nitrogen gas will be produced in sufficient quantities to meet the needs of the LLCF and several detectors in our laboratory rooms. (It would not be sufficient for large-volume cryogenic detectors like HERON or Icarus, however.) Finally, ultra-pure water is used in the water shields and in the pools of the ultra-low-level counting facility. The LLCF will have a capacity of about 65 tons/d and a purity of 10^{-14}—10^{-15} g/g U and Th. This production rate corresponds to three weeks for filling one of the pools in the ultra-low-level counting hall. As water repurification will consume about 20% of the system's operating time, there is sufficient excess capacity to produce and repurify 5-10 ktons/y of ultra-pure water for use in the experimental halls.

Other capabilities offered in the utilities area associated with the LLCF are electroforming of Cu (and possibly other metals), machining of the electroformed Cu, and a detector construction area. The electroforming area is isolated and uses the single-pass special exhaust system. The electroforming systems would be provided with Rn-free air to ensure that Rn daughters are not incorporated into materials. The procedures have been worked out with the Majorana collaboration. Production capacity is expected to be several kilograms per week. The machining area will include a clean lathe, mill, and small tools, and will be dedicated to electroformed materials, with specially selected tool bits, etc., to ensure cleanliness and radiopurity. An assembly area (4 m × 8 m × 4 m high) would be provided in the clean machine room.

Supporting surface facilities include a chemistry laboratory to handle Neutron Activation Analysis (NAA) samples, as irradiated samples will not be allowed directly into the LLCF because of contamination worries. Additional needed surface chemistry capabilities include optical emission spectroscopy, chromatography, inductively coupled plasma mass spectrometry (ICPMS), and standard chemical analysis. Clean rooms will be provided for high-sensitivity measurements, such as those with ICPMS. A surface contamination laboratory is needed for optical and x-ray fluorescence measurements of surface swipes from underground experiments. None of these facilities requires an underground location. The surface chemistry laboratory is an essential complement to the LLCF.

Space for detector development – important to many DUSEL activities – is also crucial to the LLCF, providing a dedicated area for developing new counting techniques that will later be incorporated into the LLCF. This is an essential part of the proposed facility: we envision the LLCF as an evolving, dynamic facility that not only serves the community, but also makes innovative advances in experimental technologies. In this way the diagnostic capabilities of DUSEL-Cascades will progress as new experiments make increased demands.

The WBS-2 description describes the envisioned faculty and staff levels for this national facility. We anticipate that the staff will in fact be larger because the counting specialists will share their time between the LLCF and experiments needing counting expertise. This would also be helpful in keeping the LLCF responsive to the needs of the experimental community.

National Security Operations

There is a growing need for low-level counting to address security needs ranging from nonproliferation and treaty verification to post-9/11 environmental monitoring. Many national security applications require the same state-of-the-art instrumentation and extreme depths necessary for basic science low-level counting. Similarly, new low-level-counting developments will advance both basic and applied science, including national security applications. That is, national security low-level counting would likely advance more rapidly and be more economical if it could be done as part of the DUSEL program, in a single deep location. This raises the issue of the practicality of such work in an otherwise open facility. Such work must be done securely, but without unduly affecting access or other operations crucial to open scientific operations of DUSEL.

In planning low-level counting, three conclusions were reached:

- While national security research is governed by special restrictions, those restrictions can be met without diminishing the openness or international aspects of DUSEL. For example, if a separate cavern is built for national security low-level counting, the necessary access control can be established at cavern doorways.
- National security research is traditionally approved and supported by offices distinct from those sponsoring basic research activities. Department of Energy national laboratory researchers have borne most of the responsibility for such work. They have established relationships with the sponsors and are familiar with the special institutional procedures for such work.

- There is little distinction between basic and applied low-level counting in underlying techniques or in the R&D requirements for further advancement. Advances in the national program come from both the basic and applied sides. Many national laboratory researchers involved in national security work are also leaders in basic science applications, such as double-beta decay.

These points lead to the suggestion in this proposal that national laboratory scientists design and operate DUSEL-Cascades low-level counting facilities, both secure and open, as a national facility, imbedded within DUSEL as a separate department. Specifically we propose that PNNL (lead), LANL, and other partners (possibly LLNL and LBL) shoulder this responsibility. PNNL currently is the leading DOE laboratory for national security low-level counting. As a close neighbor of DUSEL-Cascades, it will be convenient for PNNL to maintain a presence on site. Several of the potential national laboratory partners currently collaborate on Majorana, an experiment that depends crucially on DUSEL low-level counting facilities.

The laboratories will approach the Department of Energy to seek support to equip and operate the open and secure low-level counting facilities and the supporting utilities area and clean machine room. This approach will allow them to coordinate open and secure facilities, avoiding unnecessary duplication. They will address with their traditional sponsors access control and other issues affecting secure operations: anticipated requirements, such as vault-type doors, are in place at most national laboratories today, and should not complicate other DUSEL operations. They will propose procedures that will allow DUSEL management to fulfill its Washington State and federal environmental, safety, and health oversight responsibilities. It is anticipated that primary support will come from both the national security and basic science sides of the DOE, e.g., from NNSA and from the Office of Science.

