CNGS dismantling pre-study
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AWAKE Collaboration meeting
18 September 2020
Pre-study of CNGS dismantling for AWAKE

• Scope
• Introduction:
  • Examples of similar work
  • Challenges/advantages for CNGS
  • Stakeholders, resources
• Status of pre-study
• Next steps
Pre-study of dismantling the CNGS target area:

**Scope**

- Provide, on a conceptual level, a *quantitative evaluation* of its *cost, schedule and personnel needed*, as input for the 2021 CSR. This pre-study shall
  1) result in *clear requirements* of the AWAKE Run2 for what concerns *space and conditions*, defining e.g. the extent of and the radiological classification of the area after the dismantling
  2) give an *estimate*, for a scenario that fulfils the requirements mentioned above, on *required resources and their availability*.

- To this end, information will be collected from EN-STI, EN-EA, EN-HE and HSE-RP

The pre-study is a sub-project of the Coordination Package 4 (integration, infrastructure, installation) coordinated by Ans Pardons
We know how to dismantle target areas e.g. WANF was transformed into HiRadMat

- Dismantling the West AREA Neutrino Factory (WANF) in 2009 was a very interesting experience with many lessons learnt - on what to do (or not to do!)
- Lessons from WANF dismantling were applied in AWAKE, e.g. keep CNGS target area ventilated to keep humidity low (humidity → rust → contaminated dust)
- Many other examples within the EN-department: TCC2, East Area, AD target
We know how to ...

1. Clean & decontaminate (a,b)
2. Remove hottest objects remotely (c,d,e,f)
3. Dismantle infrastructure (g,h,i)
Advantages / Challenges

Advantages

• CNGS facility is “independent” from the CERN accelerator complex via TAG42
  • No access or operation constraints
  • Dismantling can be done in parallel to CERN machine operation
  • Possible to dismantle in one go without interruption (or not)
  • From LS2 experience: More CERN resources are more available during CERN complex’s operation than during long shutdown
• The most radioactive CNGS objects were designed for low-dose remote removal, with minimal human intervention. Full documentation and tools are available
• CNGS is a “recent” facility
  • well-documented
  • many CNGS experts still at CERN
  • many dedicated dismantling tools still available

Challenges

• CNGS dismantling requires
  • Dismantling of the AWAKE experimental area
  • Long interruption for AWAKE operation (> 1 year)
• Many radioactive components (including hundreds of shielding blocks) must be removed
• Component removal and access is only possible via the >1km long underground TAG41 tunnel
  • Only (slow) electrical vehicles are allowed
  • Transport is very time-consuming and radiation dose-inducing
Stakeholders (CERN)

- AWAKE collaboration and CERN-AWAKE-project
- EN-EA as host of the Coordination Package CP4
- EN-STI as owner of target and horn systems
- EN-EA as owner of all other beam line elements (incl. “orphans”) and infrastructure (incl. shielding)
- HSE-RP studies, storage etc.. (many roles)
- EN-HE for transport and handling
- EN-CV as expert of ducts, pipes, ... installed
- EN-EL as expert of cable trays, cables, ... installed
- other groups as owner of equipment to be dismantled: BE-BI, TE-VSC, IT-CS
- maybe more groups (e.g. SMB-SE if removing highly activated concrete floor)

EN-EA pre-study team (CERN)

- Sebastien Evrard
- Sylvain Girod
- Ans Pardons
- Mats Wilhelmsson

More resources (contractors)

- EN-EA Design office (Vincent Clerc)
- Radioactive area dismantling and cleaning contract (frame contract managed by EN-EA)
- Workshops + FSUs (CERN-wide)
- Service contracts (EN-HE, EN-EA, EN-CV, EN-EL, etc.)
Progress from last few months

Organisation:
- Work breakdown structure (WBS) is being defined

Dismantling sequences – see next slide:
(keep risk (incl. radiation dose) ALARA, i.e. As Low As Reasonably Achievable)
- Simulated dose-rate maps received from HSE-RP (see presentation Elzbieta)
- Dismantling sequence is being defined (e.g. hottest object to be removed first, to lower ambient dose rate for the rest of the works)

3D-CAD models - see next-next slides (*):
Note: CNGS was still mostly designed in 2D and within now-obsolete design platforms
Transformation and update of all layout drawings to updated as-built CATIA model of the CNGS target area is almost completed

(*) all 3D-models and illustrations in the following slides are courtesy of Vincent Clerc from the EN-EA design office
Dismantling sequence – some guidelines

• ALARA principle – “As low as reasonably achievable.” According to this principle, the risk (including exposure to radiation) must be reduced to the lowest level that could possibly be achieved. In other words, if a risk arises, CERN makes sure that appropriate mitigation measures are implemented.

• The activity generating the highest collective dose is not the one where the highest activated items are handled, but the one where no remote removal is possible or “surprises” occur. Therefore, it is of prime importance to carefully study and prepare the decommissioning phase of a new facility already during its from the design stage: this was the case in CNGS for the most radioactive objects

• Strategy:
  1. Clean & decontaminate first (by external expert contractor, CERN framework contract)
  2. Remove remotely hottest objects (needing results of Fluka simulations from our RP colleagues, see next talk)
  3. Dismantle infrastructure – time consuming activities – Worker training is key
  4. Set-up a temporary buffer zone to ease radioactive waste management
AREA CNGS DISMANTLING
3D MODELLING STATUS
3D-models illustrations

107m

Part 1

Part 2

SHIELDING, MODELLING 91m
3D-models illustrations

WITHOUT SHIELDING

Part 1

Part 2
Part 1

TARGET MODELLING DONE

HORN MODELLING IN PROGRESS

HELIUM TANK 1 MODELLING DONE
Part 2

REFLECTOR MODELLING IN PROGRESS

HELIUM TANK 2 MODELLING DONE

SHUTTER AREA IN PROGRESS NOT DISASSEMBLED
Vacuum line not modeled

Stripline, not modeled

Ventilation, old modelling

Various support, modelling done
Transformer, horn and reflector not modeled

Services and cables trays not modeled
Cost & Resource estimates

- Many costing methods are used in the industry
- CERN commonly uses Standard and Historical costing methods
- In the framework of this pre-study, the **first estimate will be based on several past dismantling cases** (historical costing) and then scaled to the case of CNGS.
- We aim for a Class 5 estimate (concept screening, expected accuracy range: -50% /+100%)

<table>
<thead>
<tr>
<th>Cost of Case</th>
<th>Scaling factor % CNGS</th>
<th>Cost estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>D</td>
<td>AxD</td>
</tr>
<tr>
<td>B</td>
<td>E</td>
<td>BxE</td>
</tr>
<tr>
<td>C</td>
<td>F</td>
<td>CxF</td>
</tr>
</tbody>
</table>

**Marginal Costing:** Through this method only the variable cost is allocated i.e. direct materials, direct expenses, direct labour and variable overheads to production. It does not include the fixed cost of production.

**Absorption Costing:** It is the technique to absorb the fixed and variable costs to production. In this method, full costs i.e. fixed and variable costs are absorbed to the production.

**Standard Costing:** When the costs are predetermined on certain standards in a given set of operating conditions, it is called standard costing.

**Historical Costing:** In this method the costs are determined in terms of actual costs and not predetermined standard costs. Costs are determined only after it is incurred. Almost all organizations adopt this method of costing.
Next steps:

• Continue defining dismantling sequence and identify
• Continue collecting requirements from CERN-AWAKE (see scope)
• Obtain first cost estimate by scaling WANF and other dismantling projects (see previous slide)
• Get info from equipment experts (esp. EN-STI and infrastructure)

Next status presentation will be presented in a Run 2 meeting in mid-October
Final report due early February 2021, as input for the Cost & Schedule Review in March 2021
<table>
<thead>
<tr>
<th>Cost Estimate Classification</th>
<th>Primary Characteristics</th>
<th>Secondary Characteristic</th>
<th>Expected accuracy range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 5, Concept Screening</td>
<td>0% to 2%</td>
<td>Capacity factored, Stochastic, most Parametric models, judgement or analogy</td>
<td>Concept screening</td>
</tr>
<tr>
<td>Class 4, Study or Feasibility</td>
<td>1% to 1.5%</td>
<td>Equipment factored, more Parametric models</td>
<td>Study or feasibility</td>
</tr>
<tr>
<td>Class 3, Preliminary, Budget Authorization</td>
<td>10% to 40%</td>
<td>Semi-detailed unit costs with assembly level line items, cost estimating technique includes the combinations of various techniques (detailed, unit-cost, or activity-based; parametric; specific analogy; expert opinion; trend analysis)</td>
<td>Budget authorization or control</td>
</tr>
<tr>
<td>Class 2, Control or Bid/Tender</td>
<td>30% to 70%</td>
<td>Detailed unit cost, cost estimating technique includes the combinations of various techniques (detailed, unit-cost, or activity-based; expert opinion; learning curve)</td>
<td>Control or bid/tender</td>
</tr>
<tr>
<td>Class 1, Check Estimate or Bid/Tender</td>
<td>50% to 100%</td>
<td>Deterministic, most definitive cost estimation</td>
<td>Check estimate or bid/tender</td>
</tr>
</tbody>
</table>