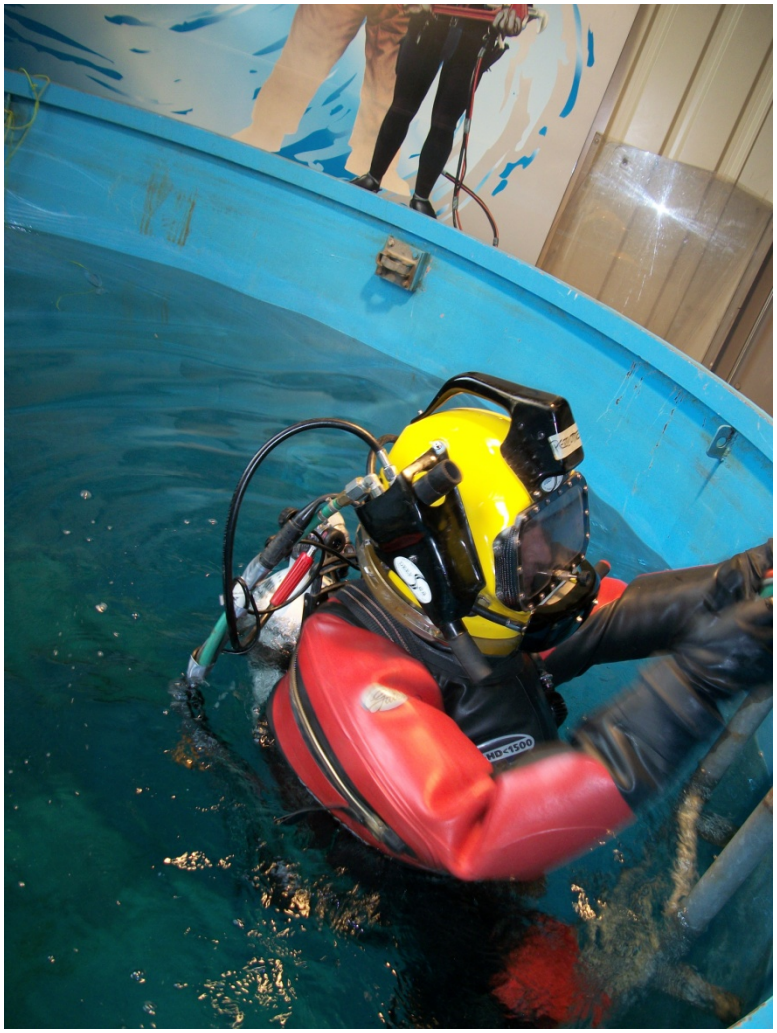
Dive Mock Up Training



- ✓ Diver entering mock-up dive tank

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Dive Mock Up Training

- ✓ Diver testing comfort of iMUX and electronic dosimetry

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Dive Mock Up Training

- ✓ Post dive equipment removal

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Implementation

- ✓ May 2012 at KKL
- ✓ Dive Equipment

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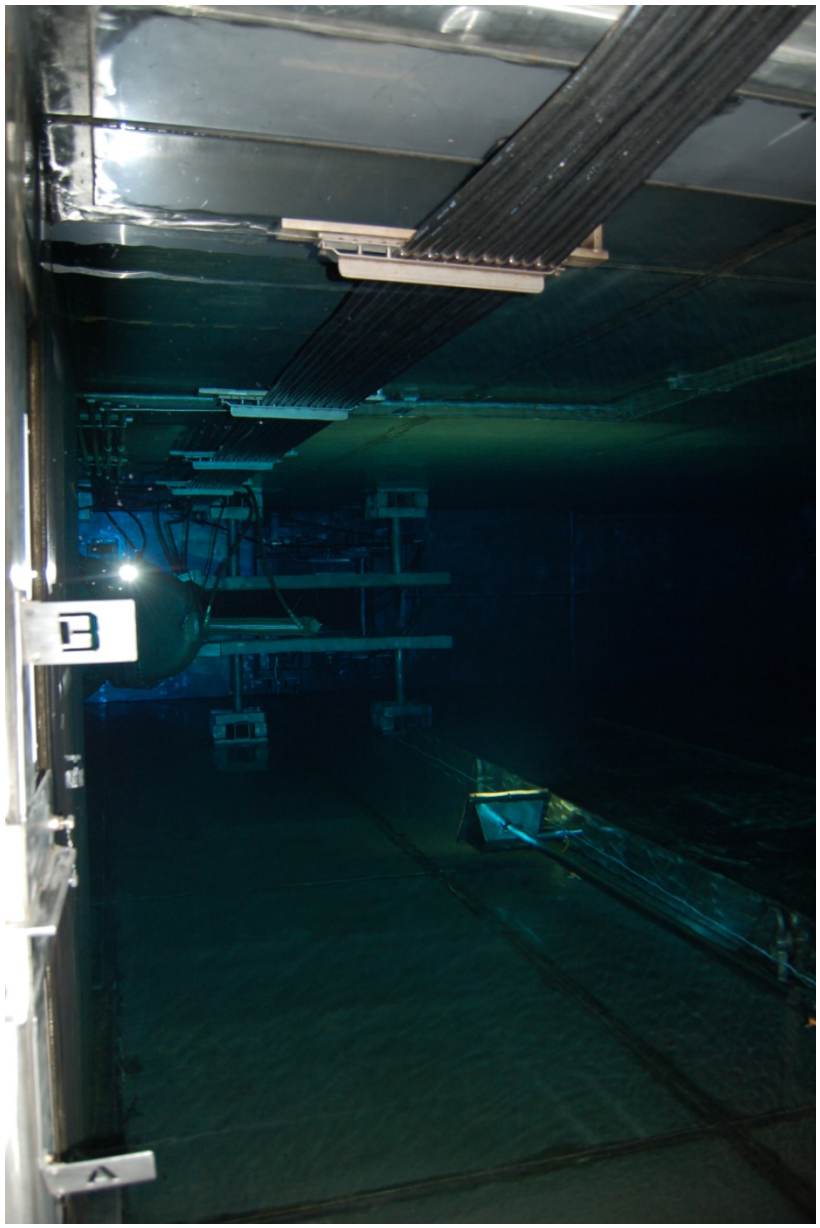
Implementation



