Testing & Commissioning Process for a Light Rail Project

A case study from the Dublin Luas Light Rail System

The IET Railway Network
Young Professionals Seminar
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ARUP
What is covered…

- **The Dublin Luas**
  - System
  - Line B1
  - Contractual Hierarchy
  - Systems

- **Testing & Commissioning**
  - Planning
  - T&C Model
  - Systems Integration

- **Examples**
  - Substations
  - Gauge Runs
  - Control Centre

- **Conclusions & Discussion**
The Dublin Luas

- Light rail / tram system since 2004 – part on street, part segregated
- Red Line – Dublin Connolly and The Point to Tallaght (15.5 km, 27 stops)
- Green Line – St. Stephen’s Green to Sandyford (9 km, 13 stops)
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- Depots – Red Cow (Red line) & Sandyford (Green line)
- Control Centre – Red Cow
Line B1

- Green line extension from Sandyford to Brides Glen
- 7.5 km, 11 new stops
- Structures – 4 bridges, 1 underpass
- 6 road junctions
- Track – Ballast, embedded, bi-block slab
- Journey time – 18 min
- €300 million project
- Being developed on a PPP basis as part of the Government’s Transport 21 programme.
Line B1

LUAS

LINE B1-GREEN LINE EXTENSION
SANDYFORD to CHERRYWOOD

To City Centre

Sandyford

Central Park

Murphystown Road

The Gallops

Leopardstown Valley

Ballyogan Wood

Reservoirs

Brewery Road

Leopardstown Road

Tonquay Road

Brighton Road

Brennanstown Road

Brennanstown

Carrickmines

Proposed Park & Ride

Racecourse

Occasional Stop

Glencairn

Leopardstown

M50

Glenmuck Road

Glenmuck Road

Brides Glen

Tully Cross

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Systems

Tramstops

- Passenger Information Display (PID)
- Passenger Announcement (PA)
- CCTV
- Lighting
Systems

Tramstops

- Passenger Information Display (PID)
- Passenger Announcement (PA)
- CCTV
- Lighting
- Emergency telephones
- Ticket machines
- Ticket Validating Machines
- Earthing
- Tramstop cubicle (power & comms)
Systems

Control System

- Central Control
- FE SCADA
- PS SCADA
- Remote Terminal Units
- Control panel
- Cable transmission, comms
Systems

Substation, Traction
- AC & DC distribution
- MV & DC switchgears
- Traction & Aux. transformers
- Rectifier
- Cabling
- UPS & batteries

3-Phase Traction Transformer

Auxiliary Transformer
Systems

Overhead Conductor System

- Switching
- Trackside distribution
- Feeders
- Return cables
- Contact wire
- Section insulators
Systems

Signalling

- AVLS loops
- On-board AVLS
- Track circuits
- Point motors
- Point heaters
- Signals
- Comms/CCS

Radio

- Radio Mast
- Repeaters
- Telephones
- Antennas

Radio Mast (at Sandyford)
Systems

Other

- Earthing
- Bonding
- EMC
- Stray Current

- Cable Ducts
- Chambers
Systems

.... and the INTERFACES with:

- All Structures and Civils
- Building services
- Utilities
- 3rd Party
- Trams

Embedded Rail to Ballast Track
Testing & Commissioning

- **What**
  - A very important phase or series of activities in the construction of a railway before it can be safely opened for commercial operation.

- **When**
  - After Detailed Design, after safety validation and submission of reports, during and after construction

- **Why**
  - To ensure safe opening of the railway
  - To demonstrate all technical and project requirements are met
  - To prove all internal and external interfaces are systematically closed

- **Who**
  - Employer, Main Contractor, Sub-contractor(s), Supplier(s), Testing Bodies
Testing & Commissioning

**Planning**
- Basic strategy by employer
- All Contractors follow the T&C model
- Contractors provide T&C Plan and other documentation
- Contractors provide supervisory and technical staff and equipment for inspection and testing
- Contractors are responsible for testing, reporting, certifying, getting approvals, etc.

