

Instructions for LBNE Requirements Documentation

This document accompanies the Excel template for entry of requirements and other objects that make up the flow-down (e.g., objectives, specifications, and so on).

This should be all you need to write up or copy over your requirements to this new format.

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Goals of this effort to re-document the requirements

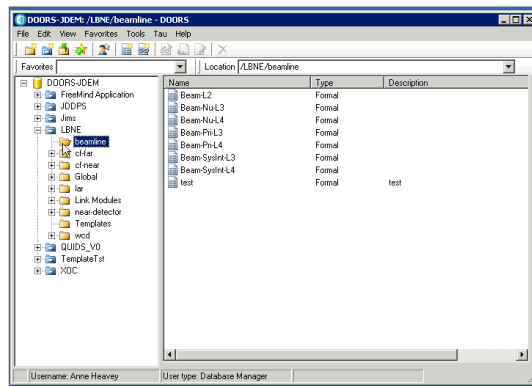
- Unify/standardize/clarify format and language of all objects in the objectives-requirements-design chain.
- Nail down requirements, organize them and distinguish them from other objects (e.g., assumptions, design parameters).
- Nail down and illustrate traceback information.
- Structure the information so that targeted requirements documents can easily be created.
- Simplify CDR (both production of and final product) based on clear requirement and design parameter documentation.
- Satisfy reviewers, pass CD-1, and have good foundation for moving ahead to TDR stage.

Plan summary

We use a requirements management software application, DOORS. It supports file import from Excel and export to Word or Excel. With the right structure and metadata, it is possible to organize and filter the information into documents that are useful for a variety of purposes.

In DOORS, we organize information into a WBS-like hierarchical structure of projects, folders and modules – where modules are like files. “LBNE” is the project, and underneath it I have subfolders for global requirements (L1), for each

subproject (L2) and for templates. Under each subproject folder is a module for each of its L3 systems and a module for the set of L4 components pertaining to each L3. Traceback links are made from a L4 module to its associated L3, from the L3 to its L2, from the L2 to the global science and global programmatic requirement modules. (CF requirements will likely point to other L2s or L3s – TBD.) At the global level, the science requirements point back to the global science objectives.



(New) If you have design parameters in tables that would be cumbersome to itemize line-by-line in the spreadsheet, you may continue to maintain them externally. We can pull tables into DOORS if we choose to.

I am providing an Excel template to use for documenting requirements to import into DOORS (LBNE docdb 3472). Please use it exactly as provided; otherwise importing the info will be difficult. If you have changes to request in the template, or any questions, please ask me (ahavey@fnal.gov).

Types of objects to document and link between for traceback:

Object type	Definition
Objective	An LBNE experimental objective (goal). Taken from doc 3056
Requirement	A statement of what each system needs to do to meet the (prioritized) objectives. Anything tagged as a requirement for a given subsystem or component is to be fulfilled by that same subsystem or component. In general,

	<p>requirements will not contain numerical values; they prescribe or constrain specifications (often numbers) from which design parameters are chosen.</p> <p>Note that interface requirements will be part of a separate interface document.</p> <p>Example: (in the section LAr → Cryostat and Cryogenics system → Cryostat) The cryostat shall provide mechanical support for the TPC.</p>
Specification	A value or range of values for a design choice or parameter, with units as needed, that meet the associated requirement(s); the chosen parameter value will need to be consistent with it.
Assumption	A statement of a circumstance or boundary condition outside the control of LBNE that the documented objects will nonetheless depend upon.
Design choice	A numerical or non-numerical choice for a piece of the design (e.g., a parameter or a material, a technology, a make and model); it must trace back to and be consistent with a specification(s) that satisfies the associated requirement(s).
Heading	Heading text to go into a requirements output document ("Object Level" determines indent level in document, as described later on)

Each requirement and specification must be:

- necessary, verifiable and attainable.
- clear and unambiguous.
- about one single issue (i.e., avoid "and").
- about what the 'system' (as indicated by its preceding heading) needs to accomplish, not what a 'component' of it is supposed to do.
- NOT about how a thing is designed, but rather about WHAT function is needed. (test: ask yourself why the requirement is needed; if this leads to another requirement, the current one is probably a specification or design choice).
- specified to the appropriate level, considering function, cost, schedule, etc. Over-specification leads to \$25k coffee pots (e.g., if triple redundancy is overkill, don't specify it).
- (specifications) appropriately stringent (e.g., don't say "exactly 100 ft" if it can be 100 +/- 3 ft).

Standard terminology

- Requirements use SHALL; they do NOT use: “is”, “was” and “must”
- Requirements do NOT contain unverifiable words like “maximize,” “user-friendly,” “adequate” and so on, without further qualification (e.g., “high enough to allow measurement of xyz” is ok).
- Requirements NEVER contain: “but not limited to”, “etc.”, or “and/or.”
- Specifications (and parameters) typically use SHALL since they follow from requirements. However, they can also just be names of quantities with value ranges (or specific values), without verbs at all, if appropriate.
- Objectives use verbs or nouns appropriate to reach goal: “measure xyz,” or “measurement of xyz” and so on.

Example of requirement wording

(in the section LAr → Cryostat and Cryogenics system → Cryostat) **The cryostat shall** provide mechanical support for the TPC.

(in the section Beam → Primary Beam → Primary Water System) **The primary water system shall** have capacity and flows that are adequate for maintaining magnet temperatures consistent with established Lab standards.

Instructions for filling out Excel spreadsheet

Please follow the above guidelines for distinguishing the different types of objects, structuring requirements properly and for language to use. Please use a separate Excel sheet or file per subsystem component (roughly WBS level 4).

Please eliminate blank lines; they create empty objects (using up unique identifiers) upon importation.

The order of rows in the spreadsheet will become the order of objects in the management tool, which will in turn determine the order of text in the output document. Order matters.

Fields with restricted values are supposed to have a choice menu (Type, Subtype, Status, Verification method). Sometimes Excel loses this information for some cells. Contact ahavey@fnal.gov if there's a problem.

- **Type:** Select from the drop-down list (see table of types above).
- **Priority:** 1, 2 or 3. “1” designates an item that corresponds to primary physics objectives; “2” corresponds to secondary ones, and “3” to the additional secondary ones. If the different levels of objectives dictate different content for your object, list it separately for each priority.
- **Object Heading:** This refers to headings for the eventual output documents. Enter headings here and leave the “Object Text” field (and all other fields)

blank. Make sure the “Object Level” (described above) is correct and consistent with the rest of the spreadsheet.

- **Object Text:** If current object is a heading, leave this blank. Otherwise, enter the text of the requirement (or other object type), using language according to the guidelines given, and leave the “Object Heading” field blank.
- **Value:** For specifications and design parameters, re-enter the value here for quick reference and to make it easier to pull out for direct entry into the CDR.
- **Units:** If you entered a value, specify the units here; please refer to the list of units, below; there are too many combinations to offer a preset choice list, but we want them standardized as much as possible.
- **Orig ID:** The id you assign as you compose the requirements.
- **Rationale:** (either this field or Parent, or both, is required.) A brief explanation of the rationale behind the requirement or other object, as needed.
- **Parent:** (either this field or Rationale, or both, is required.) Cite parent requirement via the parent’s Object Number (described above). Note that the parent may reside in a higher-level spreadsheet; using the new Object Number schema should make it easy to identify. (The linking in DOORS will need to be done manually.)
- **Author** intended to identify the person who originated the requirement (or other object),
- **Reference** : A document reference; enter the docdb number. If not in docdb, should it be? If so, add it. If not, enter a URL pointing to the document.
- **Status:** choose from the drop-down list. If an object has the "Status" of "superseded", indicate the new object that supersedes it in "Notes," along with the reason.
- **Verification method:** Requirements and specifications must be verifiable (other object types don't need this). Choose from the drop-down list the method that best describes how verification will be done.
- **Notes:** Add notes as needed/desired.

List of Unit Abbreviations to use

A	ampere (also mA, kA)
atm	atmosphere
bar	bar (also mbar, etc.)
barg	bar gauge (deprecated per Wikipedia)
b	barn
b	bit (also Mb, Gb, etc.)
B	byte (also MB, GB, etc.)
Bq	becquerel
C	coulomb
°C	degree Celsius
cf	cubic foot (also ft ³)

cfm cubic feet per minute (also ft³/min)
Ci curie
° or deg degree (angular)
eV electron-volt (also keV, MeV, GeV...)
°F degree Fahrenheit
F farad (also pF, nF)
ft foot or feet (also ft², ft³)
gal gallon
gpm gallons per minute (also gal/min)
G gauss (also mG)
g gram (also mg, kg)
Hz hertz (s⁻¹)
h hour
in inch
K kelvin
l liter
m meter (also nm, micron, mm, cm, km)
min minute
N newton
Ω ohm
R roentgen
Pa pascal
psi pounds per square inch
rad radian (also mrad)
s second (also ns, μs, ms)
scfm standard cubic foot per minute
t ton (also kt, Mt)
T tesla
V volt (also mV, kV, MV)
W watt (also mW, kW, MW)
yd yard

Questions to aheavey@fnal.gov.

Updated August 18, 2011 by Anne Heavey