- ✓ Dive Location Spent fuel transfer tube

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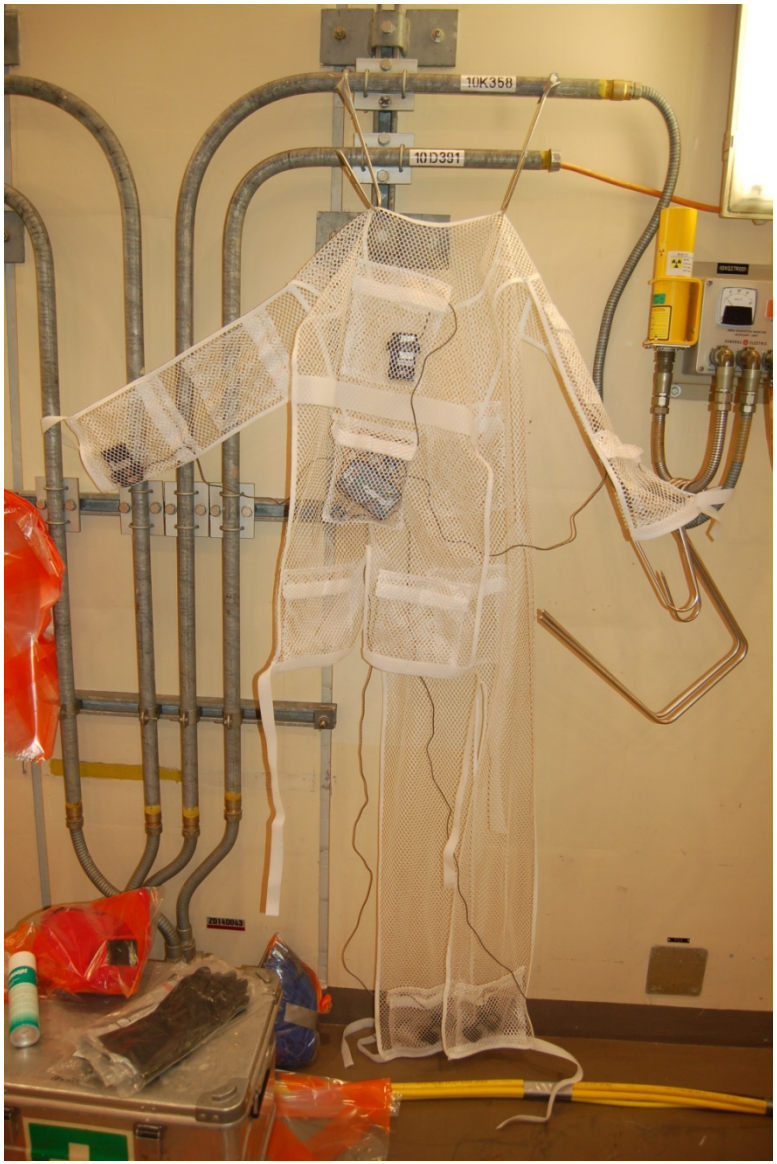
Implementation



- ✓ Dive transmitter vest
- ✓ Mesh material for comfort
- ✓ Multi pocket for versatile location of dosimetry

