TECHNOLOGY and SOCIETY

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Risk and Democracy

DAVID L. BAZELON

I was honored when asked to address the National Academy of Engineers on nuclear power issues. But I had to ask myself," what do *I* know about these issues?" I take some encouragement from Judge Learned Hand's remark to me that, "There's no substitute for the untutored approach" in judicial decisions about even highly technical matters. But I must say that the health and safety risks generated by modern science and technology are extraordinarily complex. This calls for concerted efforted to clarify the role of the courts in regulation of risks, such as administrative licensing of nuclear power plants.

I think our role is important, but often misunderstood. And the judicial perspective has significant consequences for engineers and the many other experts who contribute to public decisions about risks, such as licensing a nuclear power plant. We are among the many professions who have some rethinking to do. This is an unprecedented era of technological promise and peril. With mobility comes staggering auto accidents, plane crashes, traffic jams, and air pollution. And with the miracles of energy come the risks of coal mining accidents, nuclear reactor accidents, and even atomic terrorism.

Nobody is satisfied with existing regulation of risks. Some claim it is too lax; for others it is too strict. We all hear the current call for "deregulation." But the Three Mile Island review commissions highlight the need for more effective regulation. My court's caseload now involves challenges to federal administrative action relating to many matters on the frontiers of technology. What level of exposure to known carcinogens is safe for industrial workers? Shall we ban the Concorde SST, Red Dye Number 2, or saccharin? How can society manage radioactive wastes from nuclear reactors?

Let me tell you first that the courts cannot and do not answer such questions, even when posed as challenges to administrative actions. None of us knows enough to resolve issues on the frontiers of nuclear physics, toxicology, and other specialties informing the NRC, EPA, or FDA. Courts also lack the political mandate to make the critical value choices which ultimately are reserved for the public. These decisions must be made by elected representatives or public servants legally accountable to Congress and the people.

If the courts do not resolve technical disputes or value conflicts about technological changes, what *is* the courts' role? Of course, there are individual nuances and shifting historical trends, but in brief, the judicial responsibility is

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record must disclose the evidence heard and policies considered. This will permit quality checks through effective peer review, legislative oversight, and public education. Only if the decisionmakers disclose assumptions, doubts, and points of controversy can experts in universities, government, and industry evaluate the technical bases of the administrative action. Only then can they scrutinize the agency's factual determinations, bring new data to light, or challenge faulty asumptions.

Full disclosure of the reasons for a decision is also essential to legislative and public review. Congress and ultimately the people must make the critical value decisions about such questions as what level of radiation emissions can be accepted in the face of incomplete medical knowledge. So disclosure is essential to permit politically legitimate oversight of the agencies' implicit value choices.

Courts stand outside both expert and political debate. They can help to ensure that a complete and orderly administrative record is created. Courts can guarantee that all relevant information was considered and addressed. Further, courts can accustom decisionmakers to the discipline of explaining their actions. Finally, courts can

I had always thought that scientists and engineers understood this judicial function. But in recent weeks I have been surprised to find that this is news to many. Perhaps the advantages gained through the judicial tasks are also not widely known, although they benefit everyone, including decisionmakers themselves. For if the decisionmaking process is open and candid, it can expose gaps, stimulate the search for better information, and reduce the risk that important information will be overlooked or ignored. An open process can inspire more confidence in those who are affected. Above all, an open process protests the credibility of decisionmakers from claims that they are covering up incompetence, ignorance, or damaging information.

What consequence does this all have for you, who serve as leaders or advisors in industry or government? Part of the disclosure requirement I have described falls on the agency decisionmakers. Congress made them responsible for licensing nuclear power plants, approving waste disposal plants, and the like. Yet there is an equally important implication for your role. If your advice and plans are

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Technology and Society Staff

Committee on Social Implications of Technology

CSIT Working Groups and Their Chairmen

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Please Sign Our Petition!

Dear friend,

We ask you to support our request to the IEEE Executive Committee (see reverse side of this page) that they authorize the formation of an IEEE Society on Social Implications of Technology.

In recognition of the impact that technological decisions have on our quality of life, the IEEE amended its constitution in 1972 to include the following paragraph:

> "The IEEE shall strive to enhance the quality of life for all people throughout the world through the constructive application of technology in its fields of competence. It shall endeavor to promote understanding of the influence of such technology on the public welfare."

To this end, the IEEE established the TAB Committee on Social Implications of Technology (CSIT).

During the eight years of its existence, CSIT has played an important role in raising the level of discourse in this important area. To date, CSIT has published 29 issues of TECHNOLOGY AND SOCIETY, which, as you know, features thoughtful and provocative articles, book reviews, and commentary on such topics as energy, environmental quality, engineering ethics, arms control, cryptography, consumer product safety, and societal systems engineering. At IEEE's annual conventions, CSIT has organized formal sessions on "Social Implications of Nuclear Power" (Electro '75) and "Solar Energy: A Status Report" (Electro '77); CSIT has also sponsored workshops and open forums at IEEE conventions. CSIT has given four engineers the Award for Outstanding Service in the Public Interest, consisting of a certificate and $750. CSIT's pioneering work in the field of engineering ethics has provided the impetus for IEEE to adopt a Code of Ethics and to establish a Member Conduct Committee that enforces the Code and supports engineers who adhere to the Code.

Nevertheless, CSIT's effectiveness is severely limited by the operational constraints and the low visibility of a TAB committee. As a matter of fact, many IEEE members are totally unaware that they can subscribe to TECHNOLOGY AND SOCIETY! Surely the issues of social implications of technology are sufficiently important that they deserve to be treated at the IEEE group/society level. Converting CSIT to full Society status offers many advantages, including:

1) A refereed TRANSACTIONS has the prestige to attract more (and higher quality) papers than a Newsletter; conversely, the TRANSACTIONS would serve as an archival journal for the many excellent papers in this field that currently are unable to find a suitable vehicle for publication.

2) The higher visibility of a Society would make all IEEE members aware of our existence, and thus would give all IEEE members the opportunity to participate.

3) TECHNOLOGY AND SOCIETY's paid circulation of 2500 (which is larger than the membership of many existing IEEE societies) demonstrates that such a society is indeed feasible.

The first step in determining whether or not CSIT becomes an IEEE society is up to you. If you agree that IEEE should devote greater effort and attention to the social implications of technology, won't you please take a moment to sign and return this petition. (Your IEEE membership number appears on the mailing label on the last page of TECHNOLOGY AND SOCIETY.) We hope that you will not only sign the petition, but that you will also ask interested colleagues to sign it.

Sincerely,

STEPHEN H. UNGER
Chairman, CSIT

March 28, 1980

Petition to Form an IEEE Society on Social Implications of Technology

The undersigned IEEE members hereby petition the Executive Committee of the IEEE to authorize the formation of a Society on Social Implications of Technology.

The purposes of the Society are to develop and promote understanding of the interaction between technology and society, to enhance our knowledge of the benefits and detriments of technological options, to support the engineer in the exercise of ethical responsibilities, and to discover and promote means to make technology better serve society.

These purposes will be pursued by publishing a transactions, by publishing a newsletter, by holding meetings and conferences, and/or by any other activities appropriate for encouraging analysis, communication, discussion, and action relating to social implications of technology.

The interests and activities of the present IEEE Committee on Social Implications of Technology, including publication of TECHNOLOGY AND SOCIETY, will be assumed by the new Society.

Signature	Name (please print)	IEEE Member Number (above student grade)

Please return signed petitions as soon as possible to:

Stephen H. Unger
229 Cambridge Ave.
Englewood, NJ 07631

necessary to support operating license applications, should you not also disclose your assumptions and doubts, and the risk levels you estimate? Unless you explain the basis for your engineering judgments, the agency record to be reviewed by the court, and ultimately by your peers and the public, simply will not suffice.

Not surprisingly, many believe that complete disclosure of risks is unwise. I have heard experts say that they would consider not disclosing risks which in their view are insignificant in order to avoid the danger of needlessly alarming the public. It may well be that popular fears about risks from atomic energy are irrational. Public fears about nuclear plant meltdowns may is fact be disproportionate to the seriousness of the threat, when discounted by its probability. A sense of the public's irrationality may have led the Information Director of the French Atomic Energy Commission to observe that publication of precautions against risks "frequently has little other effect than to heighten [public] feelings of insecurity." He concluded that "there is nothing to be gained" through public debates on particular nuclear power controversies [1].

Some engineers in this country may agree with this sentiment. But I believe that this view is unacceptable in our country. It is also unrealistic when it comes to nuclear power. Nondisclosure does not eliminate public fears. Indeed, it can exacerbate them. The fact is, the public is already afraid. Loss of public confidence is cited by the Kemeny Commission as one of the worst problems with the nuclear power industry and its regulators. Alvin Weinberg, a founding father of the Nuclear Age, I think rightly warns that nuclear power will be rejected politically not because people "will actually be hurt," but because "people will be scared out of their wits" [2].

In other ages, and other cultures, the decisions of a wise man, or shaman, would resolve all doubts. But so long as we remain a democracy, the judgment of the people must prevail. And as Thomas Jefferson said, "If we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion." The genius of our system is its checks on centers of accumulated power. For this system to survive, experts must disclose their knowledge about promises and perils from technological advances. Special knowledge will undoubtedly, and rightly, give experts an important voice in political value choices. But to protect themselves, and the country, experts cannot, and should not, arrogate the decisions to themselves. Public confidence, I submit, is possible only if experts accept the difficult tasks of explaining what they know and do not know, and how they balance risks and benefits.

This message may be somewhat unfamiliar to engineers who have more experience with decisionmaking in the private sector. After all, your concerns traditionally have been to develop effective applications of scientific advances, as cheaply and as safely as possible. But today, the consequences of your judgments are of unprecedented magnitude and major public concern. Strictly private decision and technical decisions deserve and require peer and public review.

Consider the selection of safety systems at a nuclear power plant. Making a plant "as safe as possible" may call for redundant safety systems and multiple fail-safe strategies to shut down the plant at the first sign of malfunction. Yet safety features of this kind are costly to install, and even more expensive to employ. It has been said that somebody decided that safety could be purchased for a lesser price at Three Mile Island. Perhaps the safety protections there were in fact adequate. Perhaps the crisis was "only" generated by the press. But the danger came far closer than anyone had predicted, and public fears were understandably aroused. The crisis mentality might have been avoided had the public been better informed about the trade-offs behind the safety design.

Implicit in that design are value judgments which may be hidden unless deliberately exposed to view. This is the case with cost-benefit analysis in general. It calls for controversial quantitative valuations of human life and health. It also too often presumes to compare the incomparables. How does one compare low-level long-term radiation exposure with the benefits of nuclear power? Perhaps most troubling for our purposes, a cost-benefit calculus framed for private decisionmaking may significantly depart from the demands of public decisionmaking. A private firm is likely to consider only privately borne costs, and call the rest "externalities." If a public decisionmaker relies solely on that private cost-benefit analysis, the entire range of costs and risks may not be revealed to all and sundry.

I do not know if it is true, but it is said that engineers may have disincentives to disclose design defects to their private employers. A defect identified means a new cost to the manufacturer. It may even cause the loss of a contracting bid. The drive to produce the cheapest design in the shortest possible time may eliminate needed safety checks. The DC-10 is perhaps the most notorious recent example of private competitive pressures shortchanging safety. Public pressures can also push hardware faster and farther than it is ready to go. Witness the current experience with the space shuttle, whose designers kept costs down by eliminating component testing—but are now back at the drawing board. I do not mean to imply bad faith or incompetence.I just mean to point out that time and profit pressures may interfere with caution crucial to public safety. The Kemeny Commission concluded that we have a mindset problem. Infrequent accidents have produced optimism and confidence. But however infrequent, the magnitude of possible harm demands an independent and vigilent concern for safety. And only full disclosure can assure that a particular mindset does not preclude external safety checks.

Will the need for disclosure call for a change in a basic engineering approach? Countless innovations have been perfected privately by engineers through trial-and-error. But the blow-ups of experimental railroad boilers of yesteryear never posed the magnitude of public risk now present if a 747 plane crashes, or a nuclear reactor

leeway to conclude that an unresolved issue can be worked out later, if the statute demands adequate evidence now.

Consider the problem of nuclear waste disposal. Many engineers believe that the solution it within reach—in theory. It has taken the industry a long time to take the problem seriously, even though it has been the public's major concern about nuclear power for years. This problem came to my attention in a case in our court, *Natural Resources Defense Councial v. Nuclear Regulatory Commission* [3]. I became concerned because the NRC had relied exclusively on vague assurances by agency personnel that nuclear waste disposal problems as yet unsolved would be solved. Our court reversed the agency's decision in order to permit a fuller inquiry. My objection was not founded on any disagreement with the conclusion that nuclear waste disposal can be managed. Nor did I criticize the NRC for failing to develop foolproof solutions to the problem. What I found unacceptable was the almost cavalier treatment of the issue by the agency, and its apparent refusal to come to grips with the limits of its knowledge. The Commission gave no serious response to criticisms brought to its attention. No techncial oversight within the agency was demonstrated, and no peer review by the expert community at large was possible.

In this case, perhaps better known under the name of *Vermont Yankee*, the Supreme Court unanimously rejected our decision [4]. That Court concluded that we had imposed on the agency procedures not required by law. Nevertheless, the Court returned the case for us to determine whether or not the record supported the substantive conclusions of the NRC. In so doing, the Court reaffirmed the fundamental requirement of full disclosure on the record. This included thorough exploration of uncertainties, even if engineering practice would otherwise leave a problem alone until it demanded practical solution.

I was heartened by a thoughtful letter I recently received on this subject from a professor of nuclear engineering at a midwestern university. He wrote that the value system of the engineer includes acceptance of "an uncertain level of risk" because his decisions must be quick to be cost-effective. He said that compared to other risks associated with nuclear power, the waste disposal problem was "minute" to the engineer. Yet this professor acknowledged that others view the level of risk from a different set of values. For example, some seem to feel that any risk is too much. He concluded, and I quote,

> I believe that now the technical community is learning that their value system and that of the public [do] not coincide, and sometimes [do] not even seem to overlap. I also believe that it has been the courts that have mostly impressed this on them.

When public values are called into play by engineering decisions, disclosure of known risks and unresolved problems is the only course that will protect public decisionmaking.

I have been told about a final engineering trait that, if true, poses problems for public decisionmaking. That is the profession's general aversion to taking public stands on fessions. A prominent professor of medicine recently criticized his profession for its silence throughout the Three Mile Island incident. No one in the medical profession corrected the media story that the radiation leaks were no worse than those from a single X-ray shot per person. Apparently, this view neglects the more serious cumulative effect of the leaks. I certainly do not know enough to judge the severity of the health risk. But erroneous palliatives will not diminish whatever risk there was. In fact, some are now charging that better medical precautions should have been mobilized to counteract whatever danger the radiation posed. In addition, the mental stress from uncertainty is perhaps the most serious health effect from the Three Mile Island incident, according to the Kemeny Commission. The medical profession's failure to take a leadership role must in part be blamed on both counts.

Engineers may be particularly reluctant to speak out about indeterminate risks because they would rather be silent than misstate the risks. But engineers must realize that decisions will be improved, and public understanding enhanced, if experts reveal exactly what they do and do not know. Industry disincentives may, however, contribute to engineers' reluctance to "go public." I do not need to remind this group of the Bay Area Rapid Transit engineers who were fired after their safety concerns about the system's automatic train control became public.

But I do not believe that fear of reprisals causes the engineering profession's reticence. A more dominant problem is that loyalties to employers and other concerns can cause us to ignore broader public needs. The engineering profession's duty to the public is acknowledged in its ethical canons. But I do not believe that duty has been dealt with adequately. The Code of Engineering Ethics, approved by the Engineering Council for Professional Development in 1974, calls upon engineers to advance the profession by "serving with fidelity the public, their employers, and clients." However admirable a sentiment, this principle provides no structure to direct the engineer who notes a divergence between public and private interests. A number of engineering societies have adopted what looks to be a more instructive guidepost, as part of a statement on "employment guidelines" [5]. This statement directs the professional employee to withhold plans that do not meet accepted professional standards and to present clearly the consequences to be expected if that professional judgment is not followed. Admiral Hyman Rickover, the father of the nuclear submarine, put a similar view quite succinctly. He very recently urged all in the nuclear field to "face the facts and brutally make needed changes, despite signficant costs and schedule delays" [6].

None of this is easy. The costs and delays from brutal honesty and reevaluation will make your life harder, as they make life more difficult for a great many other professionals. Disclosure may scare people. It may scare the public to hear, as the Kemeny Commission has reported, that engineers have not designed sufficient safety checks

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Ensuring the Right of Professional Dissent: A Review of a Proposed New NRC Policy

STEPHEN H. UNGER

Introduction

There have been many allegation that the professional judgments of engineering employees of the Nuclear Regulatory Commission (NRC) have been peremptorily overridden by management on nontechnical grounds [1]. Furthermore, it has been claimed that, particularly when they pressed their concerns (usually safety related) beyond their immediate supervisors, the engineers involved were subjected to various forms of harassment, including "lateral" transfers to other divisions of NRC.

In 1976, engineers Robert Pollard and Ronald Fluegge resigned from the NRC, stating that their concerns over safety issues were being squelched. Between December 1976 and July 1977, at least three other engineers (Demetrios Basdekas, Evangelos Marinos, and James Conran) were the subjects of forced transfers within the agency as a result of similar situations. Basdekas and Marinos had previously expressed their views, following NRC procedures, in testimony before the Advisory Committee on Reactor Safeguards (ACRS).

The "open door" policy of NRC, whereby a professional employee could directly approach any member of management to discuss concerns about specific decisions or policies of NRC, clearly failed to operate effectively. The managers' approaches failed to follow through on the issues and perhaps, in some cases, even neutralized the dissenting engineer. It is interesting that, in November of 1976, the Director of the Office of Reactor Regulation (the division principally involved in the resignations and transfers) issued an internal letter underscoring NRC policy for resolving technical disputes. It outlined the open-door policy, including provision for documenting both the dissenting view and the responses of management. Included also was the statement, "There will be no retribution or recriminations as a result of any of these actions."

Perhaps it is true, as one NRC engineer suggested, that the problem in NRC is more with middle-level than with upper-level management. In any event, it should be understood that the suppression of engineers' views by managers and the maltreatment of dissenting professionals is by no means unique to NRC. Even more flagrant cases abound in other departments of the federal government, in other levels of government, and in private industry. NRC management has shown a real interest in finding a solution to the problem. First, a rather extensive study was made of the whole matter, including techniques that have been developed in various public and private organizations. A report [2] was written and circulated both within and outside NRC for comment. This was followed by the document that will be discussed below, written by H. J. Watters and R. L. Vandenberg, entitled, "Proposed Policy and Procedures for Differing Professional Opinions" [3]. It too has been circulated for comment.

Goals of the Proposed Regulations

The stated intent is to encourage "employees to make known their best professional judgments even though they may differ from a prevailing staff view, disagree with a management decision or policy position, or take issue with established agency practices." Such behavior is stated to be "not only the right but the duty of all NRC employees." It is further pointed out that "both the general public and the NRC benefit when the agency seriously considers differing professional opinions held by NRC employees." The proposed procedures are intended to assure "all employees the opportunity to express differing professional opinions in good faith, to have these opinions heard and considered by NRC management, and to be protected against retaliation in any form."

The key term, *differing professional opinion,* (which I shall abbreviate as DPO) is defined as "a conscientious expression of professional judgment on any matter relating to NRC's mission or organization activities that differs from prevailing staff view or policy position, or takes issue with an established agency practice." They are "not limited to the originator's area of expertise," but do *not* include matters defined elsewhere as subject to employee grievance procedures.

Specific goals of the proposal include provision of a primary channel for submission of DPO's, requiring that these be given serious consideration, that written records be maintained, that the originator be kept informed as to the status of the matter, that there be disciplinary sanctions against those who take retaliatory actions against dissenters, and that provision be made for rewarding those whose DPO's turn out to be significant contributions to NRC's mission. It is also intended that there be alternate channels for DPO's that would allow the option of anonymity for the dissenter, and that the DPO procedures be subjected to periodic assessment.

Summary of the Proposed Regulations

The DPO procedures may be invoked by an employee after normal discussions with colleagues and managers fail to resolve the question at issue. In order to utilize the primary channel, the dissenter must submit to his im-

The author is Professor of Nuclear Science, Columbia University, and Acting Chairman of CSIT. *The work on which this paper is based was supported by the National Science Foundation and the National Endowment for the Humanities under Grant No. OSS-7906980.*

mediate supervisor a signed statement incorporating the DPO and appropriate contextual information. The immediate supervisor, in consultation with the next level of management, "may allow" reasonable amounts of the work time of the originator and of other NRC personnel as well as "administrative" (I assume this means clerical) support for the preparation of an adequately written statement of the DPO. The dissenter also has the option of preparing the statement on his own time, incorporating an estimate of what resources would be needed to resolve the issue.

Within one calendar week of receipt of the DPO, the superivisor must respond in writing to the originator, outlining the actions planned to resolve the issue. Should the supervisor consider the issue as not falling within the definition of a DPO, he must state this in his response, "citing the specific exclusion." In this event, no further action under the DPO procedures would be taken. Such a decision may be appealed, by the employee, to the next level of supervision (but apparently no further).

Once a DPO has been submitted (it is not clear whether a rejection as described above removes a statement from this category) then "a written record must be maintained to provide accountability for all subsequent actions taken to resolve that DPO on its merits." Signed notations by managers are to be a part of this record. Status reports on resolved and unresolved DPO's must be provided to the NRC on a quarterly basis. Provision is made for the timely routing of DPO's to appropriate managers for consideration and action. Monthly status reports must be filed and made available to the originator, who is also notified about other DPO's in conflict with his. When finally resolved via adoption by NRC of the DPO in whole or in part, or rejection, the DPO and the management response, *"consistent with security classification"* (emphasis added) are "placed in NRC's Public Document Room."

Retaliation against the originator of a DPO is broadly defined to include not only such gross actions as transfer, denial of promotion or pay increase, and absence of assignments, but also lesser forms of harassment such as denial of attendance at professional society meetings and loss of staff assistance or space. Such retaliation is to be made grounds for redress under NRC grievance procedures (not elaborated on in this proposal), and those responsible are to be subjected to disciplinary action in accordance with other NRC procedures (not detailed in this proposal).

A Special Review Panel is to be appointed annually by the Executive Director of Operations to evaluate and report on the functioning of the DPO procedures. The panel is to consist of two managers, two nonmanagers, and one outside person. It may also recommend DPO originators for awards under NRC's Incentive Awards Program. The panel's findings and recommendations are to be made public.

Three alternative channels for dissenters are mentioned. One is dealt with in a single parenthetic note: "employees may also bring their concerns to the Office of Inspector and Auditor."

The second is a variation of the Open-Door Policy. An employee may meet with any manager, at any level from the NRC Chairman down, to discuss any matter. This meeting might culminate in the filing of an *unsigned* DPO which is then submitted to the usual DPO process by the manager, who acts as a proxy for the dissenter (who remains anonymous), receiving the usual acknowledgments and progress reports.

The third alternate approach, applicable if a safety issue is involved, is through the Advisory Committee on Reactor Safeguards (ACRS). Any member of this body may be approached, orally or in writing, openly or anonymously. A DPO may be filed through ACRS, which may append comments and then forward the DPO "for resolution to the appropriate NRC office director."

Comments

In my opinion, the statements of policy, scope, and objectives are excellent; the authors display a real understanding of the importance of such procedures and of the essential elements. These can well serve as a model for any organization employing technical professionals.

The procedures themselves are in general quite good, but there are some significant weaknesses. First, a minor point. Rather than inform the dissenter only about other DPO's *conflicting* with his, provision should be made to inform him of all other DPO's *relevant* to his.

The first serious flaw, as I see it, is that the immediate supervisor and the manager at the next highest level have too much control over the initial step in the process. They can deny the dissenter work time and other support for preparing his DPO and can rule that the subject is exempt from the DPO procedures. Since in a great many cases the dissent is likely to be against a position taken by those closest to the dissenter in the organizational hierarchy, it seems counterproductive to give these individuals so much authority to block, or at least to seriously impede, the primary DPO channel. In addition, it is not clear from the wording of the document whether the protection against retaliation applies if the initial statement by the dissenter is declared by the two managers referred to above to fall outside the scope of the DPO procedure.

