

International Development Team

Technical Design Documentation and WBS for EDR
Benno List, DESY
IDT WG2 Meeting
5.1.2021

Accelerator activities at ILC Pre-lab phase

Technical preparations /performance & cost R&D [shared across regions]

- SRF performance R&D
- Positron source final design and verification
- Nanobeams (ATF3 and related): Interaction region: beam focus, control and Damping ring: fast kicker, feedback
- Beam dump: system design, beam window, cooling water circulation
- Other technical developments considered performance critical

Technical preparation

Final technical design and documentation [central project office in Japan with the help of regional project offices (satellites)]

- Engineering design and documentation, WBS
- Cost confirmation/estimates, tender and purchase preparation, transport planning, mass-production planning and QA plans, schedule follow up and construction schedule preparation
- Site planning including environmental studies, CE, safety and infrastructure (see below for details)
- Review office
- Resource follow up and planning (including human resources)

Engineering Design Report (EDR)

Preparation and planning of deliverables [distributed across regions, liaising with the central project office and/or its satellites]

- Prototyping and qualification in local industries and laboratories, from SRF production lines to individual WBS items
- Local infrastructure development including preparation for the construction phase (including Hub.Lab)
- Financial follow up, planning and strategies for these activities

Mass-production

CE, local infrastructure and site [host country assisted by selected partners]

- Engineering design including cost confirmation/estimate
- Environmental impact assessment and land access
- Specification update of the underground areas including the experimental hall
- Specification update for the surface building for technical scientific and administrative needs

Civil engineering



Technical Design Report (TDR) summarizes TDD for publication

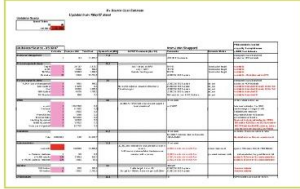
Technical Design Documentation (TDD) captures entire design efforts, results & rationale



Parameters



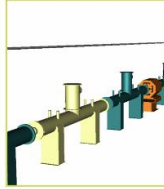
Specifications



Cost Estimation



Calculations

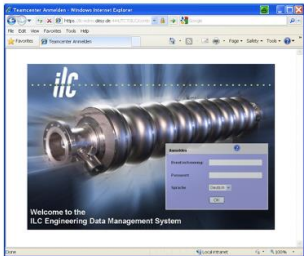
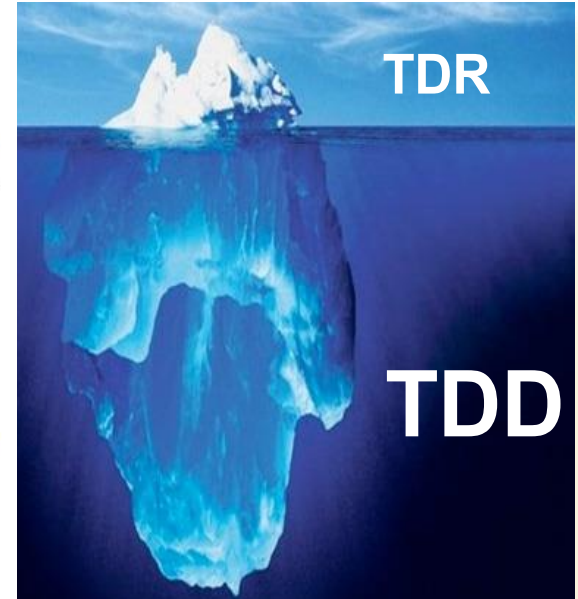


