Cityringen – Safety Certification of Civil Works

Gunni S. Frederiksen
Chief Safety Manager – Metroselskabet
M.Sc. Comp. Science/Physics

Member of
DS S-509 Committee
VDV – Verband Deutscher Verkehrsunternehmen
UITP Automatic Metro Group ("Observatory")

Standardisation work:
Cenelec/TC9X/WG-8/User Guide for EN-50126
IEC/TC9/WG-39/"AUGT"-Automated Urban Guided Transport
IEC/TC9/WG-40/"UGTMS"-Urban Guided Transport Management and Command/Control Systems
Agenda

– Overview of the Cityringen project
– Organising the Safety Work on Cityringen
– Learning from the existing Metro
– Safety Certification of the Civil Works part
– Challenges
Metroselskabet I/S

Ownership

- 50% Copenhagen Municipality
- 41.7% Danish State
- 8.3% Frederiksberg Municipality

Tasks:
- Operate existing Metro
- Construct Cityringen
- Plan for the CR Branch Off to Nordhavnen/Sydhavnen
- Prepare plans for Ring 3 for the Ministry of Transport

Organisation:
- 270 employees (Administration, Operation, Construction)
Cityringen
Cityringen + Nordhavn branch off

- 2 single track tunnels each approx. 18 km in length
- 18 underground stations
- 1 elevated station
- 2 crossover facilities
- 2 bifurcation facilities
- 3 evacuation and ventilation shafts
- 1 evacuation shaft
- Automated Control and Maintenance Centre (CMC)
- Civil Works Contracts: value approx. 1.9 billion Euro
- Transportation Services Contracts: value approx. 800 million Euro (incl. 5 years maintenance)
Safety certification is about

1: Traceability

2: Traceability

3: Traceability

Traceability of what?
Traceability of Safety Requirements

Two Sources of Safety Requirements:

– Codes & Standards (BOStrab, NFPA-130, EN-5012X, Eurocodes..)

– Mitigation of Hazards in the Hazard Log
Codes and Standards

—BOStrab
  • German Federal Regulations on the construction and operation of light rail transit systems

—NFPA 130 (Fire Safety)
  • Standard for fixed guideway transit and passenger rail systems

—Cenelec standards
  • EN 50126 (Railway applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS))
  • EN 50128 (Railway applications – Communication, signalling and processing systems - Software for railway control and protection systems)
  • EN 50129 (Railway applications – Communication, signalling and processing systems - Safety related electronic systems for signalling)
Codes and Standards

—EN/ISO/CEN Standards
  • EN 45545 Railway applications – Fire protection on railway vehicles

—IEC standards
  • IEC 62267 Railway applications – Automated Urban Guided Transport (AUGT) – Safety Requirements

—Eurodes

—Danish Building Codes
CR Safety Org. before contract

Safety Regulatory Authority “Trafikstyrelsen”

Technical Director Metroselskabet I/S

Chief Safety Manager

Deputy Chief Safety Manager

Assessor TÜV

Technical Safety Manager MCW
COWI ARUP SYSTRA

Technical Safety Manager ARL
COWI LE34

Technical Safety Manager MTS
Ramboll Atkins

Technical Safety Manager O&M
MS
CR Safety Approval Process

Milestones:

- OSD-TD: Overall System Design - Tender Design
- TRP: Test Run Permit
- DA: Design Approval
- SLDA: System Level Design Approval
- SA: Subsystem Acceptance
- ARS: Acceptance of Rolling Stock
- FSA: Functional Section Acceptance
- IAS: Installation Acceptance of Sections
- AOP: Approval of Operator Procedures
- AOT: Approval of Operator Training and Organisation
- POC: Preliminary Operator Certificate
- OC: Operator Certificate
CR Safety Organisation after contract

SRA – "Trafikstyrelsen"

TD-MS

CSM

DCSM
SM-TSM
SM-CWM
SM-ARL
SM-OC

RIM-CWM

RIM-CR

Assessor TÜV/DNV/Rovsing

CWC
SM-CWC
RIM-CWC

TSC
SM-TSC
RIM-TSC
Background

– ”Trafikstyrelsen” (SRA) is the overall authority for both the ”BOStrab” and the Danish Building Act for specific Civil and Railway Works (due to the Act on Cityringen ”Lov (552) om en Cityring”)

– SRA therefore needs to issue Building Permits for stations and shafts

– CW is special due to the ”constructing while designing” principle

– Therefore the Building Act allows issuing of Partial Building Permits
## Terminology

<table>
<thead>
<tr>
<th>Danish Term</th>
<th>English Translation</th>
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<tbody>
<tr>
<td>&quot;Byggetilladelse&quot;</td>
<td>Building Permit</td>
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<tr>
<td>&quot;Deltilladelse&quot;</td>
<td>Partial Building Permit</td>
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<tr>
<td>&quot;Ibrugtagnings-tilladelse&quot;</td>
<td>Final Permit (Permit for use, or Occupancy Permit)</td>
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<tr>
<td>&quot;Tilsyn&quot;</td>
<td>Supervision</td>
</tr>
<tr>
<td>&quot;Vilkår, betingelser&quot;</td>
<td>Condition(s) (Requirements and provisions of a Permit)</td>
</tr>
</tbody>
</table>
## Foundations for permits