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Implementation

- ✓ Diver prepared with dosimetry

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Implementation

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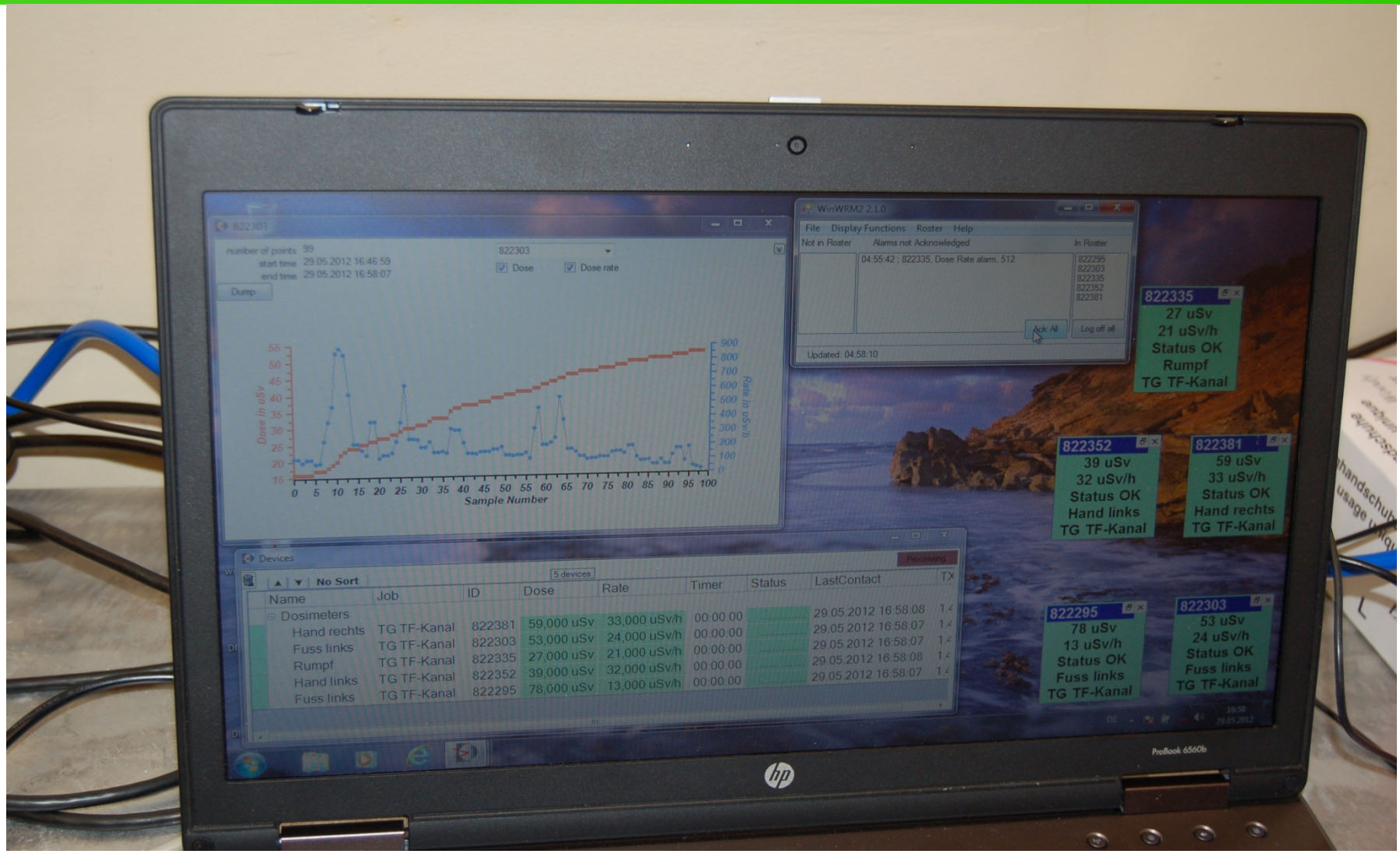
Implementation



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Implementation

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Final Comments

✓ Results

- 2 Practice dives
- 2 Working Dives
- All dives completed safely
- Equipment worked to KKL satisfaction and expectations
- Worker received 1 mSv
- Highest dose rate seen 3 mSv/h
- Regulator satisfied with corrective actions

Final Comments

✓ Excellence in Control Of Under Water Activities

- Procedure containing the following aspects
  - Clear Roles and Responsibilities
  - Constant communication capability between diver, dive supervisor and radiation protection personnel
  - Requirement for physical diver restriction (tether/underwater screen)
  - Detailed survey of underwater radiological conditions prior to dive evolution
  - Multiple dosimetry with remote monitoring by radiation protection personnel
  - Underwater survey instrumentation with remote readout to supporting RP personnel for surveying periodically
  - Clear stop work criteria with all personnel possessing stop work authority

ISOE Benchmarking

- ✓ Lessons Learned from the International Community
  - ➢ 2003 ISOE Benchmark of Oskarsham / Forsmark
    - ✓ Testing of stellite hard-faced valves for elemental cobalt after maintenance.
  - ➢ 2007 ISOE Benchmark of Sizewell B
    - ✓ End Of Cycle (EOC) Boron.
  - ➢ 2009 ISOE Benchmark of DOEL
    - ✓ Shutdown at 2% power then manual insertion of rods (Soft Shutdown)
  - ➢ 2010 Benchmark of TEPCO
    - ✓ Reduction from 100 degrees/hr to 50 degrees/hr
    - ✓ Reduced cooldown rates to decrease thermal shock release of activated material

Thank You?