Report of the Facilities Subcommittee of the MPS Advisory Committee on the Deep Underground Science and Engineering Laboratory

Introduction

On September 5, 2007, Assistant Director Tony Chan wrote a letter charging the Facilities Subcommittee of the MPS Advisory Committee to look at the Deep Underground Science and Engineering Laboratory (DUSEL). He attached to this letter a general charge for the MPSAC Facilities subcommittee:

"The MPSAC Facilities Subcommittee is charged with:

- Assessing the potential contribution of new proposed facility projects to the scientific program of MPS, the role of such projects within the existing MPS facilities portfolio, and the impact of such facilities on future plans and budgets of MPS and its divisions; and
- Providing a recommendation to the MPSAC for the MPSAC statement to the MPS Assistant Director concerning an MPS request for entry of an MPS large facility project into the MREFC defined "Readiness Stage."
- Providing advice on elements of the MPS facilities portfolio at the request of the MPS Assistant Director."

He also gave the specific charge for DUSEL:
"I am asking the Subcommittee to prepare a recommendation to the full MPSAC as to whether DUSEL should enter the 'Readiness Stage' of the MREFC process."

Since that time the Facilities Subcommittee has worked to establish a framework for carrying out its role in giving advice on facilities in general, while addressing specifically the issues relating to DUSEL. We sent to MPS a set of questions about the oversight of facilities at NSF and within MPS in addition to detailed questions about the history and status of DUSEL. MPS sent us extensive responses to those questions, and we followed up with a series of discussions with MPS leadership. The overall result has been an extended discussion between the subcommittee and MPS about facilities, their role in the MPS research program, and about DUSEL.

In this report we summarize what we have learned about the process for designing, building, and operating facilities at NSF and specifically within MPS. In addition, we present our understanding of the status of the DUSEL project, and make some recommendations.

Large Facilities at NSF

"Facilities are an essential part of the science and engineering enterprise, and supporting them is one major responsibility of the National Science Foundation (NSF)."

The above quotation is the first sentence of the NSF Large Facilities Manual. In that manual, published in May 2007, the Foundation describes its plan for planning and managing large facility projects. Each such project goes through four stages: Conceptual Design, Readiness, (National Science) Board-Approved, and Construction.

For MPS projects, the first three of these stages are funded from the Research and Related Activities Account (R&RA). The construction stage for large facilities is funded from the Major Research Equipment and Facility Construction (MREFC) appropriation. At the end of construction, responsibility for operating the new facility reverts to MPS and the R&RA account. The transitions in funding type and in the responsible organization within NSF require particularly careful planning.

The NSF has established the Large Project Office (LPO) within the Office of Budget, Finance, and Award Management. The head of the LPO is Mark Coles, the Large Facilities Project Deputy. The LPO oversees all large facilities projects, of which there are currently 11 in development or construction. They are responsible for implementing the policies and practices in the Large Facilities Manual, working with the cognizant research directorate.

The Readiness Stage

Because of our charge, the Readiness Stage is particularly important to understand. We therefore include here the most important sections of the Large Facilities Manual relevant to this topic. The section of the Manual about the Readiness Stage begins with the following paragraph:

"The Preliminary Design/Readiness Stage further develops concepts to a level of maturity in which there are: a fully elaborated definition of the motivating research questions; a clearly defined site-specific scope; a PDP (Project Development Plan) that addresses major anticipated risks in the completion of design and development activities and in the undertaking of construction; and an accurate budget estimate that can be presented with high confidence to the NSF Director, NSB (National Science Board), the Office of Management and Budget (OMB), and Congress for consideration for inclusion in a future NSF budget request."

To enter the Readiness Stage, the project needs the following:

- a completed Conceptual Design proposal that has been reviewed and approved for funding, including a Project Execution Plan;
- approval by the Assistant Director, taking into consideration scientific merit and relative importance compared to other opportunities and demands for resources, with input from scientific community, disciplinary studies, advisory committee recommendations, and internal NSF considerations; and
- recommendation by the MREFC Panel to the NSF Director, who approves entry to readiness, and the concurrence of the NSB, as recorded by inclusion in the annual NSF Facility Plan.

A great deal needs to be accomplished in the Readiness Stage, as described in the Manual:
"A candidate project exits from this stage and enters the Final Design/Board Approval stage after successful review by the MREFC Panel, and after the NSF Director recommends the proposed project to the NSB for approval to include in a future year budget request.

