EPA-SAB-EEC-95-013

March 27, 1995

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street S.W.
Washington, D.C. 20460

Re: EPA's draft Technology Innovation Strategy

Dear Ms. Browner:

At the request of the EPA Innovative Technology Council (ITC), the Environmental Engineering Committee (EEC) of the Science Advisory Board reviewed on June 29, 1994 the draft Technology Innovation Strategy (TIS) (EPA 543-K-93-002, January 1994). The TIS outlines a broad range of actions designed to foster the development and adoption of innovative technology on behalf of the nation's environmental protection goals. It identifies a problem and strategy for each of the four objectives and invites comments, particularly on priorities. The National Advisory Council for Environmental Policy and Technology (NACEPT) has reviewed the policy aspects of the TIS, and its report was input to the SAB EEC effort.

The EEC charge was to suggest improvements to the TIS as it was being rewritten and to consider what role the EEC could play in the future. Inevitably, in order to address the charge, and due to the nature of the TIS, our comments must include discussion, opinions and advice on technical managerial matters which sometimes verge on or are related to policy matters as well as on strictly technical ones. The attached report presents EEC's major findings; these are briefly summarized as follows:

a) Efficacy -- Accelerated technology innovation is indispensable to achieving national goals; the TIS enhances such acceleration.

b) Vision -- The TIS would be guided more surely by a clear articulation of a vision shared by stakeholders and a description of a process for its attainment.

c) Implementation and Measuring Progress -- The TIS should include measures of progress and accomplishments. Subjective and objective means of such measurement, as well as retrospective studies of prior efforts, are suggested in this report.

d) Project Selection -- A prioritization scheme for selecting projects under the Environmental Technology Initiative (ETI) deriving from the TIS is needed; a possible approach is presented in this report.

e) Communication -- Broader communication programs should be initiated to effectively explain the philosophy, policies, and goals of the TIS to the regions, laboratories, and headquarters.

f) Regulatory Goals -- The implied premise that technology innovation can meet all present environmental goals within the next decade is not practical and needs to be modified as unrealistic goals can stifle innovation.

g) Political Environments -- As NACEPT discussed, the selection of technologies for developmental support should be described in the TIS as primarily being market driven by cost-effectiveness; regulations and politics then would be less significant.

h) High Technology Overemphasis -- Striving for new and complex proprietary technology should be balanced with seeking effective modification to existing technology, as the latter will often fill market needs.

i) Cleaner Technologies -- A science-based concept of "environmental performance standards" on a multimedia, entire-facility basis should be considered to stimulate development and application of cleaner technologies.

j) TIS Prioritization -- As recommended by NACEPT with regard to the four strategic objectives, the need to adapt EPA's policy, regulatory, and compliance programs to promote innovation seems appropriate to receive the highest priority.

k) Role of Academia -- Academia should be specifically included as a participant in the essential elements of advancing science and educating future innovators.

l) Future -- The EEC believes an advisory body can provide helpful suggestions on the alignment of program thrusts with objectives.

Particular emphasis is placed upon Recommendations 2-4.

The SAB appreciates the opportunity to review this important initiative, an initiative that can have critical impacts on the Nation's efforts toward sustainable development. Your response will be appreciated on the key points summarized above.

Sincerely,

Genevieve M. Matanoski, Chair
Science Advisory Board

Ishwar P. Murarka, Chair
Environmental Engineering Committee

Richard A. Conway, Chair
EEC TIS Review

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ABSTRACT

The Environmental Engineering Committee of the Science Advisory Board reviewed the draft Technology Innovation Strategy (TIS) (EPA 543-K-93-002). Overall, the EEC found that the TIS is an excellent effort by the Agency which identified and developed four worthy objectives. The EEC made twelve specific findings and recommendations addressing: accelerated technology innovation, communication, vision, measuring progress, the role of academia, regulatory goals, political environments, an over emphasis on high technology, cleaner technologies, prioritization, project selection, and future review of related documents.