A second area of concern is that related to secrecy. As quoted earlier, public access to the disposition of a DPO is contingent on consistency with "security classification policy." There are at least two basic ways in which this provision could become an important factor. The DPO itself could involve a dispute as to whether spurious claims of security are being used as a pretext for withholding certain information from the public. Or just such claims might be used to conceal from the public eye the manner in which a valid DPO was improperly ruled as unjustified.

The use of secrecy to manipulate information fed to the public so as to justify managerial decisions is a standard practice both in governmental and in nongovernmental organizations. It has been used extensively by NRC and its predecessor organizatons.

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A year or two ago, a railroad car filled with propane exploded and burned, killing and injuring well over 100 persons and destroying two city blocks. This disaster was caused not by a supertanker filled with liquid natural gas, not by an underground storage vault, but by a single railroad car.

Since that time, a campground in Spain was wiped out by a truck that carried explosive gas. Miles of shoreline have been covered by oil spills. A suburb of Toronto was evacuated because of a railroad accident. The list is endless and growing.

Are natural gas and other technologies dangerous? Potentially, yes. Should we therefore discontinue their use? Clearly not, although we should make them as safe as reasonably possible.

I raise these questions in an attempt to place the current debate over nuclear power into proper perspective. Although I remain opposed to the large-scale expansion of nuclear power, I find the case against it by no means open and shut.

My opposition is largely for the same reasons that I oppose any expansion of our national energy plant. As a nation addicted to energy consumption, we need not the technological fix that nuclear power represents, but the cure that conservation offers. In any case, nuclear power is now used exclusively to generate electric power, and electric power is not an appropriate fix for many sectors, where its use is inefficient. In addition, expense and distribution problems militate against replacing many other fuels with nuclear-generated electricity.

Opposition to nuclear power, as such, can only detract from the more important effort to reduce our dependence on all energy sources, whether foreign or domestic.

Table I lists some of the problems associated with energy sources that are in use today or are often predicted for the immediate future. I first compiled the table about two years ago, in connection with an article I wrote for the Boulder *Daily Camera* at about the time of the Rocky Flats demonstrations. (This piece is based on the *Daily Camera* article.) Revising the table today, I made a major change of only one word: unlimited. Nothing is unlimited, and at present rates of growth, our energy resources are very finite indeed.

The events at Three Mile Island did not make me change my viewpoint substantially. Depending upon your perpective, what happened there was either an accident or an incident. Either a) we narrowly averted a disaster as the result of unforeseen problems and human error, or b) we successfully avoided a serious accident despite unforeseen problems and human error. I lean toward the second interpretation; what happened at TMI struck me more as a media event than anything else. Because it happened at a nuclear plant and dragged on for days, TMI was dramatic and brought out the press as well as the politicians. A far more serious disaster, such as a dam burst that kills one or two hundred, is over quickly and out of the news in a day. The residents of Seveso, Italy, had been evacuated from their homes for many months when TMI broke; their tragedy had remained in the public eye for a scant few days. In contrast, nothing much happened at TMI except to the customers and stockholders of the utility; even the few cancers that might have been caused by the accident are a small consequence compared to the yearly toll that would surely have been taken by a fossil fuel plant in the same location.

Everything is dangerous. I do not want to discuss each entry into Table I in detail, but it is clear that fossil fuels create their own hazards, both to the general public and to workers such as coal miners. (The petrochemical industry, on which we depend for food and materials, is also extremely dangerous, but I have chosen to limit the discussion to energy sources only. Nevertheless, it now appears likely that improperly discarded chemical wastes will turn out to be the most serious environmental problem of the 1980's.)

There is a rejoinder to every substantive argument against nuclear power. I can see no objection to the idea of encompassing the wastes in a glass or ceramic, suitably containing them, and storing them in any of several stable geologic formations. Possibly the long lived wastes would be returned to the reactor; in that case the stored wastes, which amount to a few suitcases full per reactor-year, would be safe in a few hundred years.

Routine emissions from a nuclear plant are negligible; oddly, a fossil fuel plant may emit more hazardous radiation than a nuclear plant. Additional emissions from fossil fuel plants cause birth defects, mutations, cancer, and other diseases. Nuclear accidents, including core meltdown, are a possibility that must be guarded against, and plants must be located, for example, to ensure that contamination of water supplies is unlikely. It is encouraging that, in over 30 years of handling weapons grade material, there has been not a single accident comparable to the explosion of that one railroad car.

Nuclear proliferation is a real problem (whereas, I think, theft of nuclear material by terrorists is not). Nevertheless, the United States may well be more able to control proliferation if it is in the nuclear power business than if it is not. This is so because the US can decide to export fuel (or fuel rods) only, while maintaining absolute control of its reprocessing plants and technology and demanding the prompt return of the spent fuel.

The rest of the world is going to invest heavily in nuclear

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West Germany to abandon plans to export reprocessing technology to Brazil. Quite possibly, a nonnuclear United States would not have been able to exert such pressure; our own policy not to export such technology may have been crucial. At any rate, if a small nation wants to acquire nuclear weapons, it will find it much easier to build a small military reactor for breeding high-grade plutonium than to build a power plant for stealing low-grade material.

Why then are so many of my fellow environmentalists violently and emotionally opposed to nuclear power? The descending. I maintain, however, that much of the fear of nuclear power lies in an incorrect identification of nuclear power with nuclear bombs and nuclear fallout (many of the Rocky Flats protesters made that association explicitly), and in an insufficient analysis of the risks of the more familiar fossil fuels. In addition, I suspect that plain old resistance to change sometimes enters the equation.

Nuclear power may be a mixed blessing; it may not be a blessing at all. But it is not the unmitigated disaster it is often made out to be.

TABLE I
Impacts of Various Energy Sources

	Waste Disposal	Other Impact	Likelihood of "Disaster"	Supply	Other Comments
Natural gas	CO_2 dumped into air.	Thermal pollution.	Explosion and fire occasionally. Storage vaults potentially very dangerous.	Very limited.	
Oil	CO_2 nitrogen oxides, organics, sulfur, heavy metals, radioactivity dumped into air.	Thermal pollution. Impact of pipelines. Land use problems of shale oil.	Oil spills common. Possible cause of next major war.	Limited.	Valuable raw material that perhaps should not be burned up.
Coal	Same as oil.	Adverse impact of strip mining. Thermal pollution.	Mine disasters common, claim 200 lives per year.	Relatively limited at projected growth rates.	Deep mining hazardous to miners' health.
Nuclear fission	Wastes stored in geologically stable sites (see article).	Thermal pollution; otherwise normally almost pollution free.	Small.	Relatively limited; larger with breeders.	Uranium mining hazardous to health.
Nuclear fusion	Radioactive container vessels and equipment will have to be stored.	Thermal pollution.	Small; thermonuclear explosion not possible.	Vast.	Completely unproven technology.
Solar electric		No thermal pollution at source.	Small; some materials highly toxic.	Limited by materials availability.	Completely unproven on a large scale.
Solar heating and cooling		Less thermal pollution than from other sources.		Limited by materials availability.	Proven technology that is now becoming competitive.
Electric power in general	All the problems listed above.	All the problems listed above.		As above, depending on fuel source.	Overall efficiency counting distribution losses poor.

Solar satellite, ocean thermal gradient, geothermal, and other sources are omitted because they can contribute only a small fraction or because they seem far fetched. Biomass, or solar energy derived from specially grown plants, will share some of the problems of coal and oil.

Continued from page 6.

for many foreseeable human errors in operating nuclear power plants. But nondisclosure violates a partnership with the public that engineers have entered by ushering in a new day in technological capabilities. If technological progress is to coexist with democracy, I believe that its creators must rethink their methods and their communication with the public. At the same time, judges, regulators, and other participants in public decisionmaking must reexamine our roles against the backdrop of the ever-evolving technological landscape. However difficult, we must all criticize ourselves to avoid hardening of the arteries in our professional conduct and moral sensibilities. We need self-regulation, not just governmental regulation, to harness new-found tools for human ends.

References

[1] Greenberg, "*Smooth Passage to Nuclear Power,*" *The Washington Post*, A19, July 5, 1979.

[2] Weinberg, "*Nuclear Energy: Salvaging the Atomic Age,*" *Wilson Quarterly*, 88, 100, 1979.