The MREFC Panel and the Director should first be satisfied that the following conditions have been met:

- the AD or office head of the sponsoring directorate or office (the originating organization) continues to assert the high scientific merit and importance of the project and has a sound financial plan for supporting the remaining pre-construction planning activities and the future operations and use of the facility;
- the Preliminary Design has been successfully reviewed internally and by an external panel of experts in order to obtain the best possible objective advice from authorities in the fields and disciplines utilized by the project;
- the DDLFP concurs that the Preliminary Design is reasonable and poses an acceptable level of risk, and that anticipated costs for construction and operation are sufficiently well known;
- the NSF Chief Financial Officer (CFO) certifies that the Preliminary Design budget has been satisfactorily defined;
- the NSF Director is satisfied that external participation in all phases of the project (other agencies, international and/or private sector entities, etc.) is well planned;
- updated Internal Management Plan and Project Development Plan documents have been reviewed and approved by the Facilities Panel (IMP only), the MREFC Panel, and the Director;
- an appropriate Project Leadership/Management team is in place; and
- the MREFC Panel asserts that the proposed MREFC project, when compared to other proposed projects – whether within the same field, across related fields, or across different fields – is among the very highest priorities for potential new facilities."

Advancement to Readiness Stage does not assure that a project will be started. The Large Facilities Manual describes the level of commitment to the project increasing as the project moves through the sequence of stages. It describes the following off-ramps from Readiness Stage:
" Projects may be removed from the Preliminary Design/Readiness stage by the NSF Director due to:

- insufficient priority over the long term;
- failure to satisfy milestones or other criteria defined in the IMP/PDP;
- eclipse by other projects;
- collapse of major external agreements;
- extensive estimated or actual cost overruns;
- significant changes in schedule for development;
- unexpected technical challenges;
- changes in the research community that indicate eroding support for the project; or
- any other reason that the Director deems sufficiently well-founded."

Budgetary Planning and Life-Cycle Costs

As facilities have become larger and more important to the national research enterprise, it has become more important to consider the costs of a facility over its entire life-cycle, including operation of the facility after construction. It is not uncommon for the operations costs to exceed the construction costs. Such operations costs are usually not reducible below a certain minimum level if the facility is to operate reliably and safely. Failure to account for these costs in budgets can cause problems for the entire research portfolio, as other programs are taxed to make up for unanticipated needs in facility operations.

We asked the MPS Directorate to provide us with their thoughts about how they are planning for the life-cycle costs, in particular the operations costs. They replied that they have been considering a “Strategic Co-investment” (SCI) model for major strategic investments, including but not limited to large facilities. In this model, a small fraction (of order 1%) of the MPS budget would be set aside each year for a special category of such co-investments, of which there would be a few across the directorate at any one time. This amount, about $15 million each year, would be given as in increment to the Divisions responsible for these strategic initiatives. This funding would be matched investments from the Division. For a construction project, MPS and the Division would reach agreement on the investment schedule at the time of approval for a construction start.

Overview of DUSEL and its Experimental Program

DUSEL is a “large scale, multi-purpose national facility that will exploit the considerable multi- and interdisciplinary discovery potential in science and engineering afforded by the deep underground environment.” The primary scientific motivation for the project is a set of experiments in the areas of elementary particle physics, nuclear physics, and particle and nuclear astrophysics, and the Physics Division has taken the lead role in developing the project. MPS is therefore the lead NSF Directorate managing the process, although there is interest from Engineering and Geosciences in making use of the facility.

The first systematic look at a dedicated underground laboratory took place in 2001, when DOE and NSF cosponsored an ad hoc committee chaired by John Bahcall to look at opportunities in underground science. Since that time, a series of committees and panels have issued reports that have given support for an underground laboratory:

1. DOE-NSF Nuclear Science Advisory Committee Long-Range Plan (2002).
2. NSF-sponsored International Workshop on Neutrinos and Subterranean Science (NESS 2002) Final Report.
3. Connecting Quarks to the Cosmos (2003), National Research Council report.
4. DOE-NSF High Energy Physics Advisory Panel Long-Range Plan (2003).
5. Neutrinos and Beyond (2003), National Research Council report.
6. EarthLab (2003), NSF-sponsored report of underground opportunities in GeoSciences and GeoEngineering:
7. Report by the Interagency Working Group on Physics of the Universe (2004), National Science and Technology Council report.
8. Quantum Universe (2004), NSF-DOE High Energy Physics Advisory Panel Sub-Panel report.
9. Frontiers of Nuclear Science (2007), the Long Range Plan by the Nuclear Science Advisory Committee
10. Revealing the Hidden Nature of Space and Time (EPP2010, 2006), National Research Council report.

