To: South Dakota Science and Technology Authority
P.O. Box 8329, Rapid City, SD 57709

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Subject: Initial Response Letter for the Homestake Deep Underground Science and Engineering Laboratory.

Date: Dec 10, 2005

Please note: two proposals are included in this letter

PROPOSAL 1

Title of proposal: Fracture Network Characterization at Homestake

List of participants: **M. Mauldon (mauldon@vt.edu) H. H. Einstein (einstein@mit.edu) and A. Bobet (bobet@purdue.edu)**

Brief description of proposed program

Rock fractures (joints) govern rock mass behavior; specifically the deformation, stability and hydraulic properties of rock masses. Important characteristics of fracture patterns, particularly fracture extent and interconnectivity, must generally be inferred from limited one-or two dimensional exposures such as boreholes or rock outcrops, or from rock core. Such observations then serve as input for three dimensional models which are used to make predictions of rock mass behavior. The problem is that it is usually impossible to determine the actual 3d fracture pattern subsequent to making predictions; i.e. to verify whether the fracture pattern models are correct or not. DUSEL provides unique opportunities to access a large amount of information about the rock mass, and this in a number of ways:

- The rock mass at Homestake is exposed at multiple faces; e.g., rock pillars, parallel drifts, and multiple levels. This provides a wealth of opportunities for direct characterization of the 3d fracture network geometry.
- Creation of new underground space or enlargements and modifications of existing tunnels and chambers. Such excavation involves removal of rock mass slices, again allowing real time construction and verification of fracture geometry models.
- Fracture data from the vast collection of rock core will be utilized in the fracture network characterization.

- Observations and measurements of water inflow and water characteristics. According to Campbell (http://homestake.sdsmt.edu/Resources.htm), brittle deformation during the Tertiary is responsible for the network of joints that transmits meteoric water into the mine workings. Information on connectivity and permeability is also provided by groundwater temperature and chemistry. Campbell reports that drifting, cross-cutting, and diamond drilling have locally intersected these "watercourses", as they are called by the miners, and encountered medium to high temperature (45 to 85ºC) water under low to high pressure **.The fracture network studies will make use of infiltration studies already carried out, and of additional seepage data collected during the early stages of DUSEL. Tracer experiments on a number of scales will also be carried out in this context**.
- Ground-truthing and calibration of indirect or remotely sensed measurement methods such as seismic, radar, etc. Signals measured with such methods are in principle related to the fracture pattern. However, information obtained by geophysics requires "ground-truthing," which is best achieved by direct correlation with the observed fracture geometry and other rock mass properties. The three-dimensional exposures mentioned above provide opportunities for such ground-truthing. Calibration of geophysical measurements against extensive exposures of rock surfaces in the DUSEL will potentially result in advances in geophysical imaging and interpretation, which will in turn be of benefit in numerous fields, including hydrocarbon recovery, underground construction and groundwater modeling.

Space requirements

No permanent space required.

Access requirements

Access to all open areas of the mine (as available) requested in order to collect fracture data
Access to existing data pertaining to the fracture networks; this includes rock core, infiltration data, etc.

Other general requirements

None

PROPOSAL 2

Title of proposal: Risk Assessment of Underground Space Modifications at Homestake

List of participants: H. H. Einstein (einstein@mit.edu) and M. Mauldon (mauldon@vt.edu)

Brief description of proposed program

Modifications and rehabilitation of the existing underground space at Homestake, as required for DUSEL in both the short term and the long term, will be subject to numerous uncertainties. These range from the engineering-geologic character of the rock mass and its suitability for creation of (or modification of) underground chambers; to possibly deleterious effects on the environment resulting from DUSEL construction activities; to strategies for tunnel and shaft rehabilitation; to the ability to deploy research programs and meet scientific research goals within a given time frame. These uncertainties have a direct effect on the risk of the DUSEL facility.

These risks, together with similar risks connected with facility operation, should be formally assessed to provide the proposers and sponsors with a clear picture of the likely range of final costs, as well as time to completion of the various phases. The framework for evaluating these risks will be provided by Decision Aids for Tunnelling (DAT), which was designed to allow determination of risks pertaining to tunnel construction, particularly with regard to geologic and geomechanical conditions, and construction delays. The methodology can be readily adapted to consider uncertainties associated with revitalization/refurbishing of existing underground facilities. The DAT structure **also** lends itself to develop a formal assessment procedure for operating and experimental uncertainties and their consequences.

Space requirements

No permanent space required.

Access requirements

Access to open drifts for evaluation of geomechanical conditions

Other general requirements

Access to rock core, inflow data, and other relevant information.