Initial Questions for Area Systems Groups February 6, 2006

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– with revisions by Bob Kephart and Tetsuo Shidara
- and emphasis on initial information needed in February 2006

Input_Area_Systems_v5_060206.doc

Introduction

Area System groups have responsibility for bringing all needed Technical System groups to bear on producing their section of RDR document and cost estimate. Global System groups will have integration responsibility across Area Systems, and must address these topics in their written sections and cost estimates: Dumps and beam stops, Machine Protection, Personnel protection, Global (common) Controls, Global (common) Instrumentation, Staged installation and Logistics, Partial commissioning, Reliability and Availability, Conventional Facilities and Site.

All of this information will eventually be needed for the Technical Design Report. We will need only the preliminary versions for the more conceptual Reference Design Report.

The most important information that is needed now to begin the activities of the Technical Systems and Global Systems groups are relatively few in number. Many longer timescale items to be supplied by either AS, TS, or GS groups, for the preliminary cost estimate (mid-June 2006), for the RDR document (Fall, 2006), or for the TDR are also listed, in order to keep them in mind. More detailed requests and requirements will be sent out as appropriate.

Graded Approach to Cost Estimating – concentrate effort on cost drivers!

The first step is to understand what information is needed to produce the cost estimate for the RDR. We have to be inclusive, get everything, and don't forget anything. However, there must be a graded approach where the limited engineering resources available to produce the cost estimate are allocated to the major cost drivers.

The largest cost driver is the Main Linac, especially with the multiplication by many units of Cryomodules (cavities, cryomodule assembly, couplers) and RF systems (klystrons and distribution). There are already Technical System groups spending major effort on understanding the costs of the Main Linac: cavities, cryomodules, magnets, and RF system groups. Much of this effort is, or will be, bottom-up engineering estimates, often based on industrial studies.

The cost of the Conventional Facilities, the next leading cost driver, is driven by the length and special geometries of the underground construction. The layout of the various machine elements, especially the transverse cross sections of tunnels, wider sections (caverns), and any special access areas will be vitally important to the CF&S group in

producing their part of the cost estimate. Therefore, it is especially important to get early specifications and sketches from the Area System groups to the CF&S group very quickly.

There are many subsystems which are similar to those previously built (or estimated for TESLA, NLC, GLC, USLCTOS) where the prior actual costs can be used, scaled or parameterized to produce unit cost, cost per unit length, etc., estimates for the ILC with minimum engineering or bottom-up estimating. Such items include conventional magnets (e.g. for Damping Rings) or even superconducting magnets (for Cryomodules or Beam Delivery System), warm FODO transfer lines, vacuum systems, mechanical supports, control system, standard instrumentation, cryogenics plants and distribution systems, dumps, and collimators. The important parameters will then be numbers of units or lengths, which should be readily available from the Area System groups.

WBS

DCB will provide a skeleton Work Breakdown Structure (WBS), but the Systems groups will likely have to expand their individual WBS sections to a greater level of detail in order to produce their cost estimates.

A brief WBS dictionary for each WBS element will be needed (mid-June) with description of what is included in that element and boundaries.

Assume the following Construction Schedule

This assumes a technically driven, not funding limited schedule.

Use TESLA's 8 year schedule

- from project approval to ready-to-begin commissioning
- included about 1 year at the beginning for
  - finalizing engineering design, specifications, drawings, preparation of bids, bidding process, choice of contractors, and mobilization
- includes parallel activities of tunneling, infrastructure
  - installation, component installation, and systems testing.
- The individual system groups have to estimate their time needs for design, prototyping, fabrication/procurement, testing/acceptance/conditioning, installation, system testing, pre-commissioning.
  - (see prior reference documents TESLA & USLCTOS)

Remember that this initial stage is intended to evolve into the 2*500 GeV configuration!

I. Information Needed Immediately:

The information most immediately needed from each **Area System** group, so Technical Systems and CF&S groups can be fully operational by the Bangalore meeting, includes:

MAD file (or equivalent)

List of functional accelerator elements – **complete: ILC BCD Beamline Descriptions**

Layout sketch of accelerator components,
showing repeated section (showing lengths, etc.) and number of sections
and details (sketch/drawing) of any special inserts or sections
(a finished drawing will be needed by mid-summer)

Component list: description, number of units needed, approximate dimensions, etc.
Field, gradient, sextupole requirements for magnets,
Number and types of collimators and beam stops, and number of cryomodules
from these component lists the Technical Systems groups can determine
the appropriate number and type of power supplies, power and cooling
requirements for CF&S group, cryogenic and RF needs, etc.

Tunnel layout – see also **CFS_CRITERIA_CONFIGURATION_LIST.pdf**
Physical requirements, both transverse and longitudinal:
special wider sections, laser straight sections, any special access areas.
Locations: where are RF cavities, klystrons, and modulators located for
the Electron Source, Positron Source, and Damping Rings?
What and where will cryogenic elements be located for the Electron Source
Positron Source, and Damping Rings?

System Interfaces – These are already **done** at a sufficient level of detail!

The preliminary boundaries (there have been some changes at KEK) are described in
Tor's **Charges for the RDR Leaders – 1/13/06**
And the preliminary beam parameters at the interfaces are contained in
Tor's **ILCBCD_beamline_info.doc** (with Andy's updates for DR 1/25/06)

Define the boundaries of your system
Where does your system start and stop
What are the physical boundaries
What are the electrical boundaries
What systems are at this boundary – simply check understanding with other AS
Is your and their definition of the boundary the same?