Partly in response to these reports, the Physics Division issued a DUSEL solicitation S-1, calling for a definition of the scientific program at such a laboratory. This led to the 2006 report *Deep Science,* written by a team led by six principal investigators from the fields of astrophysics, physics(2), civil engineering/ rock mechanics, geomicrobiology, and microbiology. (The report is available at http://www.deepscience.org .) This document gives the scientific justification for the project and recommends “a flagship world-class underground laboratory providing access to very great depth (approximately 2200 meters or 6000 meters water equivalent) and ample facilities at intermediate depths.”

The initial physics program at DUSEL will be driven by two scientific campaigns. One is the attempt to detect directly the dark matter halo that envelops us. The astronomical evidence for dark matter is compelling and consistent. But to understand the nature of the dark matter, scientists are hoping both to observe its interactions in the laboratory and to produce dark matter particles at the Large Hadron Collider. The most recent review of the status of dark matter was the Dark Matter Scientific Assessment Group, which was a joint subpanel of the High Energy Physics Advisory Panel (HEPAP) and the Astronomy and Astrophysics Advisory Committee (AAAC). The report is available on the MPS website at http://www.nsf.gov/mps/ast/dmsag.jsp . They gave very high priority to a group of proposed experiments trying to extend the sensitivity to dark matter interactions into the range expected for supersymmetric particles.

The other scientific campaign is the search for neutrinoless double beta decay(DBD), which is being carried out by scientists from both the particle physics and nuclear physics communities. If neutrinoless DBD is discovered, it will both prove that neutrinos are their own antiparticles and measure the mass of the electron neutrino. The most recent review of the neutrino program was done by the Neutrino Science Assessment Group (NUSAG), a joint subpanel of HEPAP and the Nuclear Science Advisory Committee (NSAC). Its report on neutrinoless double beta decay is available at http://www.science.doe.gov/hep/NuSAGReport1final.pdf . They gave very high priority to an experimental program designed to increase the sensitivity in neutrino mass by one order of magnitude beyond present experiments.

Both of these reports were used as input to the “Particle Physics Roadmap,” written by P5, the Particle Physics Project Prioritization Panel, in October 2006:
http://www.science.doe.gov/hep/P5RoadmapfinalOctober2006.pdf
That roadmap reserved the first group in its recommendation for the multibillion-dollar international collider projects needed to explore the energy frontier: the Large Hadron Collider now and the International Linear Collider in a decade’s time.

The second group includes projects that are national in scope and significantly less expensive than the largest colliders. The three experimental programs given highest priority are dark matter, dark energy, and the exploration of neutrino mass. They said: “This grouping includes three small experiments: the 25 kg Cryogenic Dark Matter Search experiment, the Dark Energy Survey, and the Daya Bay reactor experiment. Also in this group is the support to develop the Stage IV dark energy experiments, the LSST and SNAP, to bring these to the ‘Preliminary Design Review Stage’ in the case of the NSF and ‘CD2 Stage’ in the case of the DOE over a two to three year time frame… The final item in this group is the R&D funding for DUSEL, along with support by the NSF and the DOE for R&D for both a large dark matter and neutrino-less double beta decay experiment. “

The P5 panel is now working on a new charge from Dennis Kovar of the DOE High Energy Physics program and Tony Chan of MPS. They have asked P5 to assess the current plans for the field of particle physics in the U.S. under four different budget scenarios. “The report should also provide a detailed perspective on how the pursuit of possible major initiatives (such as DUSEL, ILC, Project X, etc.) would fit (or not) into the program you recommend in each of the scenarios." The panel is operating on a very compressed schedule. "We would appreciate the committee's preliminary comments by March 1, 2008 and a final report by April 15, 2008."