Keywords: technology, innovation, strategy, environmental, engineering, development, demonstration, clean technology

U.S. ENVIRONMENTAL PROTECTION AGENCY
Science Advisory Board(EECROS)
Environmental Engineering Committee

Review of the EPA'S Draft Technology Innovation Strategy

June 29, 1994

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1. EXECUTIVE SUMMARY

At the request of the EPA Innovative Technology Council (ITC), the Environmental Engineering Committee of the Science Advisory Board on June 29, 1994 reviewed the draft Technology Innovation Strategy (TIS) (EPA 543-K-93-002, January 1994). The TIS outlines actions to foster the development and adoption of innovative technology on behalf of the Nation's environmental protection goals.

The TIS identifies a problem and strategy for each of the four objectives. The objectives relate to: adapting EPA's policy, regulatory and compliance framework to promote innovation; strengthening the capacity of technology developers and users; investing EPA funds in the development and commercialization of promising new technologies; and accelerating diffusion of innovative technologies. In order to address the charge and due to the nature of the TIS, our comments must include discussion, opinions and advice on technical managerial matters which sometimes verge on or are related to policy matters as well as on strictly technical ones. We offer these opinions on the basis of our collective experience in our fields, not only as technical experts but from our backgrounds in technical management.

The EEC's major findings and recommendations are summarized as follows:

a) Efficacy -- The SAB agrees that accelerated technology innovation is indispensable to achieving national goals, and finds that the TIS enhances such acceleration.

b) Vision -- As with any strategy, the TIS would be guided more surely by a clear articulation of a clear vision statement and a description of a process for its attainment. The vision should be recorded, shared, and accepted by the participants. The niche assigned/co-opted by EPA in the Nation's endeavors for environmental technology innovation should be more clearly described in terms of a focused and stable program, consistent with funding levels.

c) Implementation and Measuring Progress -- The TIS should include means to measure progress and accomplishments. Both subjective and objective means are suggested in this report. Retrospective studies of prior EPA technology programs are recommended.

d) Project Selection -- A prioritization scheme is needed; some elements are given in Table I.

e) Communication -- Adequate and timely communication programs should be emphasized within EPA to effectively explain the philosophy, policies, and goals of the TIS to the staff at various levels involved in the decision-making process so that clarity aconsistency can be maintained while implementing the Strategy.

f) Regulatory Goals -- The implied premise that technology innovation can meet all present environmental goals within the next decade is not practical and needs to be reexamined and modified as unrealistic goals can stifle innovation.

g) Political Environments -- As NACEPT discussed, the selection of technologies for developmental support under the TIS should be described as market driven by cost-effectiveness; regulations and politics then would be less significant elements in influencing such selection.

h) High Technology Overemphasis -- The emphasis on new and complex proprietary technology should be balanced with seeking effective modification of existing technology, as the latter often will fill market needs.

i) Cleaner Technologies -- The concept of science-based "environmental performance standards" on a multimedia, entire-facility basis should be considered for addition to the TIS to provide the flexibility needed to stimulate development and application of cleaner technologies.

j) TIS Prioritization -- As recommended by NACEPT with regard to the four strategic objectives, the need to adapt EPA's policy, regulatory, and compliance programs to promote innovation should receive the highest priority and most attention, since it will be essential for achievement of the other objectives and will thereby require concerted effort over a sustained time period.

k) Role of Academia -- Academia should be specifically included as a participant in the essential elements of advancing science and educating future innovators.

l) Future -- Specific comments regarding FY95 ETI thrusts cannot be made, since the information was not available for the Committee to review. However, the EEC believes an advisory body can provide helpful suggestions on the alignment of

program thrusts with objectives, and suggests such information be addressed at a SAB review in the formative stages of the thrust areas for FY96.

Details of each finding along with commentary are presented herein.