**Documentation**
- T&C Plan – by Contractor
- Test Procedures – by Sub-contractor/ Manufacturer/ Approval Body
- Test Reports – by Sub-contractor/ Contractor
- Test Certificates – by Sub-contractor/ Contractor
- Snag Lists, etc.
Testing & Commissioning

- **T&C Model: FAT-SIT-SAT-SATOV**

- **FAT – Factory Acceptance Tests**
  - To prove that components and equipment meet specifications.
  - **FAT Types:**
    - **Hardware**
      - Routine Tests – on individual components
      - Type Tests – on ONE complete equipment
    - **Software**
      - Simulations
      - Test bench
  - Responsibility: Manufacturer (or Contractor)
Testing & Commissioning

- **T&C Model: FAT-SIT-SAT-SATOV**

- **SIT – Site Installation Tests**
  - To demonstrate all equipment are correctly installed, wired, checked and suitable for operation.
  - **SIT types:**
    - Visual
    - Functional
    - Operational (low level)
  - **Responsibility: Contractor + Manufacturer**
Testing & Commissioning

- **T&C Model: FAT-SIT-SAT-SATOV**

- **SAT – Site Acceptance Tests**
  - *Pre-commissioning stage*
  - To show that the equipments and sub-system can functionally operate as an integrated system.
  - **Sub-stages:**
    - **SAT-Interim**
      - Pre-verification of performance of interfaces to minimise modification
    - **SAT-Internal**
      - Integration of equipment under one contract/ discipline/ scope of works
    - **SAT-External**
      - Integration of equipment under more than one contract/ discipline/ scope of works

- **Responsibility: Contractor**
Testing & Commissioning

- **T&C Model: FAT-SIT-SAT-SATOV**

- **SATOV – Overall Site Acceptance Tests**
  - **Commissioning stage**
  - To prove that overall system will operate satisfactorily in commercial service and can be handed over to the employer.
  - **Sub-stages:**
    - SATOV-Equipment
      - Functional
      - Operational
      - Degraded Mode
      - Endurance
    - SATOV-Line
      - Take-over by employer
      - Trial running of old/new trams on new infrastructure
  - **Responsibility:** Employer + Contractor + Operator
Testing & Commissioning

- **Actual T&C Model used:** FAT-SIT-SAT-SAT-Dynamic-SATOV

- **SAT-Dynamic – SAT-External + Trams**
  - Integration of equipment under more than one contract/ discipline/ scope of works
  - Tram running takes places at low speeds to test integration with various sub-systems.
  - Responsibility: Contractor + Operator (with Employer witnessing the tests)
Systems Integration

Systems Test Room

STR is a true replica of the Central Control Room (CCR)

Used to:

- Test systems without affecting existing service
- Upgrading the Central Control System and Room
- Smooth migration of systems

STR was used during systems testing for Line C1

STR tested systems for Line B1 and for any future lines
SIT (Substation)

- Visual
- Functional
- Operational
  (low level)

Cable Tests

Rectifier

Battery Charger

MV Switchgear

PS SCADA - RTU & Panel

MV Switchgear – Dielectric Test
Gauge Tests – Structures

Gauge Tests – Platform

Interface between – Tram & Crossovers, Pantographs & OHLE
SAT & SATOV

Energisation – Voltage, Sectioning & interface with substation

Central Control Room – CCTVs, PIDs & interface with AVLS
Conclusions & Discussion

- **Strengths**
  - Robust model, phase-wise, whole systems approach
  - Repetition of certain tests while closing interfaces between disciplines
  - Ensures low level interfaces/snags are closed before high level integration
  - Hands over a safe, integrated system with complete testing records

- **Weaknesses**
  - Stage split up could be unclear if not laid out at the beginning
  - Time consuming

- **Some lessons learnt**
  - Ideal versus practical?
  - Time, budget constraints and safety?
  - Competency of the T&C personnel?
  - Best Practice?
Questions?

Thanks

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