For the present purposes, we assume that the two experimental programs that comprise the flagships of the initial DUSEL physics program, double beta decay and the dark matter search, will keep their high priority in the new report. It is also important to follow the development of plans for additional major experiments for DUSEL. P5 is discussing the evolution of the accelerator-based program of particle physics in the U.S. over the next decade or two. They are considering the possibility of using the Fermilab accelerator complex as the base for the world's leading program of neutrino physics. This could involve the construction of a massive neutrino detector at DUSEL, serving as the target of a new, intensive neutrino source at Fermilab. This would extend the scope of the DUSEL experimental program beyond that planned for the initial round of experiments. It would involve large participation from the DOE High Energy Physics program. More information about those plans will be emerging from P5 and HEPAP in the months ahead.

The DUSEL Process

The NSF has conducted three program solicitations in association with DUSEL. The S-1 solicitation was for the development of the science case, and resulted in the "Deep Science" report. The S-2 solicitation was for statements of interest from candidate sites. The S-3 solicitation in the second half of 2006 was for a Deep Underground Science and Engineering Laboratory (DUSEL) Site Selection and Technical Design Development. In July 2007 NSF announced funding for a single proposal to develop advanced plans for DUSEL at the Homestake site, out of four proposals that were received. The team is led by Kevin Lesko of University of California, Berkeley and Lawrence Berkeley National Laboratory. The Conceptual Design Report associated with effort is available here: http://www.lbl.gov/nsd/homestake/conceptualdesign.html . The summary and conclusions section of this report includes the following: "The preliminary cost estimate ($FY07 without contingency) for the MREFC application is $410 M (including $225 M in experiments and $9 1M in design and outfitting for underground laboratories). Other funding totaling $180 M, including the Authority-controlled funds, will provide nine years of pre-operations support and underground lab preparation."

The commitment by the NSF is to the site and the proposing team for development of a technical design for the facility and is governed by a Cooperative Agreement (CA) with the submitting organization for the Homestake proposal -- the University of California, Berkeley. The CA is now in place and the first year funding of the three year award has been awarded. UC Berkeley is accountable for the success of the technical design phase of the facility. There is no commitment by NSF for the funding of DUSEL beyond the design phase, nor is there any implied commitment beyond the design phase to the project management organization.

With respect to the technical design of the experiments for DUSEL, it will be governed via a fourth solicitation (S4) that is in preparation. Institutional management, oversight, and accountability of the project beyond the design phase would be identified at the appropriate time in the project life cycle.

Oversight and Program Management of DUSEL

Assuming that the DUSEL project advances, MPS will take the lead in the development of the facility infrastructure, including large-scale physics instrumentation, in support of DUSEL maintenance and operations, and in support of the physics experiments and groups that would participate in DUSEL. The oversight will be done in consultation with Program Directors (PDs) from the three Directorates (MPS, ENG, and GEO), with a PD representing the Biological Sciences serving in a advisory capacity. All programmatic decisions and their implementation regarding DUSEL are and will be made in a collaborative fashion. Each Directorate is expected to support the research programs in its own disciplines.

DUSEL is currently overseen by one full-time Program Director (PD) in the Physics Division. Other PDs in Physics provide additional help during times of peak oversight activity. A search is under way for a second PD dedicated to DUSEL. The Program Director will conduct the project reviews, using external experts for both the technical and project (cost and schedule) aspects.

Budgetary Planning

It will be critically important to know both the construction costs and the management and operation (M&O) costs at the time of project approval. The present budgetary planning for the M&O phase of DUSEL has been done using a rough estimate that NSF will need to provide $50 M per year, or 10% of the construction cost. The ongoing technical design process should produce detailed cost estimates for both the construction process and the M&O phase.

MPS will need to provide funding for the parts of DUSEL not included in the MREFC appropriation, including planning, R&D, preoperations, and M&O. It is presently assumed that the integrated cost for these items will ramp up linearly from the level of $7 million per year in FY 2007 to an amount of about $50 million per year at the time construction ends. PHY is requesting co-investment from MPS for a base budget build-up of PHY by an amount of 3M$/year/year over the 7 years of construction. For reference, the requested PHY and MPS budgets in FY 2009 are $298 M and $1.403 B, respectively. About $250 M of the MPS budget is used to support the operation of facilities every year.

Prompted by the DUSEL discussion, MPS has been thinking more broadly about a “Strategic Co-Investment (SCI)” model in order to build up needed funding for important scientific initiatives, whether facilities or other large initiatives. The developing idea is for MPS to set aside up to 1% of its budget to set aside each year for increments in a small number of initiatives, to be matched equally by the relevant division. The integrated increment to a division budget for a specific initiative would be subject to a cap of 1.5% of the MPS budget. The set-aside of 1% of the MPS budget for SCI increments would probably be sustainable only in a period where the MPS budget was growing faster than inflation, at least slightly.