2. INTRODUCTION

At the request of the EPA Innovative Technology Council (ITC), the Environmental Engineering Committee of the Science Advisory Board on June 29, 1994 reviewed the draft Technology Innovation Strategy (TIS) (EPA 543-K-93-002, January 1994). The TIS outlines actions to foster the development and adoption of innovative technology on behalf of the Nation's environmental protection goals. The TIS identifies a problem and strategy for each of four objectives and invites comment, particularly on priorities. The objectives are:

a) "Adapt EPA's Policy, Regulatory and Compliance Framework to Promote Innovation;

b) Strengthen the Capacity of Technology Developers and Users to Succeed in Environmental Technology Innovation;

c) Strategically Invest EPA Funds in the Development and Commercialization of Promising New Technologies; and

d) Accelerate Diffusion of Innovative Technologies at Home and Abroad".

The co-chairs of the ITC Strategy Committee briefed the EEC on 29 June 1994. The EEC charge was to suggest improvements to the TIS as it was being rewritten and to consider what role the EEC could play in the future, e.g., concerning the planned gaps analysis, FY95 program and FY96 thrusts. The National Advisory Council for Environmental Policy and Technology (NACEPT) has reviewed the policy aspects of the TIS, and its report was input to the SAB EEC effort. In order to address the charge, and due to the nature of the TIS, our comments must include discussion, opinions and advice on technical managerial matters which sometimes verge on or are related to policy matters as well as on strictly technical ones. We offer these opinions on the basis of our collective experience in our fields not only as technical experts but from our backgrounds in technical management.

3. FINDINGS

3.1 Efficacy/Communication/Focus

Overall, the TIS is an excellent effort by the Agency, and four worthy objectives have been identified. Clear articulation of a vision will surely fortify the TIS.

The Agency needs to prepare for the introduction of this new program. Since the EEC discerned only limited effort toward this end,the EEC recommends that the EPA develop an internal communication plan, particularly with the regions, and a management plan be established to allow the Agency and its permitting process to nurture environmental technology innovation.

There is a danger in focusing entirely on delivering short-term results; given such a focus, new barriers will tend to develop and with them, changes in technology advancement will be impeded. Of the four objectives, the first objective should have the highest and main priority to achieve both short- and long-term results. This objective is an essential driver for achievement of the other objectives and would require concerted effort over a sustained time period.

3.2 Vision/Scope/Emphasis

The TIS must begin with a shared vision statement for the initiative; this will provide consistent understanding and direction for all participants. While the EEC perceives that a vision is implicit in the Strategy and/or in the August 1993 National Performance Review: Report of the Environmental Technology Team prepared for Administrator Browner (U.S. EPA, August 1993) clear delineation of a vision must be developed to guide implementation. The EPA undoubtedly has a vision in mind, but it should be clearly recorded, shared, and accepted by the participants. EPA representatives indicated that a vision could be found in the National Performance Review (U.S. EPA, August 1993); such a vision statement needs to be reviewed and made a part of the Strategy. In fact, the development of the shared vision statement could be a critical step in developing the "buy-in" necessary to ensure successful implementation. The development of a vision statement also provides opportunity for broader stakeholder involvement.

A second starting element that needs further clarification is the definition of "innovative technology." The intended scope of this term was not clear to the EEC, and there appeared to be some discrepancies between potential definitions and proposed objectives. For example, innovative environmental technologies might imply sophisticated, high performance systems or processes. However, such systems/processes are unlikely to be suitable for export to developing

countries where more basic, low cost systems/processes may be critically needed. The EEC also considered it important to include innovative combinations or integrations of technologies to solve environmental problems, since the more complex multimedia environmental problems will likely not be solved by applications of singular technologies. In addition, the EEC believed that a definition of when a technology
progressed from innovative to commercially available would be helpful. Objective #3 suggests that there are select technologies poised on the brink of commercial deployment that only need EPA's limited assistance to make the breakthrough. If these technologies are so poised, then they likely have already gone through the innovation process.