<table>
<thead>
<tr>
<th>Building Permits</th>
<th>“Byggelov” Act §16 and BOStrab §60</th>
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</thead>
<tbody>
<tr>
<td>Partial Building Permits</td>
<td>“Byggelov” Act §16 [and BOStrab §60]</td>
</tr>
<tr>
<td>Final Permits</td>
<td>“Byggelov” Act §16 and BOStrab §62</td>
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</table>
# Mapping to “Metro process”

<table>
<thead>
<tr>
<th>Permit Type</th>
<th>Approval Milestone</th>
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</thead>
<tbody>
<tr>
<td>Partial Building Permit</td>
<td>None (Not specified for any operational safety approval milestone in CCB-4.5 “Safety Process”)</td>
</tr>
<tr>
<td>Building Permit</td>
<td>“Design Approval” (DA)</td>
</tr>
<tr>
<td>Final Permit (“Ibrugtagnings-tilladelse”)</td>
<td>“Installation Acceptance for Section” (IAS), “Operator’s Certificate” (OC)</td>
</tr>
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CR Safety Approval Process

Milestones:
- **OSD-TD**: Overall System Design - Tender Design
- **TRP**: Test Run Permit
- **DA**: Design Approval
- **SLDA**: System Level Design Approval
- **SA**: Subsystem Acceptance
- **ARS**: Acceptance of Rolling Stock
- **FSA**: Functional Section Acceptance
- **IAS**: Installation Acceptance of Sections
- **AOP**: Approval of Operator Procedures
- **AOT**: Approval of Operator Training and Organisation
- **POC**: Preliminary Operator Certificate
- **OC**: Operator Certificate
Preliminary and Detailed Design

DB
Design Basis

PD

DD
- Retaining walls
- Roof, Intermediate, Technical, Platform level
- Internal structures
DETAILED DESIGN
PACKAGES TYPICAL SECTION

**DD1a**
- Temporary sheet piles (where required)
  - Guide walls
  - Retaining walls

**DD1b**
- Temporary bracings

**DD1c**
- Capping beams
  - Roof slab
  - Construction Sequences and Hold Point during excavation

**DD2a**
- Formworks
  - Waterproofing system

**DD2b**
- Reinforcement of
  - Base slab
  - Lining walls between base slab and intermediate level slab

**DD2c**
- Lining walls between intermediate slab and below concourse level slab

**DD3a**
- Reinforcement of
  - Lining walls between below concourse level slab and concourse level slab
  - Below concourse level slab

**DD3b**
- Reinforcement of
  - Lining walls between concourse level and top slab
  - Concourse level slab

**DD3c**
- Detailed design for M & E works
  - Integrating main most probable suppliers

**DD4a**
- Detailed design for M & E works
  - Including Construction drawings for equipments

**DD4b**
- Detailed design for M & E works
Basis for Partial Building Permits based on PD

- The PBP template from CMT listing the content of the PD package including VC-Certificates approved by MS
- Construction Risk Safety Report or site specific risk register
- CMT evidence of control of ground settlement
- CMT evidence of control of ground water
- CMT evidence of structural integrity, water tightness and fire safety
- MS supplied list of applications/approvals from other Authorities
- A dedicated Assessor Report on the above mentioned documentation
Flow of CW Safety Documentation for PD/PBP

- **CMT**: Design Review
- **MS**: Design Review
- **TÜV**: Assessment/Inspection of Safety
- **Trafikstyrelsen**: Safety Approval

- Conteco Check Certificates
- MS "No Comments status"
- Assessment or inspection report on Safety
- Safety Approval
Prerequisites for MS Safety Notification (site work)

- PBP at PD level obtained from TRS
- The DD package is well described from CMT
- The VC-certificate from CMT for the DD package signed by CMT’s VC-checker (Conteco) & CMT and approved by MS
- The review comments from MS on the DD package have been answered satisfactorily i.e. MS “No comments status” obtained
- The Assessor’s Inspection Report on the DD package gives the status “Accepted by the Assessor”/Assessor signature on the Safety Notification
Flow of CW Safety Documentation for DD/MS Safety Notification

CMT
Design Review

MS
Design Review

TÜV
Assessment/Inspection of Safety

Trafikstyrelsen
MS Safety Notification

Conteco Check Certificates

MS "No Comments status"

Assessment or inspection report on Safety
The complete/final Building Permit at DD/DA

1. CMT’s Safety Case ”containing” all the safety cases for the DD construction suppackages + all the VC-certificates + mitigation of the Operational Risks

2. The (updated) Construction Risk Safety Case (only in case of a leading location)

3. MS (updated) list of applications/approvals to/from other Authorities

4. The Assessor Report on the above documentation

5. Metroselskabet's application to SRA for the Complete Building Permit (DA)
Challenges

– Size and complexity

– CW process by tradition is "constructing while designing"

– Interfaces between subsystems and between the two contracts

– ”New” proces for CW approvals by the SRA (”Trafikstyrelsen”)