[3] Natural Resources Defense Council v. Nuclear Regulatory Commission, 547 F.2d 633 (D.C.Cir. 1976), *reversed sub nom.* Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, 435 U.S. 519 (1978). Nothing in these remarks should be taken to intimate any views of the merits of this case in its present posture, on remand from the Supreme Court.

[4] Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, 435 U.S. 519 (1978).

[5] Statement on "Employment Guidelines," *IEEE* (Institute of Electrical and Electronics Engineers) *Spectrum*, 57-60 (Apr. 1973), quoted in *American Association for the Advancement of Science, Scientific Freedom and Responsibility*, 36-37 (1975) (prepared by John Edsall).

[6] Whittemore, "*Rickover Puts Safety Over Profits,*" *Parade* 6,9 (Oct. 21, 1979).

Nov. 19, 1979

TO THE EDITOR:

I read your article "Nuclear Power and Some Lessons of TMI-2" in Vol. 7, No. 27, Sept. 1979.

I agree with you that both the NRC and the utilities could be considered criminally lax in the handling of their responsibility, but I feel that all the variables must be examined when evaluating the energy option. Your approach would be equivalent to calculating the line to ground fault on a transmission line without considering the effect of the zero sequence component. You would arrive at the correct mathematical solution. Your answer just would not reflect the real world.

It is not a matter of striking the nuclear option and then claiming the public health and safety is protected.

You state the biological damage is caused by any level of nuclear radiation. This may be true, but all of us are continuously exposed to natural radiation independent of nuclear plants. The amount produced by the nuclear plant is a very small amount compared to the natural field. If the amount of radiation from nuclear plants is so damaging, why does society allow air travel, mountain climbing, or any other activities that would expose us to direct sunlight, because the above would expose the body to much more radiation damage than that produced by being close to a nuclear plant.

The scenario should also include all components of the energy/sociological equation. This would include the cost of energy scarcity in relation to the public health and welfare, and also the increase in nuclear pollution caused by nuclear war started by faltering societies fighting for reduced oil reserves.

I believe the proper approach would be to make the NRC and the utilities more accountable to the public and correct the past institutional abuses. The plants can be made safer and employees better trained. Nuclear power is the most environmentally sound option we have, let's make it better—not eliminate it. We certainly don't want to live in an energy starved or extremely heavily polluted world which would be caused by a coal economy. We certainly cannot expect the untrained public to make wise decisions when we as engineers continuously bring before the public unsound technical evaluations to advance technology.

ROBERT I. COREKIN
Director, Electric Department
City of Martinsville, VA.

Nov. 1979.

TO THE EDITOR:

It was a surprise to me to see you condemn nuclear power out of hand in IEEE's TECHNOLOGY AND SOCIETY. This publication may properly serve for the airing of different opinions, but for you, the editor, to imply gross lack the industry seems a questionable use of your committee position. May I hope for more restraint in forthcoming issues?

If you had lived near and worked in nuclear plants for 35 years, as I have, you would have had more confidence in their safety. If you had studied the economics of nuclear power compared with that of other power sources, as many utilities have, you would have known that nuclear power would certainly be economical if the artificial impediments now being placed in its path were removed.

W. J. DOWIS

Nov. 3, 1979

TO THE EDITOR:

It was a rewarding experience to read your statement in the September issue of TECHNOLOGY AND SOCIETY on "Nuclear Power and Some Lessons of TMI." In less than three pages, you have identified all of the fundamental deficiencies in our country's nuclear power program and in our politically dominated policies.

When all of the dust has settled on the multimillion dollar investigations currently under way, I am confident that very little new information will emerge to modify your exceptionally wise judgement and basic conclusions.

I believe I can speak with considerable confidence in view of my own analysis of the revolutionary new technology of atomic energy, as reported in various published papers, such as "Atomic Power, A Failure in Engineering Responsibility" in the *Transactions of the American Society of Civil Engineers*, Vol. 128, Part V, 1963, Paper No. 3497. This paper includes an Amicus Curiae brief I filed in the Supreme Court of the United States in 1961 and was rewarded with many supporting discussions.

Your critique of the statement presented by the IEEE Energy Committee to a Congressional Committee on June 11, 1979, is also noteworthy. It is like a breath of fresh air sweeping through a hidden dungeon, where policy and strategy are concocted without regard to the traditional engineering disciplines and overriding commitments to the best public interest.

Keep up the good work!

ADOLPH J. ACKERMAN

Nov. 8, 1979

TO THE EDITOR:

I must take exception to the critique of nuclear power appearing as the lead editorial in the September issue of TECHNOLOGY AND SOCIETY. While I fully agree that the nuclear engineering profession can stand an honest self-examination in the wake of TMI, an emotional and biased treatment as this is not warranted or calculated to help an already badly messed-up situation. You offer the pages of your publication to factually based rebuttals, yet your own example is certainly not factual. Instead, it is slick, using

disguised insults of the NRC and President Carter. The only current catch-word of the new elite missing from your polemic is "obscene."

Just to rebut a very few of your factual inadequacies:

1. You brush off breeder reactors, yet fail to mention that use of the breeder could be a means of avoiding, or at the least, minimizing the incestuous demand you agonize over. You also fail to mention the possibility of reclaiming spent fuel as a further means of reducing the drain on our dwindling resources. Third is the possibility of reclaiming useful fuel from mine tailings, not only from uranium mining, but from other minerals, e.g., phosphates.

2. You claim the WASH-1400 study is now discredited. I dispute this and wonder if in fact, you actually read the Lewis report. If you have not, by all means do so. If you did, you obviously committed the same crime you accuse Carter of—having your mind made up in advance.

3. The slurs against the NRC as being motivated primarily by need to protect the nuclear industry are unwarranted and libelous. I am sure this is not the understanding of CSIT or of IEEE or of the great majority of its members, only your own biased opinion.

I could go on, but the above should give ample evidence of my strongly negative reaction to your writing on this subject. It is in strong contrast to the measured treatment of the subject contained in the current SPECTRUM. I would also recommend that you read the letter from Prof. Glen Wade on page 6 of that issue.

May I respectfully suggest that you henceforth leave treatment of subjects such as this to those best equipped to handle them.

R. F. SHEA

A far stronger condemnation of the NRC than mine was issued by the President's Commission on the Accident at Three Mile Island, in its Report released October 30, 1979; so strong that the Commission recommended the abolishment of NRC as now constituted. (See excerpts in the December 1979 issue of TECHNOLOGY AND SOCIETY.*)*

Readers are again reminded that TECHNOLOGY AND SOCIETY *carries on its front page the following statement: "The views and statements published in* TECHNOLOGY AND SOCIETY *are those of the respective authors and not necesarily those of IEEE, its Board of Directors, the Technical Activities Board, or CSIT."—Ed.*

Nov. 6, 1979

TO THE EDITOR:

You deserve congratulations for having called attention to the clearly prejudiced views of the present chairman of the IEEE Energy Committee, Mr. Hilton Brown. Your critique of his statement submitted to the House of Representatives is devastating and faces squarely the problems of ethics which arise when an authoritative body or its committees make public statements of a quasi-political nature. Although it may seem impractical, there would be benefit, I think, in publishing the financial interests of nuclear energy so loudly. Are they receiving income from nuclear investments, such as utilities stocks, stocks in manufacturing, construction, or fuels for nuclear reactors? Are they consultants on nuclear power, or do they work directly for companies involved in the nuclear power field? It is simply amazing how such financial interests can influence the "professional" recommendations of our solidest citizens, sometimes even without their own consciousness. I do not know Mr. Brown, but I do know that there have been quite a few "heavies" in IEEE who have made it appear that all of us are gung-ho for nuclear power. I feel that this is far from accurate.

Again, congratulations for calling a spade a spade.

JOHN G. SINCLAIR, JR., SM

Dec. 10, 1979

TO THE EDITOR:

If IEEE wasn't, in general, a society that promotes sound engineering practices and technology supportive of the public welfare, I wouldn't be a member. Frankly, it does bother my conscience that a part of my freely contributed dues is used to support your left wing rag. My only consolation is that you represent a minor faction in our organization.

I wish you, Ralph, Amory, Barry, and company could be set off in your own little corner of the world to practice your small-is-beautiful games and try to avoid freezing to death in the dark.

J. S. SPENCER, SM

Nov. 20, 1979

TO THE EDITOR:

Thank you for the comic relief recently provided in your article, "Nuclear Power and Some Lessons of TMI," in TECHNOLOGY AND SOCIETY, Vol. 7, No. 27, Sept. 1979. It is encouraging to know that the TECHNOLOGY AND SOCIETY review is finally getting away from all that heavy, boring, scientific stuff, and finally migrating towards light, imaginative writing. With luck, and much more of your esoteria, the TECHNOLOGY AND SOCIETY journal may soon rank with *Reader's Digest*, or maybe even *True Confessions*.

PIERRE GOYETTE
JOHN SHIELDS
Ottawa, ON, Canada

Jan. 18, 1980

TO THE EDITOR:

I must challenge the long letter by K. K. Murthy in the December 1979 issue of TECHNOLOGY AND SOCIETY. It is not true that "the market economy countries stress the material aspect" at the expense of social and religious benefits. It may appear so from the perspective of socialism, or to those not yet enjoying the benefits of the market economy. But the essence of Western society has

Murthy's philosophy of "progress" amounts to setting up political structures to regulate and presumably balance material, social, and religious benefits—inherently interfering with individual rights in the process. The philosphy of "liberty," by contrast, permits individuals to conduct business, cooperate socially, and worship God as they choose. It is surely no accident that the countries with the most liberty have become the wealthiest, the most generous in international aid, and havens for those escaping religious persecution elsewhere. In fact, our very language enshrines the connection by giving the word material benefits.

It was the twin engines of the Protestant Reformation (religious liberty) and the Industrial Revolution (freedom from material shortage) which drove Western society to its present postion of social liberty. Indeed, it is difficult to conceive of true social liberty in the absence of material abundance and freedom of conscience; the three are intrinsically linked, but the way is to grant all possible freedom in all areas—not to attempt central control over every aspect of life!

ALAN T. CHATTAWAY

Reviews

Connections, by James Burke. Little, Brown & Co., 1978, and **Connections**, a PBS Television Program, Fall 1979. *Reviewed by Terry L. Hewitt.* (A related Courses-by-Newspaper program with accompanying book, *Technology and Change*, will be reviewed in a subsequent issue.

James Burke, the author of *Connections* and also the narrator of the television series, is a graduate of Oxford University in England. He was the chief reporter for the BBC in the coverage of the Apollo missions to the moon. He has done extensive work in television and has received several awards for his accomplishments.

The ten-part television series closely parallels the book, although there are some differences due primarily to the characteristics of each medium. The series was in production for over two years, and the research and filming required visits to over 150 locations in about 20 different countries.

Burke explores the development of various technologies from a historical perspective which aims to demonstrate a fundamental thesis that technological developments—regardless of how revolutionary they may appear—are actually evolutionary and depend on the progressive contributions of many persons and events. Quite often these contributions are accidental, and Burke contends that it is impossible to predict the course of technological advances. Burke chooses certain technologies because they are prime examples of the "trigger effect" characteristic of the zigzag evolutionary path of most major technologies.

Burke takes a look back at the paths followed in the development of these technologies. The particular paths chosen must obviously be due to the author's own interpretation and selection, since so many other alternative paths and contributions could have been chosen.

Burke's efforts must be evaluated both with repect to his writing of history and with his sociotechnological theses. *Connections* could very well have been prepared as only a history, and it would still have been a considerable achievement. But Burke's addition of exploring the implications of this history adds a dimension to the work that stimulates further thought and discussion beyond the mere reading of a good history book or the viewing of an excellent television series.

Burke has an excellent writing style. He wastes few words, and he moves rapidly and with very interesting content. Such extensive periods of history are covered that the reader may wonder how much is really factual—but any such doubts are insignificant in comparison to the enjoyment of the reading.

Chapters generally begin with the consideration of a modern technology. Those chosen are the computer, the production line, telecommunications, the airplane, the atomic bomb, plastics, the guided rocket, and television. The basic format of each chapter is to start with a general discussion of the present state of the technology. This may often include discussion of some of the sociotechnological implications. Burke then moves—usually very cleverly—back into a related point in history. For example, in discussing plastics he includes the modern plastic credit card and asks, "What happens when every individual lives in deficit?" This provides the jumping path to another period of debt-ridden prosperity—15th century Europe.

From this past point in history, Burke then moves forward along the various paths he has selected, covering a vast number of events and developments until he again reaches the modern period at the end of the chapter with a technology which then becomes the focal point for the beginning of the next chapter.

Burke's history seldom considers much of the modern era. This can be somewhat disappointing to those of us in the field of electronics, where such tremendous technological contributions have come about within the lifetimes of many IEEE members. One wishes that Burke would have lent his writing and historical touch to produce a more detailed historical accounting of at least one or two of the modern-day advancements such as computers, semiconductors, or communications. Even though the theme of the book uses modern technology as the bridge to the past, the recent history of these modern-day developments is touched upon very lightly. A prime example appears in the concluding paragraph of the chapter titled "Faith in Numbers."

> beginning of this century, being used in tabulators and calculators, and finally in electronic enumerating machines. Today the data goes in and comes out via keyboards and video display units, but the concept is essentially the same. Bouchon, and the automata makers before him, had hit on the binary code, the "yes or no" language spoken by the immense computers that run the modern world, and without which that world would grind to a halt.

This paragraph also concludes with one of Burke's more arguable themes. This theme is here conveyed as the belief that the "world would grind to a halt" without computers. It is true that our society is heavily dependent on technology, as Burke continually reminds us, but to believe that worldly activity would come to a halt with the loss of even major technologies is rather difficult to imagine.

From Burke's telling of history we are reminded of some very important lessons of history. For example, we learn that shortages of natural resources are not only a modern-day phenomenon. There have been numerous periods in the past where shortages of energy and materials have pressed not only small segments of society but also countries.

Burke also attempts to dispel a few historical "myths." We learn, for example, that James Watt did not invent the steam engine (but he did provide a very significant improvement), nor did Eli Whitney conceive the idea of interchangeability of mechanical parts.

But perhaps Burke's best attempt at demythology concerns Thomas Edison, who is commonly regarded as the world's most prolific inventor. Although Burke gives Edison credit for his inventiveness, it seems to be done rather begrudgingly. Burke strongly suggests—and we shall see that this also extends, at least by implication, to anyone involved in the creative process—that Edison's accomplishments were, at least to a considerable degree, due to the efforts of his co-workers, contemporaries, and those who preceded him throughout past ages. This is, of course, true to some degree, but Burke presents a much stronger thesis, which is stated very well in his first chapter:

> As each story unfolds it will become clear that history is not, as we are so often led to believe, a matter of great men and lonely geniuses pointing the way to the future from their ivory towers. At some point every member of society is involved in the process by which innovation and change comes about, and this book may help to show that given average intelligence and the information available to the innovators of the past, any reader could have matched their achievements.

Perhaps...But I still have some doubts in my mind as to whether I personally could have invented the transistor even if I had been at Bell Labs in the 1940's. Burke appears to be creating his own myth regarding inventiveness and creativity and, although the general reader may accept Burke's thesis, it is doubtful whether many engineers would believe that "any reader" can invent. Burke seems to be confusing "Now why didn't I think of that?" with "If I had been there, I could have done it too."

Burke also makes no attempt at differentiating between science and technology or between the theoretical and the applied. He also largely overlooks the contributions of other related disciplines such as mathematics. Thus, Burke putting pieces together, without considering the complexity of discovering, analyzing, and utilizing the pieces.

Burke again touches on this thesis in his final chapter, in which he also discusses other implications of technology and takes a look at the role of technology in the future.

The book concludes with the challenge that:

> ...If we are to realize the immense potential of a society living in harmony with the systems and artifacts which it has created, we must learn—and learn soon—to use science and technology to enrich our intellectual lives.

There is an extensive listing of further reading material related to each chapter of the book and a thorough index.

Connections should be read because of the sense of history it conveys. It is an interesting and informative book, and it extends at least some of the history of technology to the general reader rather than confining it largely to the academic or technical world. It may, however, be necessary to regard Burke's socio-technological theses more as a stimulus to further thought than as being proven by the course of history.

The television series makes optimum use of the medium of communication. It does not—and obviously cannot—go into the detail possible in the book. On the other hand, the series contains a much more visually effective presentation of the many events, as well as the geographical locations and the actual physical devices and systems being described.

Some of the events are presented in an unnecessarily overly dramatic fashion which is obviously used for impact and general audience appeal, but which thereby takes time which could have been more productively employed. A prime example, which occurs at the beginning of the series, is the rather long, dramatic portrayal of the power blackout in northeast United States in 1965.

Although some events, such as the power blackout, are portrayed rather slowly, at other times there is such rapid progression through historical events that the connections may not at all be evident. And television—unlike a book—does not allow the viewer the opportunity to review or reflect on what is passing by. This speed through some events is also due to Burke himself, who narrates the series, since he has a rapid-fire manner which is atypical of the usual television narrator.

The television series also makes use of the traditional host—in this case, E. G. Marshall—and the panel of experts who present their opinions at the end of each program. Apparently the producers of the series felt that these additions were necessary, and considering the difficulty in making significant commentaries in such brief periods of time, the panel's contributions were reasonably well done. However, one gets the feeling that the panel of experts, as well as a number of other techniques, is provided more for the purpose of exploiting the techniques of televison than for making useful contributions.

Nevertheless, the television series is a most excellent contribution to the overall *Connections* effort and provides the visual and auditory impact that one cannot obtain from a book. It also serves the purpose of reaching many

hoped, however, that the television series has the effect of motivating viewers to read the book. The television series is also available on film and video cassette, and is likely to be a very popular series for schools and other organizations interested in exploring a very vital topic.

The Viewer's Guide is a fairly brief but useful and informative book. Each program of the television series is covered by a chapter in the guide which contains a summary of the TV program and its background, themes, readings, and discussion questions. The guide also offers a time chart which relates historical time to a number of the *tions,* as well as to other significant events in world history.

The overall combination of the book, *Connections*, the companion televison series, and the *Viewer's Guide* is a significant contribution which presents a popular exposure to the history of technological development and also a challenge to explore and analyze the implications of this history—of which we are all participants. It is also hoped that this series will provide a stimulus to those of us in the technical community to both more fully appreciate our past, and to approach the future with a keener awareness of the social implications of our efforts.

Continued from page 8.

Explicit provisions should be made for preventing this type of abuse from nullifying the DPO procedures. (It may well be that the most important aspect of these procedures is the requirement that a clear, public record be produced showing how identifiable managers responded to the arguments made by a professional.) One possible approach is to provide for the establishment of widely representative panels of knowledgeable people outside NRC (preferably outside government) who can be given the appropriate security clearances enabling them to review the facts and arguments and rule on whether the information in question cannot be released without improperly violating the privacy of some individual or incurring a serious threat to national security.

The third area of concern has to do with mechanisms for enforcing the provisions against retaliation. The problem here may simply be that the proposal is not sufficiently self-contained. References are made to sections of the NRC Manual having to do with adverse actions and with grievance procedures. Not having access to that document, I am unable to judge how effective these provisions are. Since protection against retaliation is of prime importance in the DPO procedures, it is unfortunate that the relevant information was not included in the proposal document. I can only hope that the referenced regulations place the decisionmaking power in such cases in the hands of those adequately insulated from the normal line of supervision.

Conclusions

The objectives of the proposed policy and procedures are well stated and, despite the noted exceptions, it is evident that a good deal of study and thought went into the preparation of this proposal. Properly amended, the procedures specified could be of great value in resolving or avoiding many difficult situations and in raising the standards of conduct of NRC's professional staff. The amended procedures could be a valuable tool in the hands of managers who want to do the right thing. They could, in fact, encourage managers to act fairly. Furthermore, even in cases where they failed, they could provide data for remedies of another type.

Any such failures are likely to occur in certain very serious cases where the organization is committed at the highest level to policies that may be detrimental to the common good. In such situations, it would be unreasonable to expect an internal review process, no matter how well thought out, to ensure a correction. A dissenter must also have available external agencies to which he can appeal. These might include some sort of special appeals board within the executive branch of government, congressional committees or individual members of Congress, professional societies, or public interest groups.

Where an appeal is made to such an outside agency, a record established under the proposed procedures would provide valuable data in assessing the validity of the dissenter's argument.

References

[1] Committee on Governmental Affairs, United States Senate, "The Whistleblowers: A Report on Federal Employers Who Disclose Acts of Governmental Waste, Abuse and Corruption," US Government Printing Office, 1978.

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[3] Watters and Vandenberg, "Proposed Policy and Procedures for Differing Professional Opinions," Office of Management and Program Analysis, US NRC, NUREG-0567, 1979.

PAC Chairmen Create Alternate USAB- Program Plan

Robert Bruce, Long Island Section/USAB Liason

Almost anyone who looks at the 1979 USAB Program Plan, 3rd edition, would be astonished at the number of tasks listed in the plan – 41. And, depending on his point of view, he might be delighted or dismayed to find that only about 12 of the 41 tasks provide direct benefit to the member in his capacity as practicing engineer. The remaining 29 tasks serve mankind, the telecommunications industry, the energy industry, Congress, USAB, TAB, EAB, etc. So if the grass-roots member or PAC Chairman got the impression that the $1.27M 1979 USAB budget is a pork barrel to serve whatever cause captures the fancy of the U.S. Activities Board, he might be close to the mark.

Among the numerous discussions that took place at the PAC National Conference on October 11 - 13, 1979 in Chicago, there was one about the USAB Program Plan. Most attendees (PAC Chairmen) concurred that the Plan was too extensive or too diffuse. After some deliberation, they created a plan of their own, with only 16 tasks plus a budget to run the IEEE Washington office. Here is the document they created.

PROPOSED USAB PROGRAM WRITTEN 10/13/79

Listed below are all the programs in a USAB Program Plan created by PAC Chairpersons at the PAC National Conference in Chicago on October 11 - 13, 1979. It also lists funding (after overhead and G&A are added). The brevity of this list is deliberate. We want these programs and no others. Present USAB program plans are too extensive, too elaborate, too grandiose.

PAC Created USAB Program Plan for 1980

1.	Pensions	$130 K
2.	Wage busting (ending it by legislation	55 K
3.	Age discrimination (affirmative action programs, enforce existing laws and write new legislation)	90 K
4.	Patent reform (write new agreement & legislation)	25 K
5.	Professional ethics	40 K
6.	Surveys	60 K
7.	PAC communications	90 K
8.	Regional funds for local projects	60 K
9.	To run the Washington office	640 K
10.	Long-range planning	20 K
11.	COMPOW	5 K
12.	Awards	5 K
13.	Registration & certification	5 K
14.	Career maintenance	5 K
15.	SILA	5 K
16.	Manpower activities	5 K
17.	Discretionary for Chairman	50 K
	TOTAL	$1290 K

**All other programs should not be abandoned but rather be paid out of general or other Boards' funds, as in other societies.

Reprinted from *The Pulse*, Jan. 1980.

Solar Energy Workshop, Farmingdale, NY, April 12, 1980

Time:
9:00 A.M. to 3:00 P.M.
Date:
Saturday, April 12, 1980
Place:
Polytechnic Institute of N.Y.
Long Island Center
Route 110, Farmingdale
Registration:
$10.00 – members of IEEE and allied professional societies
$20.00 – non-members
Make checks payable to "L.I. Section IEEE". Please include your home and business phone, and send to:
Mannie Schweisberg
132 Melville Road
Huntington Station, N.Y. 11746
Home, after 6 pm (516) 421-5387
Subject:
The Long Island Section IEEE will again sponsor a day-long workshop on solar energy for home heating, on April 12, 1980, at POLY, Farmingdale.

The Workshop will consist of three one-hour tutorial sessions alternating with one-hour discussion and question periods for a total of about six hours. Arrangements for lunch will be announced in the February 1980 PULSE.

Some of the latest topics to be covered are:

- Local Solar Radiation statistics.
- Fundamentals of heat transfer.
- Estimate of house heating energy requirements.
- Survey and economic comparison of solar energy conversion to heat, electricity, wind-electric, ocean-thermal-electric, biomass.
- Economics of solar heating in terms of current fuel costs.
- Fundamentals of solar heating systems.
- Active vs. passive systems.
- Collector efficiency.
- Non-concentrating collectors, concentrating non-focusing, and focusing collectors.
- Heat storage and delivery.
- Domestic water heaters.
- Controls.
- Heat pumps.
- Greenhouses.