What are the "machine boundaries" e.g. emittance, momentum spreads, TWISS parameters, and polarizations at each hand-off. Both sides of the interface need to know what is expected of them.

II. Information Needed by the Bangalore meeting:

In the slightly longer term, each Area System group will also need to supply or the Technical System or Global System groups will need to determine:

From the component list, the Technical Systems groups can determine the appropriate number and type of power supplies, power and cooling requirements for CF&S group, cryogenic and RF needs, etc.

Current requirements – # circuits (or engineering optimization?) – from TS
Associated power supplies (amps, volts, power) – from TS

Power requirements (amps, volts, voltage drops, power) – later TS
Cooling systems: Total required, Distribution – later from TS

These overall power and cooling requirements are needed by CF&S group

Vacuum equipment – from TS
Don't need this level of detail if cost estimate by scaling previous systems
- Size of vacuum pipe and vacuum requirements (can vary with position)
- Pumps, gauges (multi-level)
- Leak checking equipment
- Isolation valves
- Bakeout equipment (heaters, power supplies, controllers)

RF system – from TS
- Distribution systems
- Interlocks
- x-ray protection
- RF sources (number of klystrons, modulators, etc)
- Auxiliary systems (solenoids, cooling water, filament supplies, etc)

Abort and machine protection systems – from GS
Personnel protection systems – later from GS

Personnel access and egress – later from CF&S
Tunnel equipment transport system (e.g. mono-rail) – later from CF&S
Tunnel personnel transport system (if not the same) – later from CF&S

III. Information Needed by mid-June – to prepare for Vancouver meeting:

Need initial cost estimates by mid-June - final cost estimates will come later

Installation and infrastructure information (include and cost)

Component support stands and mounting – from TS
Survey monuments, alignment equipment, alignment labor – from TS
Cable plant (number, type, length, cost/length, installation cost)– from TS

Industrial Cooling Water system – from TS
(estimate heat rejection, temp, ΔT, flow, pressure)
Low Conductivity Water system – from
(estimate heat rejection, temp, ΔT, flow, pressure)
Radioactive Water system? (dumps etc) – from
(estimate heat rejection, temp, ΔT, flow, pressure)

Installation plan – from GS
installation fixtures
required component storage on or off site

Shipping plan – from GS
shipping containers
shipping fixtures
shipping costs
on-site handling cost and equipment

Preliminary Cost estimates - mid-June (will evolve with time)

Cost estimates must be supplied with description of basis of estimate.
saying how cost estimate was obtained: scaling, industrial study, learning curve, free market pricing, etc.
fill out "risk questionnaire" for each cost estimate.
DCB can use the answers to these risk questions to find suggested contingency

Estimate of Manpower – for collaborating institutions manpower
This will be needed along with the preliminary cost estimate for mid-June, 2006

This should be done at the lowest WBS level so it can be rolled-up for each Area System, Technical System, Global System section.
Supply with number of Full Time Equivalent years of each type of manpower v. system v. year into construction.
Types of manpower - we will request only two categories for each WBS element:

1. scientists and engineers (include designers & draftspersons)

2. technical staff

Note that institutional administrative manpower (management, ED&I, purchasing, legal, secretarial, accounting, etc.) will be listed under the Other Infrastructure or Administration categories.

Contract personnel will be treated as material purchases.

Time profile of manpower is needed.

<u>WBS dictionary</u> (brief description of what's included for each WBS element)

<u>Outline of proposed chapter for RDR document</u> (will evolve with time)

Topics for consideration should include

accelerator performance requirements
definitions of boundaries/interfaces/ and I/O beam parameters
brief overview (maybe full description)
accelerator physics - how design works, meets requirements
statement of status of beam design, components, production
list of questions and issues still outstanding
brief description of prior R&D accomplishments
current activities: R&D, industrial studies
what is keeping us from implementing this now! (beside availability of funding)
what are the risks? (e.g. can't get 10 MW, or 35 MV/m)
how do we deal with these risks?

These topics should be discussed for baseline configuration elements and also very briefly for alternate configuration elements
(but can be more sketchy for ACD since more R&D needed)
but should say why Alternates are being investigated, e.g.
promise of enhanced performance, reduced cost, improved availability

Discuss effect and remediation of "problems"
such as drop-out of klystron, coupler, quadrupole, trim

with how many off can you still operate (installed redundancy)?
what will be affect of retuning?

<u>IV. Information Needed for TDR (next year), but listed here to serve as reminder:</u>

<u>More detailed component specifications</u>

Magnet uniformity, multi-pole, aberration requirements
Beam aperture requirements
Power supply specs regulation/accuracy/reproducibility
Device ***Specific*** controls and instrumentation
(in addition to Global Controls & Instrumentation)
Device ***Specific*** diagnostic equipment, commissioning software or hardware

<u>Software & computing</u> – later GS

What design tools do you need? (e.g. commercial FEM or CAD software)

Is diagnostic software required? Where does it come from? Specify

What data bases are required? (e.g. cable data base, alignment data base, magnetic field measurements, cavity performance, construction travelers, repair history, etc.)

What computing infrastructure is required to support all this ? (hardware platform, license fees, FPGA programming, microprocessors, etc.)

State the reliability/availability requirements assumed for components & systems. How would the cost/design/delivery vary if MTBF and MTTR differed by a factor of 2? – much to involved for this stage – for TDR

END