The Strategy presents confusing information about what an innovative technology might be and where/how it might be applied. There is an implied focus on efficiency or improvements to existing systems, or identification of approaches/systems which are in the final stages of testing or delivery. The Agency appears to be focusing on approaches which can be implemented or commercialized quickly and thus become the next "best" available technology in the short-term; the emergence of new concepts might be stifled by such a short-term focus.

3.3 Implementation Plan

The normal next step in developing a strategic plan is to identify a process which the Agency will use to establish where they are now relative to where they want to go, i.e., implementing the vision. The EEC supports the continued discussion of the Strategy with stakeholders through workshops. However, this is not adequate to completely define where the Agency is relative to both desired environmental technological capabilities and ongoing technologies development by industry and other agencies. The gaps study could contribute to this process; but the committee did not directly review the plans for this study. Nonetheless, the Strategy should define how the present status could be assessed in relation to the strategic goals e.g., internal EPA input, cost-benefit analyses, interviews with target environmental control experts. A series of self studies might be useful in areas such as Superfund and wastewater treatment. How did EPA help or hinder technology innovation? How could EPA help? The EEC recommends that such a self study or retrospective evaluation be developed and included in the Strategy.

3.4 Measuring Progress

In addition to the above means for tracking implementation, any effective strategic plan can benefit from quantitative means of measuring progress toward achieving the vision. The selection of appropriate metrics is tied to the vision. If an outcome is important, then progress toward that outcome must be periodically measured and mid-course corrections made, if needed.

Since the document does not clearly articulate a vision, it is not possible to establish ways to measure progress with a high degree of certainty. However, the EEC offers the following for consideration. Measures of progress for development and use of innovative technology should reliably (credibly) indicate whether, compared to baseline technology, the following results are achieved.

a) increases in the ratio of Gross Domestic Product (GDP) to the quantity of a contaminant of interest,

b) decreases in the contaminants of interest in absolute terms,

c) increases in conservation of raw materials,

d) increases in number of environmental patents awarded to U.S. citizens, and, if possible, the number of patents actually licensed and/or put into practice.

e) increases in number of compliance permits tied to a pollution prevention initiative,

f) increases in job creation in the proposed environmental technology Standard Industrial Code (SIC),

g) increases in consulting services by U.S. firms at home and overseas or partnering with foreign firms.

No one parameter can fully measure progress; several will be needed.

3.5 Role of Academia

A basic tenet of the Strategy should be the assurance of sufficiency, translation, and sustenance of good science by a cadre of well-trained professionals both within and outside the Agency. Scientific input should be given in the areas of technology identification, development and certification, recognition of technology gaps, adjusting for future needs, and assessing the adequacy of an approach and providing tools for implementation. In this regard, academia is considered a vital participant and contributor to the success of the Strategy. This participation

should involve both scientific interpretion and leadership of technology development through education and research, and the endowment of complementary educational credentials and associated expertise of its graduates who will constitute a significant element of the environmental workforce of the future. The need to forge a partnering alliance with academia should be clearly acknowledged, and enabling mechanisms should be established consonant with a concomitant support structure to make this output a reality. Scientific advances are often the starting points of the innovation process. Investigation into basic concepts or science should continue to stimulate innovation as well as benefit the completion of partially developed technologies beyond the limits of current science.

3.6 Regulatory Goals as a Barrier to Technological Development

An unstated, but implicit assumption of the TIS is that technology will be capable of meeting existing regulatory standards. The presumption is that innovative technologies will help reach these goals in a more rapid or cost-effective manner. In many instances, however, regulatory standards or goals may not be technologically achievable, at least within the next decade or beyond. These goals, in turn, can create barriers to innovation.

