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Why every national deep-geological-isolation program needs a long-term science & technology component

R. J. Budnitz

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Robert J. Budnitz
Lawrence Livermore National Laboratory
Livermore, CA 94551 USA

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A. Introduction: Rationale for a Long-Term Science & Technology Program

The objective of this paper is to set down the rationale for a separate Science & Technology (S&T) Program within every national deep-geological-isolation program.

The fundamental rationale for such a Program is to provide a dedicated focus for longer-term science and technology activities that ultimately will benefit the whole repository mission. Such a Program, separately funded and with a dedicated staff (separate from the "mainline" activities to develop the repository, the surface facilities, and the transportation system), can devote itself exclusively to the development and management of a long-term science and technology program. Broad experience in governments worldwide has demonstrated that line offices are unlikely to be able to develop and sustain both the appropriate longer-term philosophy and the specialized skills associated with managing longer-term science and technology projects. Accomplishing both of these requires a separate dedicated program office with its own staff.

As discussed in more detail below, the philosophy of an S&T Program should be to undertake projects that are longer-term in character. The S&T Program should not be explicitly charged with developing information or tools to support the regulatory needs of the repository development office, nor should its projects be intended to be in the critical path vis-à-vis any such line-office responsibility. Each repository-development line office has the responsibility to maintain its own technological capabilities to support its own mission. The S&T Program's jumping-off point must be to assume that the main repository-development activities are all proceeding on their own schedule, with more than adequate technical capabilities, and with more than adequate safety margins when

compared to all applicable regulations. Nevertheless -- that is, even if the mainline repository-development work is proceeding successfully, including getting to the point that the repository begins waste-emplacement operations -- it is clear that *the most that can be expected of the repository's design approaches and analytical methods is that they capture the best current practice at the time.* However, *such best practices do not remain static over time*. Hence, given the multi-decade period over which a repository program will be operating both the underground repository and its supporting surface and transportation facilities, it is incumbent upon every repository program to work diligently to introduce both advanced technologies and advanced analytical methods, so as to *improve on "current practice*." Ultimately, it is expected that many of the new approaches will become “current practice.”

If any repository program were to remain technologically static over a several-decade-long time period, it would be a serious disservice! More importantly, because of the unprecedented requirement to assure safe radioactive-waste isolation for many many thousands of years, the country's regulations, as well as the broad society speaking through the spirit of those regulations, should insist that throughout the operating phase of the repository there must be efforts to continually challenge and probe the technical basis for the repository's ability to isolate the radioactive wastes adequately. Only by so doing can society achieve increasing confidence that the ultimate disposal of the waste deep underground is adequately safe. Achieving this increasing confidence requires a continually improving science-and-technology knowledge base -- hence the need for an ongoing Science & Technology Program.

The S&T Program must be an institutionalized part of the overall repository program, but it must be explicitly separate from the mainline activities --- connected to them enough to assure that the advanced technologies and methods being pursued are useful and appropriate, but separately funded and managed. This is because if the S & T Program is managerially linked directly to the mainline repository-development work, the shorter-term perspective of the latter will end up compromising the longer-term perspective of the former. This inevitability is well established by experience in other government programs.

B. S&T Program Objectives

The objectives of an S & T Program should be:

1) to improve existing and develop new technologies to achieve (a) <u>savings</u> in the waste management system schedule and life-cycle costs, and (b) <u>efficiencies</u> in the waste management system (transportation, waste handling, disposal), and

2) to increase <u>understanding</u> of repository and surface-facility performance.

These objectives are complementary, in the sense that some of the projects to be undertaken will address parts of both of these objectives, and also in the sense that increasing our understanding of system performance often will enable the introduction of new technologies that can achieve savings or efficiencies.

C. S&T Program Philosophy

The S&T Program philosophy should embody a few major principles. These are discussed below:

C1. The Scope, Nature, and Character of the S&T Program Activities

O The S&T program should be charged with taking the longer view, supporting efforts that sometimes might take 3 or 5 or even 10 years to mature.

O The S&T Program should be explicitly distinct from the mainline repository-development effort, which will always comprise the vast majority of the repository Program's effort and resources. In practice, this means that no S&T activities should be on the critical path of the repository Program's work, nor should S&T activities have as their principal goal to provide direct short-term support for that work. This is because the nature of the S & T work is that it is research that is expected to be successful, but not guaranteed to be successful. Indeed, it is desirable for the S & T Program to support some speculative technical projects that have only a modest likelihood of success but would have large benefits if successful. It is clear that, given the desirable speculative character of the overall S & T Program portfolio, nothing within that portfolio can be on the critical path for the overall repository program.

O The S & T Program should encourage innovative ideas that are new, creative, or conceive of a different approach to an existing Program activity or analysis. In order to accomplish this, the Program staff is charged with keeping abreast of technological advances in all of the fields relevant to the mainline Program.

O The S&T Program scope should be very broad -- the intent is that the S&T Program should support all repository Program activities, including not only the underground repository but the surface facilities, the transportation activities, and systems integration work.

Thus, the S&T Program should be devoted to the pursuit of long-term technical opportunities, including enhanced understanding, that have the potential for implementation within the mainline Program. This makes the S&T Program an applied program in practice, insofar as results are always intended for future application to the mainline geological-repository system. Hence, technical

projects within the S&T portfolio can represent a mix of scoping studies, exploratory investigations, applied engineering projects to develop a promising technology, and more fundamental scientific studies.

C2. How the S&T Program Should Operate

O The S&T Program should carry out its projects using the best available resources at a variety of institutions. It should support projects at government laboratories as well as at outside institutions (for example, private firms, universities, institutes, and foreign entities).

O The S&T Program should encourage multi-institution collaborations wherever feasible. The rationale is that historically such collaborations have often been more effective than a single institution at developing new ideas, novel tools, and improved methods of analysis.

O The S & T Program requires periodic independent peer review. One effective way is to appoint a peer-review committee that meets periodically, with membership drawn from the appropriate technical disciplines, but other approaches are also workable.

O The S&T Program should welcome periodic communications with outside groups. This includes presentations to prestigious review boards both within the country and internationally. The benefit to the Program from diverse perspectives is always a valuable source of input.

O How a Science & Technology project's results are ultimately implemented by the mainline repository Program is important. When an S&T project has carried its work sufficiently far that it is ready for implementation, then the S&T Program's work has been completed, and a "handoff" to the mainline Program should occur. At which stage this "handoff" will occur can only be determined on a case-by-case basis. However, the governing philosophy is that the S&T Program's responsibility extends to the point of proof-of-concept, or sometimes further to a demonstration or a trial. After this point, the work will approach the implementation phase, which should be supported and managed by the mainline repository Program.

O It is important for the S & T Program to reach out to the broader technical community by publicizing the existence of the Program, and by informing itself about potential advances in each of the several technical areas within the Program's scope.

D. Products of the S&T Program

The S&T Program should produce several different types of "products", depending on the project. Typical products could include:

O Periodic and final reports for each project

O Technical data or design information

O Hardware or software prototypes

O Analysis tools, either developed, demonstrated, or both

O Improved understanding, aimed at making the waste management system more efficient or effective.

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Robert J. Budnitz
Lawrence Livermore National Laboratory
Energy & Environment Directorate
7000 East Avenue
P.O. Box 808, Mail Stop L-632
Livermore CA 94551
(Phone) 925-423-4648
(Fax) 925-422-9913
Email: budnitz1@llnl.gov