Applying this general model to the specific case of DUSEL, there would be $3 M annual increment from MPS, which would represent about 20% of the 1% SCI investment fund for MPS each year of this period. By the end of the construction period, the total MPS contribution to the PHY annual base budget would be then about 1.5% of the total MPS budget, or $23 M. PHY would be expected to contribute the remainder, about $27 M, to meet the estimated operating costs of $50 M for DUSEL operations. This simple model will need to be refined after a detailed budget for DUSEL M&O validated by review as part of the ongoing Readiness Stage.

The DUSEL project is the only new facility now in planning stages by the PHY division. Advanced LIGO and Ice Cube are now in construction, with planned operations costs to MPS of $12 M and $4 M annually. The Large Hadron Collider (LHC) is in the operations phase now, with an annual budget of about $18 M. A planned upgrade to LHC instrumentation is in early stages of discussion, with a roughly estimated construction cost of $100 m, with the schedule still uncertain.

Findings

The experimental program for DUSEL has been given excellent reviews by several national panels. The flagship experiments of the initial program, double beta decay and dark matter search, have been given high priority within the national particle physics program by the P5 panel. The particle physics community is also discussing the possible need for a very-long-baseline accelerator experiment to advance neutrino science. The only suitable underground laboratory in the world for this may be DUSEL, which would greatly expand its scientific scope.

The MPS Advisory Committee is not constituted to conduct a new evaluation of the scientific promise of DUSEL that is independent of the evaluations given by the reports already published. DUSEL has emerged as the only new project in the planning pipeline for the Physics Division, which is consistent with the high priority given by several panels to the experiments it will enable. However, the MPS Advisory Committee is not in a position to evaluate the decision to give DUSEL top priority in Physics or across MPS. The HEPAP subpanel P5 will be issuing a revised roadmap over the next several months, and will provide important additional input on scientific priorities.

NSF reorganized the DUSEL process in 2004. Since that time, the development of the project through the S-1, S-2, and S-3 phases has gone according to plan. The two most important milestones in this process were the completion of the Deep Science report in December 2006 and the announcement of the selected site in July 2007. The next stage in this process is advancement to Readiness Stage.

Concerns

At the end of the Readiness Stage, NSF will review the bottoms-up cost and contingency estimates, the expected operations costs, the risk analysis, and the detailed project schedule. It is not uncommon for one or more of these items to present a significant change from the present level of understanding. We believe that it is very important for a set of independent experts to review all of this information in great depth so that the NSF Director can bring the project to the Science Board with as much confidence as possible for such a complex project.

To be ready to start construction on DUSEL in as little as three years will take three large, well-organized efforts: one from the group that has already received the S-3 award, one from the organization that will receive the S-4 award, and one at the NSF. By the time this project goes to the National Science Board, the program goals and scientific requirements must be sharply defined and adequately compelling for the project cost. The organization capable of managing a very complex $500 million project must be in place and functioning well, and NSF must have developed a DUSEL program office capable of overseeing that organization. All of this would represent ambitious goals for the next three years, even if this project were being managed by an existing laboratory with expert teams and management all in place. In the case of DUSEL, however, one is forming the laboratory from scratch while developing the project.

The construction and operation of a deep underground laboratory present additional challenges in the management of the environment, safety, and health. This is a very different environment from a typical university laboratory, and it is important to build into the institution a high level of attention to issues of from the beginning. In its Antarctic research program, NSF has established its ability to manage a laboratory in the most difficult location on earth. The DUSEL will not be as unusual an environment as that, but it will need additional focus on the environment, safety, and health.

We are concerned that the present level of funding, starting with no preexisting laboratory, may not be sufficient to develop the facility and experimental designs and to build up the strong management teams by the end of the S-3 and S-4 award periods. It will require establishing a laboratory organization with key management and scientific personnel that is capable of functioning efficiently while growing into a laboratory of a few hundred people by the time construction is complete. It remains to be seen whether the commitment of NSF involved in the Readiness Stage is sufficient to convince key leaders to commit their careers to DUSEL. The NSF will have to develop a DUSEL program office capable of overseeing this period of facility construction and laboratory formation. The experience and best practices of deep underground laboratories around the world should be called on for advice.