CAD Models



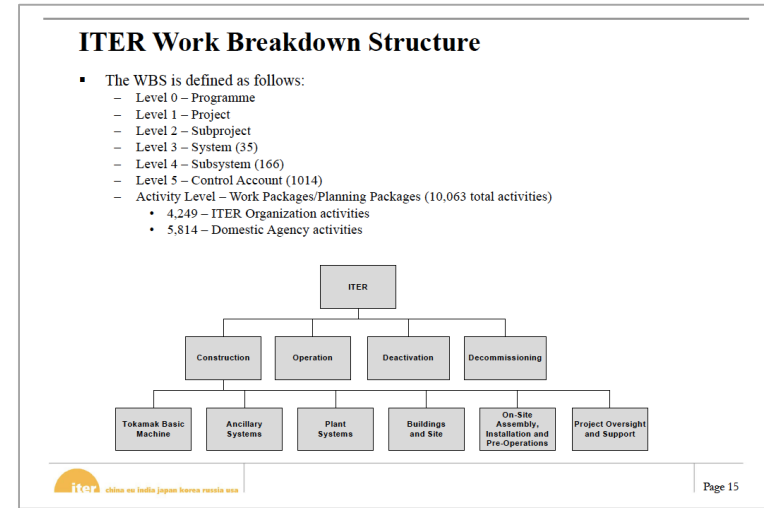
Design Summary

...



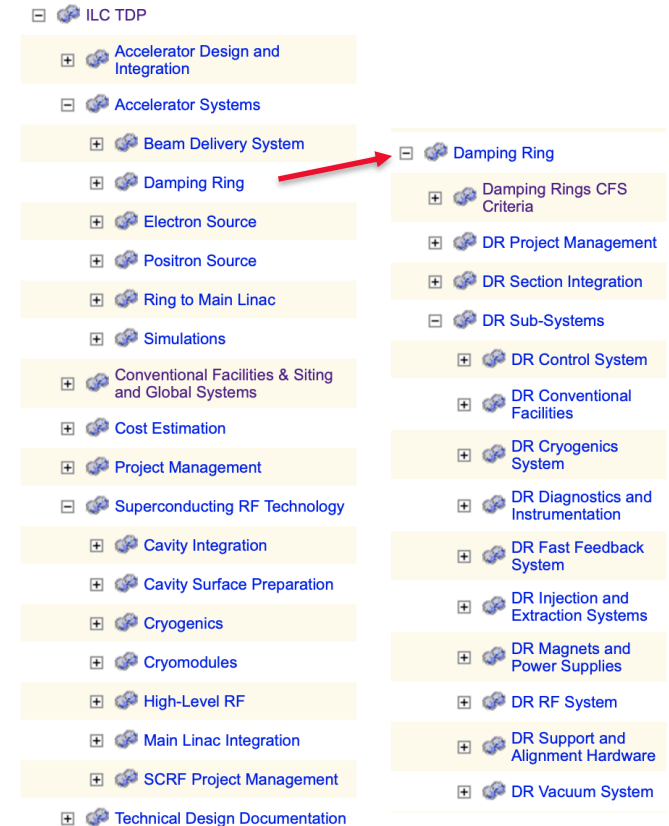
ILC-EDMS organizes the Technical Design Documentation, providing **structure, traceability, version & configuration mgt., and change control**

- **Technical Design Documentation is organized along WBS**
- WBS: “A deliverable-oriented hierarchical decomposition of the work to be executed by the project team” [PMBOK]
- Different project phases are projects of their own, with their own WBS:
 - WBS for Technical Design Phase TDP
 - WBS for Prelab phase
 - WBS for construction phase
- In each phase, prepare WBS for next phase
 - Define WBS for prelab phase now
 - Define construction project WBS in prelab phase



Example: ITER WBS.
Top Level ist programme phase

- WBS for Technical Design Phase II (TDP-II) was never fully formulated
- Provisional WBS used to structure Design Documentation
- Main Structure:
 - Accelerator systems
 - SCRF technology
 - CFS
 - Some cross cutting activities: AD&I, Costing, Project management, Documentation
 - Other Technical Areas (magnets, vacuum, ...) from RDR only present as parts of accelerator systems
- After Black December (12/2008), value engineering reduced to bare minimum, technical area groups outside SCRF non-existing -> No top-level element for Technical areas other than SCRF