For example, the concentrations of particular contaminants are regulated to the part per billion level in ground water systems. Such concentration levels are deemed by respected scientific bodies to be unachievable within a reasonable time frame (i.e, 50 years) at many Superfund sites. (Alternatives for Ground Water Clean-Up, National Research Council, 1994) Innovative or non-traditional technologies, such as bioremediation or chemical flushing, may offer the potential to reduce contaminant levels and risks at such sites. In the existing regulatory climate, however, there is little incentive to develop and market technologies whose performance will ultimately fall short of regulatory standards. Thus, in order to achieve its stated objectives, the TIS should incorporate a plan to examine the process of establishing regulatory goals/standards, and their influence on technological development.

3.7 Regulatory and Political Impacts on Technology

As NACEPT discussed, the reality is that in the environmental control technology arena, the Agency determines the market via the establishment and implementation of regulations. The

Agency's response to political pressures tends to erect barriers to innovation, resulting in regulatory inconsistencies that give rise to marketplace uncertainties. Few investors are willing to venture forth into the market not knowing which direction political forces will turn the Agency. For the market to take a defined course, the Agency must become a more flexible, facilitating and predictable partner.

Technology has an important and complex role to play in environmental protection. For example, through the years, the remediation process has become more intensive in litigation and paperwork to the detriment of clean-up technology use. As a result, the return on investment of resources in terms of actual environmental protection is relatively small. The solution may be less prescriptive regulation and more science-based decisions in the regulatory process. The process seems much too complex to expect the Agency to simply regulate innovative technologies into existence.

Perhaps the Agency should define the playing field and then let the market place work; NACEPT could address this policy issue.

The EEC realizes that this is a paradigm shift for the Agency. It is one that can be achieved neither quickly nor without pain. Because of this, the EEC believes that Objective #1 contained in the Strategy is, without a doubt, the most important.

3.8 Tendency for Overemphasis of Proprietary High Technology

One of the stated objectives of the TIS is to promote and accelerate the diffusion of innovative technologies at home and abroad. This objective implies that the categories of technologies promoted must satisfy the environmental control needs of the prospective clients in terms of effectiveness, cost, reliability and operability.

Intrinsic to the Strategy developed by the Agency is the assumption that the effective and marketable environmental control technologies will utilize so-called high-tech, sometimes proprietary, advances. In reality, modifications to conventional, low-to-medium technologies may be more marketable in some advanced countries and certainly in most developing countries. International economic status would most likely constrain technology acquisition interests to those that are affordable in terms of technical/administrative requirements for their implementation.

3.9 Cleaner Technologies Stimulation

EPA should consider including the Strategy element of stimulating the development of cleaner technologies by industry through a science-based concept of multimedia, entire-facility environmental performance standards. For example, instead of having predetermined, set permits for each release point in a given industrial facility, the permit writer would have the flexibility to allow, on a risk-reduction basis, appropriate "leeway" on some environmental releases if others were reduced, ideally through pollution prevention, so that the overall environmental impact/risk of a facility is reduced. The extent of leeway would be science- based in terms of being well within the uncertainty range associated with the standard. For example, for conventional water pollutants, such as suspended solids and biochemical oxygen demand, the uncertainty of adverse effects might be estimated either by scientific method or by consensus expert judgement as being about 25%. Thus, for this example, a facility would be allowed to exceed the National Standards by 25% on these point sources if it reduced its overall environmental impact more by reducing some other releases, such as to the atmosphere, especially by preventing the generation of pollution through cleaner technology.

Technology-based standards became a barrier to new or innovative technology literally because they were defined as "best available", and performance evaluation is based on these standards. This barrier could be penetrated by setting processes that make standards which involve goals such as pollution prevention, risk reduction, levels of risk management or relative risk. Flexibility in parameters of success of a technology or impact of an entire waste stream rather than individual pollutant standards could do more for technology innovation than searching for new technologies to respond to existing definitions of waste streams. This is especially important in light of the plan to identify and "focus on technologies at critical points of development", that is, those which are ripe for development or simply lack the resources for final commercialization or implementation.