The NSF oversight of DUSEL, both the construction project and the laboratory, must be clearly of such strength as to instill confidence that the project and scientific goals will be met. It is important that the executive and legislative branches see this as a model of management for large scientific facilities and that the scientific communities judge the scientific management of DUSEL to be comparable to the best-run national laboratories. We want to make sure that the best practices of program review and oversight are applied to DUSEL, including:

- regular cost, schedule, safety, and management reviews of the DUSEL construction project by an expert team that continues for the life of the project;

- regular reviews of the DUSEL laboratory organization, especially during the period of rapid growth from the present skeleton organization to full strength; and
- regular reviews of the laboratory operations budget as it takes shape, making sure to capture all costs that will be transferred from the construction budget at the end of the construction project.

The oversight and program management of DUSEL will tax the lean management structure of NSF. The Large Facilities Manual is a good document to guide the management of large facilities projects, but full implementation of it requires a large effort by several people experienced in oversight of large science facilities. Two dedicated Program Directors in the Physics Division may not be sufficient to supervise a project of this size. In addition, we note that the Large Projects Office is presently overseeing 11 large projects in various stages, with a smaller staff than other science agencies with similar levels of construction activity.

Conclusions

We conclude that the DUSEL project is ready to advance to the Readiness Stage, but with some qualifying recommendations spelled out below. The scientific program has been reviewed by the appropriate scientific communities and has been given strong support and high priority. The site selection process has been carried out successfully and is accepted by the involved communities. The Conceptual Design is at the appropriate level for this stage of the project. We are impressed with the progress made by a relatively small number of people over the last year.

Because of the importance of the scientific opportunities made available by the DUSEL project, we have taken a broad view of what will give it the best chance of success. This has led to a very productive discussion with MPS and PHY going beyond science to issues such as budget, management, organization, and oversight. The rest of this section summarizes our conclusions on these issues.

We recommend that MPS continue to develop the Strategic Co-Investment (SCI) model in more detail, in consultation with the divisions, the NSF directorate, and the MPSAC. The SCI model is an interesting framework for institutionalizing the process of building up funding for strategic initiatives. This model could be used for any strategic initiative that requires building up a large funding base over several years, not just large facilities. But it is important that SCI funding be reserved for initiatives with scientific opportunities that justify the level of investment and commitment by MPS and the division.

We recommend that MPS and the DOE High Energy Physics program develop a formal arrangement for close interagency coordination in the DUSEL scientific program. The scientific program will be supported by both agencies over decades, and the relevant scientific panels report to both. We expect rapid advance in our understanding of dark matter an neutrinos over the next decade, and optimizing the scientific program will require such close cooperation. We note that the agencies worked closely together on the U.S. LHC project, with great success, and this can be the basis for similar cooperation on DUSEL.

We recommend very close review and oversight of the DUSEL program from now until the laboratory starts operation. It is natural to consider a strong role for the DOE Office of Project Assessment in the review process for DUSEL. If this is not considered feasible, a review process equally comprehensive and detailed to that used for the LHC project must replace it.

We recommend that MPS follow closely the planning process being carried out by the HEPAP subpanel P5, which receives its charge from MPS and the DOE Office of High Energy Physics. When the P5 report becomes public, MPS and PHY should receive a briefing from the panel chair and take into account any additional statements they make about the priority and role of DUSEL.

We recommend that NSF and MPS look at DUSEL as an integrated and continuous long-term program, and take responsibility for the success of that program. This program includes the design and construction of the facility and experiments, establishment of the laboratory, preoperations and operations. For parties to commit their careers to DUSEL, the NSF will have to communicate that it is committed to the success of the project, assuming that all of the goals of the Readiness Stage are met. The sharing of responsibility among the Large Facilities Office, MPS and PHY must be done in a seamless matter, with all parties taking ownership of the entire process. It is possible to predict and avoid many possible problems by comparing closely with the large number of similar facilities project already done, but only if there are enough experienced eyes looking hard at every aspect.

We believe that the Deep Underground Science and Engineering Laboratory could be host to great science if these conditions for success are met.

Appendix 1

<u>Membership of the MPS Facilities Subcommittee</u>

Michael Witherell, Chair
Douglas Arnold
Larry Dalton
Sol Gruner
Robert Williams
James Yeck