ETW Notes:

- The numbers in the requirements document did not come from the long-baseline PWG and were never presented to us – I do not know what the thinking was behind these numbers
- Serious answers to the questions in your template require more than a few minutes thought and discussion within the working group – I'll give my initial thoughts here but will have to get back to you with more complete answers
- Some of the listed science requirements are significantly more stringent than others, so the design requirements are likely to be driven by just a few of the science requirements
  - For lack of a better method, I'll quote required exposure in kt-MW-yrs from CDR as a proxy for how difficult a measurement is
  - We don't have studies that determine exactly where sensitivity is coming from for most of these. It's possible that some get more sensitivity from resolution, low-energy part of the spectrum, etc than others

Working Group: Long Baseline

- **Primary Science Goals for 10(40) ktons:**

1. Reject wrong mass ordering at >3(>5) σ for worst set of parameters
   - MH at worst point (5σ) requires 230-400 kt-MW-yrs
   - Hard to imagine this will drive requirements
2. Measure δ_{CP} to better than 20(7) degrees
   - Depends on true value of δ_{CP}
   - 10° @ δ_{CP}=0 requires 290-450 kt-MW-yrs
   - 10° at δ_{CP}=90 requires > 1000 kt-MW-yrs
   - 7° is close to the best possible measurement if δ_{CP}=90
3. Measure $\sin^2 2\theta_{13}$ to <1%
   - Reactor experiment precision: 0.084 ± 0.003 (~3.5%) requires 850-1200 kt-MW-yrs
   - Reaching 1% does not seem possible, perhaps the requirements are thinking of θ_{13}?
4. Measure Δm^2_{23} to <2%
   - Requires ~1200 kt-MW-yrs
5. Measure $\sin^2 2\theta_{23}$ to <2 degrees (note: this does not make sense)
   - Agree that this is inconsistent
   - 1° resolution on θ_{23} at θ_{23}=42° requires 45-70 kt-MW-yrs
   - 2% resolution on $\sin^2\theta_{23}$ at $\sin^2\theta_{23}$=45 requires ~200 kt-MW-yrs
   - 1% resolution on $\sin^2\theta_{23}$ at $\sin^2\theta_{23}$=45 requires >1000 kt-MW-yrs

Completeness of Goals

(any missing? Are they quantitative enough for a design?)

- Why is CPV sensitivity not listed as a science requirement, when it has been treated as the primary science requirement publicly?
  - Related to δ_{CP} resolution
  - Goals include:
    - 5σ for 50% of δ_{CP} values (550-810 kt-MW-yrs)
    - 3σ for 75% of δ_{CP} values (850-1320 kt-MW-years)

Justification of Quantitative Goals

(For each primary goal: Is there a reason to reach precision X, or is it just the expectation from a nominal design? If precision reached was 2X, what would be the consequences?)

- MH: Experiment must determine MH unambiguously
- CPV: P5, publicly stated goals: CPV is the primary science driver so we should be at "evidence" or "discovery" level for as much of phase space as possible
- $\sin^2 2\theta_{13}$: comparable to reactor sensitivity for unitarity measurement
- Δm^2_{23}: better than current world average?
- $\sin^2 2\theta_{23}$: octant sensitivity depends strongly on true value so hard to set a requirement, sum rules are main justification for high precision measurement, don't have quantitative requirements for sum rules yet

Is the list of performance parameters in LBNF-DUNE-V1.8-parameters complete?

(Are there important missing performance parameters? Are there some parameters listed that are not very important? In each case, is the range quoted realistic?)

- No ν_τ background requirement
- "Signal normalization" not super well defined, we have been using 5%$\oplus$2% separately for ν_e and ν_e
- …out of time…will update

The top five technical specifications most likely to affect performance for my topic are: