Comments on
the EDR and Magnet Systems

JCT for the Magnet Systems Group

070201

The ILC EDR
(Engineering Design Report)

- What is it?
  - Detailed design report as a basis for approval to proceed as a project
- What is the Scope?
  - Early discussions: "~25-30% design level"
    - Sufficient detail to establish technical design package
    - 3-D magnetic field calculations
    - Define all interfaces – pedestals, stands, power, lcw, sensors, etc.
    - Develop accurate beamline layouts with real space allocations
    - Estimate of tooling requirements, design concepts
    - Sufficient information for detailed cost estimate

EDR Scope, cont.

- Scope, recent discussions…
  - "complete design package" for all magnets
  - Detailed design of all components completed
  - Tooling design completed
  - Drawing packages completed
  - Ready to begin procurement…
- In either case, the resources required are a factor of ≈(3–10)x more than have been used in the RDR
  - Magnet physicist/engineers
  - Design/drafters
  - Tooling designers
  - Etc.
- Clearly, an EDR definition needs to be "published" by management

Organization of EDR Work

- We are told that work will be done through Work Packages issued by Area Systems Groups
  - Nominally consistent with organization of RDR/BCE, but…
    - Area Systems, in general, didn't fund design work
    - Management structure above Area Leaders still to be developed
    - Program manager
    - Integration function still lacking in ILC organization
  - Quasi-independence of work packages leaves some concerns on uniformity of approach, duplication of effort, 'enforcement of standards"
    - Are we designing 6 independent machines…?

Magnets

Our View of Magnet Systems Work Packages

- Three distinct components
  - Magnets (12 ea)
  - Power Systems (6 ea)
  - Test and Measurement Facilities (2 ea)
- Magnets and Power Systems divide among Area Systems in a natural fashion
  - Exception – pulsed magnet systems are still R&D intensive and have significant commonality across several areas; it is not sensible to split it up (abort kicker systems)
- TOTAL about 12 + 6 + 2 + 3 = 23 WP's (not incl. kicker pulsers)

A Generic Magnet Work Package

- **Format stolen from P. Bellomo, M. Zisman, M. Palmer, et al.**

1. Objective

1.1 Develop and design Area System conventional DC magnets, support stands, and interfaces to other systems.

2. Task Description

2.1 Work with Area System physicists, engineers, and designers to develop conventional magnet designs and specifications which meet the magnetic field requirements, alignment and stability requirements, aperture, length, and other dimensional requirements, availability requirements, electrical power requirements, heat generation requirement, radiation hardness requirements, and any other achievable system requirements.

2.2 Explore options to provide a cost-effective design meeting the above criteria and carry out the necessary engineering design work required by the Engineering Design Report.

2.3 The scope of work includes DC magnets, associated support stands, and definitions of interfaces with other systems; it does not include pulsed magnet systems.

3. Deliverables

3.1 Furnish, by <completion date> the following performance specifications, drawings and cost estimates:

3.1.1 Magnet specifications, including field strength, effective length, field uniformity/magnitude of allowed , aperture, physical dimensions, total weight, electrical properties, including total resistance and inductance, required LCW flow rate and pressure drop (if applicable), operating temperature, conductor cross section, and other parameters necessary for design, fabrication, installation, and operation.

3.1.2 Magnet support stand specifications, including support points, adjustment range along and transverse to beam line, adjustment resolution,

3.1.2 Definition of interfaces with other systems: including vacuum systems, power systems, LCW, alignment, installation fixtures, etc.

3.1.3 Complete set of design and fabrication drawings suitable for procurement

3.1.7 Other information as necessary for the Engineering Design Report

Magnets

Work Package Discussion, cont.

- "Bottom line" questions:
  - Can Area Systems manage the magnet design and cost work?
  - Do Area Systems have the budget to do it?
  - Is an overall Magnet System coordination/management function required?
- Answers to the questions
  - Possibly, depending on Area, but neither their priority nor strength
  - Probably not
  - Yes
- (Feed – down of requirements caused delays at the start of RDR, this is not so much of a problem now)

EDR Comments, cont.