- New Web interface:
<https://edmsdirect.desy.de/treebrowser/ilc/>
- Provides easy navigation through the TDR WBS and the associated documentation
- No log-in required
- Integrated preview of document PDF
- Documents are interrelated through links
- Link to EDMS interface also provided
- Some elements (costs!) are only available after log in with EDMS account, documents are visible only in full EDMS client

The screenshot displays the EDMS web interface. The top navigation bar includes the EDMS logo and the text 'Treebrowser'. A status bar indicates 'Last update: Jan 5, 2021 10:37:38 AM'. The main content area shows a tree view of documents under the 'ILC TDP' and 'Accelerator Design' categories. A red arrow points to the 'SB2009 Proposal Document' entry. Below the tree view, a detailed view of the document is shown, including its name, ID, item type, status, and description. A 'Relations' table is also visible, showing the document's relationships with other documents. The document preview on the right shows the title 'SB2009 Proposal Document' and the release date 'December 2009'.

Relations	Count
Relates To Documents	8
Is Related From Documents	12
Is Depended On By	1

- Design Register gives overview over design status of accelerator systems and their documentation
- Has a list of “mandatory documents” whose status is tracked
- Includes cross references
- Good practice: Prepare a list of artefacts / mandatory documents to be provided by the work packages
 - Drawings / CAD models
 - Schematics
 - Data sheets / specifications
 - Requirements
- Calculations: Power, heat, costs, availability...
- Procedure descriptions (installation, alignment, diagnostics, maintenance,...)

international linear collider
Design Register

Nicholas J. Walker, Benno List

Version 6.0 21.03.14
EDMS ID D00000000959505

Revision History:

Version	Date	Author	Remark
0.9	17.06.2011	NW, BL	First Version
1.0	18.9.2011	BL	Updated: Added title page, added page on mandatory documents, updated DR references
2.0	02.11.11	BL	Updated: Added Electron Source Section
3.0	30.11.11	BL	Updated Mandatory documents section
4.0	01.02.12	BL	Updated Mandatory documents and references section
5.0	22.05.12	BL	Removed "Treaty points" sheet, updated all sheets
6.0	21.03.14	BL	Updated all sheets, WIP

Overview over Mandatory Documents

	Global	Electron Source	Positron Source	Damping Ring	RTML	Main Linac	BDS
MSB	complete	incomplete	incomplete	incomplete	incomplete	incomplete	incomplete
System Overview	incomplete	incomplete	incomplete	incomplete	incomplete	incomplete	incomplete
Parameter List	complete	complete	complete	complete	complete	complete	complete
Beamline Description	complete	complete	complete	complete	complete	complete	complete
Beamline sketch	complete	complete	complete	complete	complete	complete	complete
Lattice	complete	complete	complete	complete	complete	complete	complete
Treaty Point Definitions	complete	complete	complete	complete	complete	complete	complete
Component List	complete	complete	complete	complete	complete	complete	complete
Component Specifications	complete	complete	complete	complete	complete	complete	complete
Heat Load Calculation	complete	complete	complete	complete	complete	complete	complete
CPB Criteria	complete	complete	complete	complete	complete	complete	complete
Cost Overview	complete	complete	complete	complete	complete	complete	complete

- Guiding principles of a WBS:
 - Deliverable-oriented
 - Compatible with work organisation
- Example:
 - One group designing magnets solely for Damping Rings, as part of a separate DR design effort: “DR magnets” under “Damping Rings”
 - One group designing magnets for several (or all) accelerator systems as a separate effort: “Magnets” as separate Work Package
 - Decision on structure depends on how work is organized
 - Can change between project phases
 - > Can have a “Magnets “ work package in prelab phase, and a “Damping Rings” work package including magnets in construction phase
- **What are the deliverables in the Prelab phase?**
 - **Final deliverables: construction-ready design, project plan, cost book**
 - **Intermediate deliverables: Component counts, power estimates, requirements, design criteria...**
 - **EDR is (“only”) a human-readable summary of these design deliverables**

Accelerator activities at ILC Pre-lab phase

Technical preparations /performance & cost R&D [shared across regions]

- SRF performance R&D **Technical preparation**
- Positron source final design and verification
- Nanobeams (ATF3 and related) Interaction region: beam focus, control and Damping ring: fast kicker, feedback
- Beam dump system design, beam window, cooling water circulation
- Other technical developments considered performance critical

Final technical design and documentation [central project office in Japan with the help of regional project offices (satellites)]

- Engineering design and documentation, WBS **Engineering Design Report (EDR)**
- Cost confirmation/estimates, tender and purchase preparation, transport planning, mass-production planning and QA plans, schedule follow up and construction schedule preparation
- Site planning including environmental studies, CE, safety and infrastructure (see below for details)
- Review office
- Resource follow up and planning (including human resources)

Preparation and planning of deliverables [distributed across regions, liaising with the central project office and/or its satellites]

- Prototyping and qualification in local industries and laboratories, from SRF production lines to individual WBS items **Mass-production**
- Local infrastructure development including preparation for the construction phase (including Hub.Lab)
- Financial follow up, planning and strategies for these activities

CE, local infrastructure and site [host country assisted by selected partners]

- Engineering design including cost confirmation/estimate **Civil engineering**
- Environmental impact assessment and land access
- specification update of the underground areas including the experimental hall
- specification update for the surface building for technical scientific and administrative needs

- Accelerator design*
 - Overall integrated design -> AD&I
 - Sources, DR, RTML, ML, BDS -> Acc. Systems
 - Artefacts: Lattice, beam parameters, system description, input for CFS design criteria (requirements), component counts, design for specific components, availability data,
- SCRF design and prototypes*
 - Cryomodules, cavities, couplers, tuners, SC quad, BPM, HLRF (klystrons, modulators, PDS), cryogenics -> SCRF groups
 - Artefacts: Component designs, technical data, prototypes, subsystem design, component unit costs, subsystem costs, production plans, requirements
- Technical components design*
 - Magnets, vacuum, diagnostics, LLRF, controls, dumps, collimators, survey and alignment, installation... -> Technical area groups
 - Artefacts: Component designs, technical data, prototypes, subsystem design, component unit costs, production plans, requirements
- Conventional facilities and site design*
 - Civil engineering (caverns, tunnels, surface buildings) design
 - Technical infrastructure (el. Power, water, HVAC, network, transport, safety, ...) designs
 - Site design (Campus, transport, water, power lines, housing...)
 - Artefacts: Requirements / design criteria, construction plans, costs, schedule, schematics, env. impact assessment,
- Project plan*
 - Cost estimate, cost book, project implementation plan, project schedule, construction project WBS and organisation, logistics plan, legal framework... -> project office
- Engineering plan
 - System architecture, Requirements, Risks, CAD model, Technical Documentation, QA plan...
- Outreach & PR material
 - Web site, videos, lectures, exhibitions... -> Outreach team

* = "based on TDR, consolidated and updated"

THE ACCELERATOR (PRODUCT)

- Accelerator Design and Integration
 - Design the accelerator, its accelerator subsystems and their subsystem specific components
- SCRF and HLRF Technology
 - Design all SCRF and HLRF components and the cryogenic system, for the ML and other accelerator subsystems, produce prototypes, qualify vendors and hub labs, establish/qualify production sites and companies
- Accelerator Components
 - Design accelerator components (except SCRF/HLRF), including instrumentation and controls
- Conventional Facilities and Siting
 - Design all conventional facilities and the site

CROSS-SECTIONAL ACTIVITIES

- Project Management and Legal Affairs
 - Perform project management of the prelab phase (cost, schedule, ...)
 - Prepare Project Management of the Construction phase
- Systems Engineering and Quality Management
 - Support systems engineering processes of prelab phase (documentation, CAD, requirements, ...)
 - Prepare Systems Engineering processes for construction phase (all of the above, risk management, quality management, ...)
- Outreach and Public Relations
- Safety and Environment
 - Manage all safety, health, radiation and environmental protection issues