The closed portion of the LLCF will require instrumentation very similar to that already described:
- germanium detector arrays for gamma spectrometry
- beta detection in solids via flow-through counters
- beta detection in gaseous samples using gas cells
- beta detection in liquids using liquid scintillator
- alpha counting and spectroscopy in liquid scintillator
- alpha counting and spectroscopy in vacuum chambers

Some simple chemistry capabilities for sample preparation underground would be desirable. For example, air-filter samples could be processed to chemically separate radon daughters. This might involve an ashing procedure in a small muffle furnace followed by chemical suspension and group chemistry on the residue. Such activities would require HEPA filtered fume hoods, which would be connected to the laboratory's special exhaust system.

The closed LLCF is expected to shoulder certain routine sampling duties connected with treaty monitoring. In the case of a sample tagged as potentially indicative of treaty violation, typically the staff would be notified to expect the sample by air or other courier. A fast screening would be done to check the sample's activity. The sample would then be counted underground for an extended period, with results on key short-lived species reported daily to a central control. The underground facility would also handle many routine daily samples in order to double check the results of earlier assays done in the field. Measurements are typically calibrated against national standard bodies, such as those provided by NIST. Thus appropriate calibration materials are required. Special secure cabinetry (e.g., a facility capable of monitoring sample bar codes every few seconds) is needed to satisfy chain-of-custody requirements, as backlogs in counting may require such storage.

All samples counted at DUSEL would be low in activity. High-activity samples would be detrimental to the facility and thus would not be shipped to DUSEL. Monitoring systems at the receiving offices of the Science/Administration building and at the underground laboratory would check all samples on receipt.

The data produced by the laboratory would be transmitted over a private network with encryption, to maintain confidentiality. Access control requirements are also needed to assure the physical security of samples and data. It is expected that the NNSA and other possible clients would be consulted at the time of the facility's design, to make sure the security provisions are adequate. This includes both physical and procedural controls for samples and data. We anticipate the requirements will include vault-type doors, law-enforcement response protocols, and the capacity for secure communications, storage, and computation. Most likely the closed LLCF will have a single entrance at which access is controlled, with options for additional customized security for various segregated experimental spaces. Infrastructure for ventilation, communications, power, and other utilities must meet both security requirements and general laboratory safety requirements.

WBS2 provides a receptionist (or guard) to be available at the entrance of the secure LLCF during a 16-hour period each day, in anticipation that some of the required security may be addressed by procedural controls. Costs for physical controls, such as vault-type doors or a Faraday cage to ensure against the loss of electronic signals, have not yet been estimated or included in WBS2. Such costs will be part of the plan for secure counting that our national laboratory partners intend to formulate. Note that such costs are not envisioned as part of NSF obligations.

The design would allow U.S. nationals to enter and provide services within the facility. The highest security areas would be those behind the vault-type door. Other areas would have more modest controls. Generally the space would be segregated in ways that provide access to an area only if the visitor has a specific need for that access.

Space for measurement research and development is also needed, though some of this could be on the surface. Researchers would develop and build more sensitive measurement systems, automate existing technologies, and explore new detection methods. This will require moderate amounts of engineering laboratory space and access to generic electronic and mechanical tools, such as auto tubing welders, cut-off saws, small mills, etc. The use of such tools would have to be consistent with the laboratory's general safety procedures for electrical and mechanical systems.

PNNL and its national laboratory partners will work out a detailed plan for the secure LLCF, in cooperation with the NNSA and other potential sponsors. This plan should then be integrated with the overall plan for low-level counting (secure and open), including clean machine room and specialized utilities (ultrapure water, scintillator, etc.). The national laboratory participants from this proposal have the required design expertise; interested university researchers will also be invited to help.

The DUSEL-Cascades proposal's relatively modest space for secure counting, about 1500 sf, is in accordance with discussions that took place at the Lead and other community meetings through 2002. More recently PNNL scientists have estimated that 2000 sf will be needed for sample measurements, roughly consistent with what we provide. In addition, PNNL estimates perhaps another 2000 sf for measurement research and development. In addition to the substantial utilities area provided in the open LLCF plan, the proposal provides approximately 2200 sf of space in a clean machine room, which houses capabilities very similar to those needed for the detector research and development described above. (This space, currently designated as open, could be assigned as needed.) Thus the current proposal likely provides about the right amount of space. However, a re-examination of the apportioning of LLCF activities between open and closed areas, as well as between the utility area and the clean machine room, is needed. Rather than attempting such a re-examination in the proposal, the DUSEL-Cascades proposers will await future community discussions, which national laboratories and their university partners will likely soon hold. If the resulting recommendations include a significantly larger secure area (either by expanding current plans or by apportioning space differently between closed and open activities), it might be appropriate to include the closed-space excavation requirements in WBS2, which currently is limited to equipment and operations costs.

A final issue that may need to be re-examined, given that many LLCF needs are quite urgent, is the establishment of temporary facilities at some existing (though less deep) location. This would address current applied and basic science needs. The organization of such a facility might be a valuable experience for the community, prior to undertaking the more ambitious DUSEL LLCF project.