- A Magnet Systems Design Coordination/Management function is necessary (3 ea WP)
  - It should be independent of specific Area Systems
  - It should set standards, review work, and be responsible for magnet system interfaces to other Technical Systems
    - Vacuum
    - Controls
    - CFS – LCW, power, etc.
- It should have three components
  - DC Magnets – both conventional and SC,…
  - Power Systems
  - Pulsed Magnet Systems

Magnets

EDR Magnet Design and Cost Effort

Preliminary Staffing Estimate for "100% Design"

070202

100% of Magnet design – "EDR+2"

Magnet Category	Est. No. of Styles	Eng./Phys. (FTE)	Prcrmnt (FTE)	Designer (FTE)
Con. Conventional Magnets	75	13.8	1.3	36.7
Uncon. Conventional Magnets	15	6.3	0.5	18.0
Superconducting Magnets	6	3.2	0.3	8.4
Totals	96	23.3	2.1	63.1
Yearly (over EDR period)		*7.8*	*0.7*	*21.0*
Scaled by RDR and similar experience				
Totals		*36.9*	*3.3*	*99.7*
Yearly (over EDR period)		*12.3*	*1.1*	*33.2*

Separate Estimates (R&D support)	
	Specialty Magnets - kicker, septums, pulsed magnets (T. Mattison, UBC)
	Wigglers (M. Palmer, Cornell University)
	Undulators (J. Clarke, Daresbury Lab.)
	BDS final focus SC magnets (B. Parker, M. Anerella, BNL)

Ad hoc scale factor	1.6	*Reality - description*
'Overhead' for task sharing	1.10	People not full time on task: context switching - re-start/'re-learn' penalty
Changes in requirements	1.15	Specifications change due to system detail design changes, R&D input,
Programmatic shifts	1.25	Major system and requirements changes, etc. for programmatic reasons

Note: while the last two scale factors are not completely independent; their product is a realistic estimate of additional work encountered during RDR

Hours in work-year	1800
EDR time period (yrs)	3

Summary (Tompkins for the Magnet Group)

- A formal definition of EDR scope is needed
  - Level of design detail, Target completion date, Resources to be committed
- Without sufficient support, this is a futile exercise
  - Cannot carry out the EDR at the RDR level of support for Magnet Systems
  - At present, there does not appear to be sufficient resources in existing US R&D budgets for the EDR work (even for the 25-30% design level)
    - (e.g. DR Magnets: 1.4, 2 FTE in 08/09 resp.
    - ~ 50% less than requested, 50% less than scaled estimate)

Summary, cont.

- There must be a mechanism for overall management & coordination of Area System based 'magnet' work packages:
  - Best mechanism to aggressively apply 'value engineering' (MCR)
  - Coordination/integration issues
  - Minimize number of different magnet styles for cost savings
  - Design standards for availability/reliability and cost savings
  - Review function
  - R&D overlap or gaps
- Design should be coupled to R&D results in EDR
- R&D and Work Package review and assignment needs a more formal approach with external reviewers

The ILC EDR – Cryo (Peterson)

- Work packages arising from unique ILC cryogenic system problems
  - many of these issues will be addressed by XFEL at DESY and/or by LHC at CERN,
  - a significant engineering effort needed for ILC cryogenic system designs,
    - just rough concepts now.
- some overlap with cryomodule development and design work.
  - Other areas cryogenic system design requires collaboration with RF and magnet system designers.
- There has been and will be significant international collaboration; the work listed below is intended to be international, distributed among all the collaborators.

Summary of topics:

- liquid control,
- heat loads and flow rates,
- cryomodule thermal optimization,
- plant design (with industry),
- repair scenarios, reliability
- 2 K heat exchangers,
- emergency venting,
- grouping surface components,
- ODH,
- compliance with engineering standards,
- cryo box design,
- damping ring system,
- beam delivery system.

This list is certainly not comprehensive; other topics will no doubt be added to the work list.

Total effort

- A total of ~10 man-years of engineering and design labor are identified below, with effort for tasks estimated in man-months.
  - The RDR cryogenic system effort has had less than 1 FTE of effort through the past year.
  - A minimum of an FTE in each region is needed through the EDR phase.
  - If cryogenic experts around the world all continue to have other, local commitments in addition to ILC, this work will require part-time (but significant fraction) efforts from at least 2-3 people in each region.

Effort Summary – 30% - Peterson

Liquid Control	0.5 person-years
Heat Loads	0.5
Thermal optimization	1
Plant Design	0.5 + industrial study
Maintenance, rel,…	0.5
2K HX	0.5 + industrial study
Emergency Venting	0.5
Surface components	0.5
ODH	0.5
Engineering Standards	0.5
Cryo Box design	3

Comments:

- The above is a 'bottoms – up' basic estimate of the EDR effort and organization required for Magnet/Power Supply & Cryo
- Structure needed is different
  - A 3rd example would be controls
- 'Global' integration issues not directly singled out
  - RDR effort has examples/counter-examples of how well this went

- T. S. Group Leaders 'eager' to contribute further to organizing task, especially given additional framework