Accelerator Design and Integration

- Accelerator System Integration
 - Integrate accelerator subsystems, provide overall design and performance
- Sources
 - Design electron and positron sources and specific components (undulator, target regions, gun and laser system)
- Damping Rings
- RTML
- Main Linac and Bunch Compressors
 - Design Main Linacs and Bunch Compressors, based on SCRF design
- BDS

SCRF and HLRF Technology

- Cryomodules
 - Design all L-Band cryomodules for Main Linac, sources
 - Produce, transport to and test prototypes in Japan
- Cavities
- Cavity Material
- Tuners
- Couplers
- Quad / BPM package
- Klystrons
- Modulators
- Waveguide distribution
- Cryogenics

Accelerator Components

- Magnets, Kickers and Power Supplies
- Vacuum
- Dumps and Collimators
- Instrumentation
- Controls and LLRF
- Installation, Supports and Girders
- Survey and Alignment

Conventional Facilities and Siting

- Civil Engineering
- Electrical Power
- Water Cooling
- Heating, Ventilation, Air Conditioning
- Site Activation

Project Management and Legal Affairs

- Project Management and WBS
- Costs
- Schedule
- Project Risks
- Procurement
- Logistics
- Human Resources
- Legal Affairs

Systems Engineering and Quality Management

- Technical Documentation
- Requirements Management
- Technical Risks
- Quality management
- Configuration Management
- Standards and Conformance
- Change Management

Outreach and Public Relations

Safety and Environment

- Safety and Health Protection
- Environmental Protection
- Radiation Protection

- Cost estimate from TDR phase
 - WBS based – organized according to a WBS
 - Bottom-up – add number * unit costs of all components
- Final result was reported in a matrix form: (accelerator systems) X (technical areas)
- Cost estimate is based on WBS of construction project – need not be identical with WBS of prelab phase!
- In strictly WBS based costing, a “Magnets” work package would contain all costs for fabrication of magnets, ”installation” would contain costs of installation
-> a parallel “Damping Rings” work package would not include these costs!
- Does not answer “**How much do the Damping Rings cost?**” or “**Which components drive DR costs?**”
- TDR WBS tried to answer these questions by a convention for levels 1/2 of WBS
 - 1: Accelerator systems
 - 2: technical areas
- Runs into many problems:
 - CFS: two systems in one tunnel
 - Same components in different systems: How to handle one-off costs, quantity rebates, spares
- Strength of a WBS based costing is 100%-rule: Every level is exactly the sum of its parts
- Reports on cost distribution are based on attributes, not on structure!
 - Distinguish atomic items from items that are summed up
 - Atomic items get attributes to allow all kinds of reports
 - Cost sharing over attributes must be possible (e.g. 75% BDS, 25% Sources)

- Define the deliverables of the Prelab phase
 - What designs have to be provided
 - Designs: How mature / detailed?
 - Ready for detailed design
 - Ready for call for tender
 - Ready for fabrication
 - Other documents: Cost book, schedule, legal documents, ...
 - EDR only summarizes these efforts
 - > EDR contents and structure to follow project organisation and results
- Reinstate accelerator system groups to design the accelerator
- Reinstate technical areas to design components -> input to accelerator design, CFS, project management
- Define artefacts that need to be provided by the work packages, with target dates:
 - Component specifications and data sheets, system overview, component counts, unit costs, heat loads, ...
 - Make sure necessary inputs are requested and provided in time (CFS heat loads require component counts and component data sheets, which require component specs from lattice design...)
- Cross-Sectional activities (project management, systems engineering)
 - Support Prelab phase
 - Prepare Construction phase

Reserve

- CFS Design Criteria for all subsystems
- Americas Region TDR for CFS
- Japanese Studies

