U.S. CRP Cold Testing: Goals and Requirements

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Informal U.S. Cold Box Review

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Charge

The purpose of this review is to evaluate the baseline design and planned operations of the DUNE CRP cold box for the testing of CRUs for FD2. The design status and preliminary cost ranges will be presented. This system will be used for the final functionality and acceptance tests of the CRP assemblies at the US factory sites before their shipment to SURF for underground installation.

The committee is asked to evaluate and comment on the following questions:

1. Does the design of the cold box and supporting systems meet the technical, scientific, and operational requirements for CRP testing?
2. Is the cold box design sufficiently advanced for preliminary costing and project planning?
3. Are the cold box plans sufficiently advanced to meet the CRP PRR and construction schedule?
4. What are the open design and planning issues? When will the coldbox be ready for a final design review?
5. Has the CRP consortium considered alternative approaches to the cold box design and CRP testing?
6. What are the outstanding risks to the project in terms of cost, schedule, and safety?

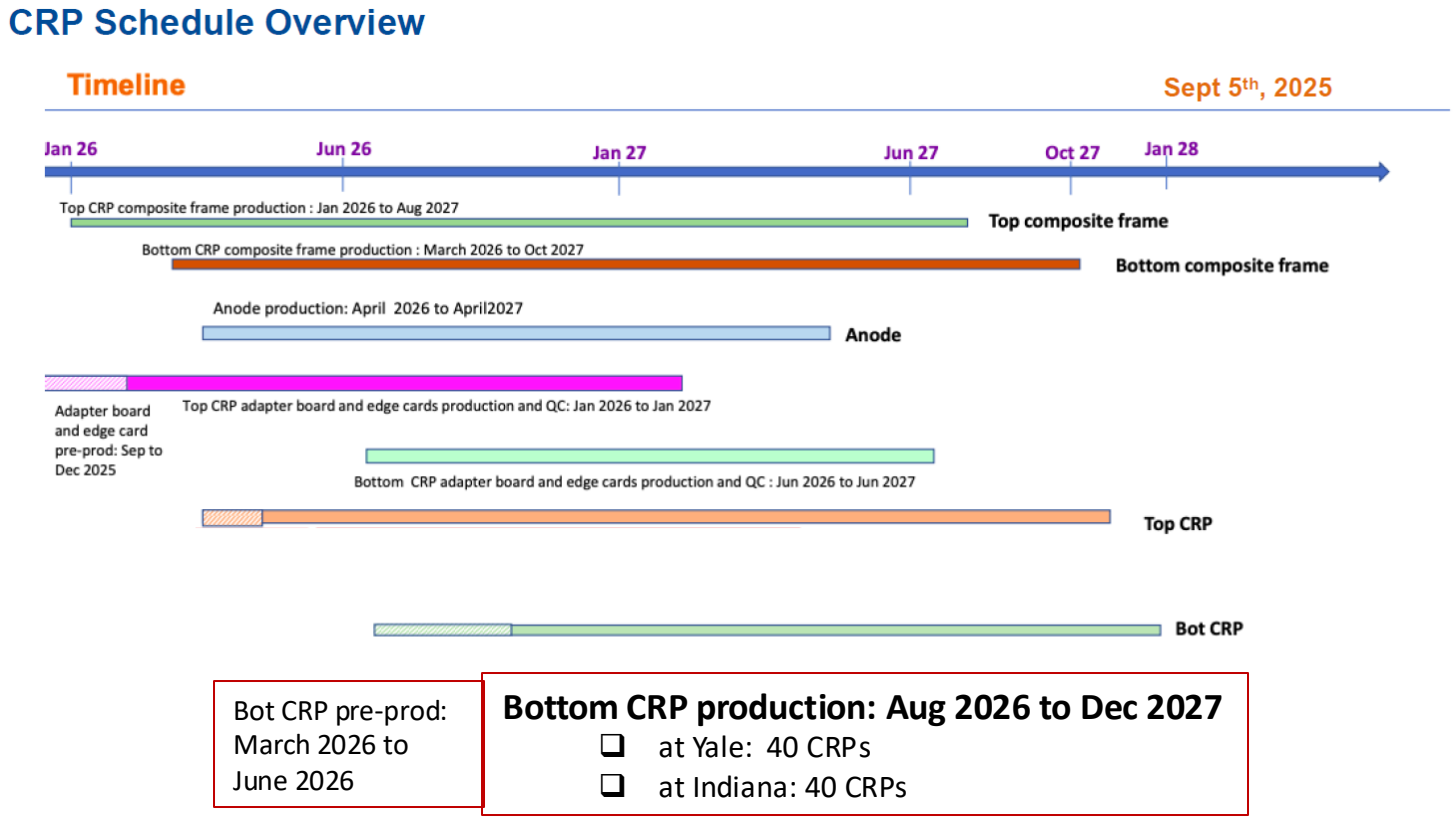
Comments from U.S. CRP group:

A great deal of labor time has gone into this value engineering. As factory setup ramps up, those labor hours will increasingly be needed elsewhere.

A decision on how to proceed is urgently needed to maintain the planned schedule.

CRP Production Schedule

- CRP production at Yale, IU from Aug 2026 to Dec 2027.
- ~56 weeks to assemble and test 80 CRPs
- Note: 1 CRP = 2 CRU
- With contingency, need throughput of 2 CRUs per week.
- Need to be able to test total of 4 CRUs per week.
- No capability for testing at SURF.
- Testing at factories (2 CRU per week) allows use of factory labor, contingency for problematic boards.



Bot CRP pre-prod: March 2026 to June 2026

Bottom CRP production: Aug 2026 to Dec 2027

- ❑ at Yale: 40 CRPs
- ❑ at Indiana: 40 CRPs

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Testing Requirements: General Considerations

- Test 4 CRU per week across both sites
- Check connectivity of anodes, edge cards, adapter boards
- Check HV for leakage current
  - Requires box to function as a Faraday cage
- Warm test prior to cool-down
- Cold test
- Warm test after warm-up

Testing Requirements

- Temperature of CRU: ≤ 140 K
- Maximum rate of temperature change: 3 K/minute (90 minute cool-down)
- Temperature stability (in time) during testing: ± 10K
- Temperature uniformity (in space) across one CRU: ± 20K
- Distance to wall to prevent HV breakdown: No requirement (not at issue in nitrogen at this voltage).
- Temperature difference between CRUs: No requirement (as long as all are ≤ 140 K).
- Moisture/condensation: Dry nitrogen during cooldown is sufficient. Warm to room temperature before exposing to lab air.
- Cleanliness: To be made precise depending on specifics of factory setups. Grenoble test setup was ISO 8. At minimum, coverings should be used to prevent dust from falling on CRU.
- Liquid testing: No hard requirement, but if most are tested in gas, aim to test 10% in liquid.
- BDE cable: The 7 m cables are sufficient. Cables should be inside the cold box.

Overview of status and plan for this meeting

- Costs for initial testing plan with LN2 presented in May were prohibitive.
- We have looked at a number of options for reducing the cost.
- The best option we've identified is cold gas testing at both factory sites (with small number of liquid tests).
- The bottom line cost estimate is $270k at each factory (cf. $410k presented in May).

We plan to walk through how we arrived at this estimate and why we believe it is the most cost-effective solution:

- Cold box design for cold gas testing (James) will show the revised design
- Analysis of alternatives (Steve) will show the other options considered. None of these provides a clearly cheaper solution for testing.
- Feasibility of gas testing (Tyler) will show that gas testing is sufficient to meet requirements.
- Cryogenic systems (Brandon) will show reduction in nitrogen consumption under the revised plan.
- Cost, schedule, resources, and risks (Steve and Matt) will show a full cost estimate breakdown.
- Operation and schedule during production (Tyler) will present the revised testing procedures.