3.10 TIS Prioritizations

As part of the overall TIS, an implementation program that documents the process and provides accountability is clearly needed. Part of this implementation program requires a prioritization scheme that will rank the myriad of tested and untested environmental technologies in terms of their relative importance and timely contributions within the context of the ETI. This prioritization scheme would be used in the planning process to decide what technologies should be funded, tested, and possibly commercialized. This process would allow limited resources to be directed to the most promising technologies. Objectives #1, #2, and #3 will facilitate the development of the technologies receiving priority, while the successful commercialization of a technology will fulfill Objective #4.

In developing a prioritization scheme to accomplish the above screening, several factors to be considered fall into three general categories: 1) Technical, 2) Economic, and 3) Procedural. A first attempt at developing the factors within each category and a qualitative ranking system to evaluate each of the factors is presented in Table 1 in this report (page 12). Each factor is judged on a scale of 1 to 5 (from least to most promising), so that the higher the cumulative score, the greater the opportunities for technology development and application. The ranking scale may change depending upon the final vision governing the TIS and ETI.

3.11 Consensus Building and Technology Transfer

Consensus building on practical strategy and technology focus can be of benefit and can be successfully accomplished through discussions in the form of national technical consensus forums or workshops that involve all the major players in the technology innovation area. The recent efforts such as the Remediation Technology Development Forum (RDTF), DNAPL Workshops, and "Decision Support Tools Workshop" that either involved EPA or were arranged by the Agency are good examples of such consensus building and technology transfer.

TABLE 1
SOME SUGGESTED PRIORITIZATION FACTORS

Factors	Rating Scale [a] 1.0 1.5	2.0 1.5	3.0 3.5	4.0
I. TECHNICAL				
Stage ofTechnology Development	Conceptual or Mature		Single Large Scale Test	Proven Pilot or Bench Scale
Potential for Breakthrough Performance Improvement	Incremental Advance		Step Change	Break-through
Potential for Breakthrough Cost Reduction	Incremental Advance		Step Change	Break-through
Likelihood of Reaching Objective	Unlikely		Fair Chance	Likely
Soundness of Scientific Basis	Not defined		Fair basis	Firm basis
Relative Risk of Problem Addressed	Low Relative Risk		Medium Relative Risk	High Relative Risk
Position in Waste Management Hierarchy	End-of-Pipe Control		Clean-up or Recycle	Pollution Prevention
II. ECONOMIC IMPACT				
Job Creation	Few		Some	Many
Commercialization Potential	Low		Medium	High
Market Share Potential	Small		Medium	High
Breadth of Application	Narrow		Medium	Broad
Export Potential	Low		Medium	High
III. IMPLEMENTATION				
Ease of Implementation	Difficult		Medium	Easy
Permitability (or Waiver)	Difficult		Medium	Easy
Strength of Regulatory Drivers	Weak		Medium	Strong
Duration of Regulatory Drivers	Short-term		Medium-term	Long-term
Public Acceptance	Difficult		Medium	Easy

[a] Rate each factor 1.0 to 4.0; then add all factor scores for total rating of project.

3.12 Looking to the Future

In response to its charge, the EEC examined how it or some peer review body might participate as the ETI and TIS move along. Specific comments regarding FY95 thrusts cannot be made, since the information was not available for the Committee to review. However, if the thrusts parallel the eclectic FY94 mix, it is unlikely that program objectives will be effectively met. The EEC believes a peer review body can provide helpful suggestions to the congruence of program thrusts and objectives, and suggests such information be discussed at a SAB review in the formative stages of the thrust areas for FY96.

4. REFERENCES

Technology Innovation Strategy (TIS) (EPA 543-K-93-002), January 1994

Environmental Technology Initiative: FY94 Program Plan (EPA 543-K-93-003), January 1994

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