Our lecturer will again be Dr. Richard LaRosa, who will this year be joined by another solar energy disciple, Mr. Harold Adkins. Dr. LaRosa is presently head of the Electrophysics Laboratory at Hazeltine. He helped organize and teach a PINY graduate course on solar energy for heating of buildings, and has assisted with other solar courses, building projects and testing programs. His experimental solar-assisted heat pump is now in its eighth home-heating season. Mr. Adkins is presently General Manager of Digitron, which produces computers and systems. He has worked on control circuits for solar systems, and has built and installed his own solar water heater. He has also built and installed his own solar space heater on his home. A more detailed biography of both lecturers will be provided in the February 1980 PULSE.

Fourth International Conference on Collective Phenomena

The following information was transmitted by IEEE President Leo Young.

Ms. Dorothy Hirsch, Director
Committee of Concerned Scientists, Inc.
9 East 40th Street
New York, NY 10016

Dear Mrs. Hirsch:

I am pleased to accept your invitation to join the other distinguished sponsors of the Fourth International Conference on Collective Phenomena to be held in Moscow, April 13-15, 1980.

This interdisciplinary conference will promote the expansion of contacts, communications and exchange of information between scientists and engineers as envisaged in the 1975 Helsinki Agreement.[1] The very existence of the conference is a tribute to the courage and determination of scientists and engineers who wish to remain in touch with their scientific and professional fields under very difficult circumstances. They deserve our full support.

The Board of Directors of the Institute of Electrical and Electronics Engineers is keenly interested in the welfare of engineers and scientists everywhere. The Board went on record in September 1973 with a resolution expressing support for basic human rights of engineers and scientists.[2] It is in this spirit that I am proud to be one of the individuals to sponsor the Conference.

I hope that other individuals and organizations, both within IEEE and from other scientific and professional bodies, will be able to assist the organizers of this and future such conferences in a spirit of friendship toward all who seek the truth.

Sincerely yours,

LEO YOUNG

Resolution on Basic Human Rights of Engineers and Scientists

Adopted by the
IEEE BOARD OF DIRECTORS

September 11-12, 1973

The Board of Directors of the Institute of Electrical and Electronics Engineers, an organization of approximately 160,000* electrical engineers all over the world, is keenly interested in the welfare of engineers and scientists everywhere.

This Board views with great concern the infringement on basic freedoms wherever they occur, particularly when engineers and scientists are singled out as the victims because of their profession.

This Board regrets that many engineers and scientists and their families have been denied their right to emigrate in violation of recognized international practices,** often solely because of their professional qualifications in science and engineering.

These practices seriously endanger the spirit of transnational friendship and cooperation on which the operation of this Institute is based. The Board of Directors of the Institute of Electrical Engineers appeals to its sister organizations, and to the National Academies of Science and Engineering or similar institutions in every country, to join in support of equal rights for engineers and scientists.

[1] *SCIENCE,* Vol. 207. No. 4427. p. 137, January 11, 1980

[2] *IEEE SPECTRUM,* Vol. 10, No. 11, p. 58, November 1973; text appended to this letter.

* Over 200,000 in 1980.

** The International Covenant on Civil and Political Rights, U.N. Document A/RES/2200 (XXI), adopted by the United Nations' General Assembly on December 16, 1966, states in Part II, Article 12, Paragraph 2, "Everyone shall be free to leave any country, including his own."

Nuclear Industry Honored by English Teachers

SAN FRANCISCO, Nov. 1979—The nuclear power industry was the easy winner of the 1979 Doublespeak Award. The award, which is presented annually by the National Council of Teachers of English, was given in recognition of meritorious performance by nuclear industry officials in connection with the "normal aberration" that occurred at the Three Mile Island Unit-2 nuclear power plant on March 28, 1979. William Lutz, an English Professor at Rutgers and Chairperson of the Council's Doublespeak Committee, credited the industry's spokespersons with inventing "a whole lexicon of jargon and eupehmisms" that emanated from Pennsylvania in the course of the TMI "plant transient." Helping the nuclear industry top all other contenders were such entries as "energetic disassembly" to denote "explosion" and "rapid oxidation" to denote "fire."

(See *Science*, Dec. 7, 1979, p. 1163.)

Call for Papers
IEEE Transactions on Education
Special Issue on Energy and Energy-Related Studies

The Editorial Advisory Board of the IEEE TRANSACTIONS ON EDUCATION has planned a special issue for May 1981 on the subject of energy and energy-related studies. The purpose is to bring together in one document papers on the study of, and education for, energy sources, energy conversion, energy utilization, and problems relating thereto. Since this special issue is supported by the IEEE Energy Committee, paper topics might parallel (but would not be limited to) the subjects of the several position

are directed to:

Electricity in the United States energy economy
Energy conservation
Fusion power
Solar energy
Solar power satellite
Energy from municipal solid waste
Cogeneration
Breeder reactors

Authors wishing to contribute papers should send complete manuscripts before September 1, 1980 to:

Dale C. Ray. Professor
School of Electrical Engineering
Georgia Institute of Technology
Atlanta, GA 30332

Final drafts of papers will be due by January 1, 1981.

Energy in Transition, 1985–2010

That's the title of an 800-page report issued on Jan. 14, 1980, by the National Academy of Sciences ad hoc Committee on Nuclear and Alternative Energy Systems (CONAES). The report concludes that conservation efforts to reduce the growth of energy demand "should be accorded the highest priority in national energy policy." Another conclusion is that the ratio of present U.S. energy consumption to GNP can be cut in half over the next 30–40 years by technical efficiency measures alone, without endangering economic prosperity. This is contrary to the conventional notion of a direct relationship between energy consumption and GNP. The report also recommends a vigorous effort at increasing energy supplies, including rapid development of a synthetic fuels industry and a "balanced mix of coal- and nuclear-generated electricity." The co-chairmen of CONAES were Harvey Brooks, Professor of Technology and Public Policy at the Board of Varian Associates and an IEEE Fellow. The study was commissioned by the U.S. Energy Research and Development Administration (now the DOE).

Once More: Abolish NRC

Following the Three Mile Island accident last March, the Nuclear Regulatory Commission (NRC) commissioned a study of itself. A report issued on Jan. 24 by the study group, directed by Mitchell Rogovin, came to conclusions similar to the earlier report of the Kemeny Commission: abolish the NRC immediately. The report described the operation of the NRC in scathing terms: not just badly managed, "not managed at all." Said the report: "A radical reorganization of the Commission's structure and management is called for, now." Since President Carter has apparently already decided against a radical reorganization of NRC, perhaps the $3M cost of the latest report could have been used for other purposes.

A number of other recommendations were also made; they were remarkably similar to recommendations made by the Kemeny Commission three months earlier.

Conference Announcement

A National Conference on Engineering Ethics will be held at Rensselaer Polytechnic Institute on June 20–22. The conference is intended to bring together both academics and nonacademics from a range of disciplines including engineering, philosophy, religion, sociology, history, political science, and management. The focus of the conference will be on ethical issues associated with the practice of engineering, but papers of a broader nature will also be considered.

Deadline for submission of papers is April 1st. Papers (8–10 double-spaced pages) should be sent to:

Human Dimensions Center
RPI
Troy, NY 12181

IEEE Position Papers

Solar Power Satellite

The spectrum of energy sources that could be available for use by the year 2000 is under active evaluation. Solar energy comprises one group of major alternate power sources under consideration as fossil fuel availability diminishes. One proposal requires placement of large, solar power satellites in geostationary, equatorial orbit. Solar energy is captured, converted to microwave energy, and beamed down to earth. Such stations have a major advantage which most earthbound systems do not have: almost continuous availability, regardless of the weather or day/night cycles.

In addressing the SPS, the IEEE Energy Committee has limited its assessments to those areas of its primary expertise, although it is aware of other concerns. These specialty areas include generation, transmission and distribution of both ordinary electrical power and microwave power, solar energy conversion using photo-voltaics, data management, and systems control. In addition, those design disciplines dealing with electromagnetic compatibility, including radio frequency interference, interaction of microwaves with the earth's atmosphere, and reliability are within our expertise.

The assessment of the IEEE Energy Committee is that this energy option, while not expected to fully mature until the early part of the next century, has sufficient merit to continue research with first priority into the environmental

issues. It also believes that better assessments of the technical and economic validity of the concept are dependent upon carrying out research and development in the space portion of the SPS, especially technology areas that have long lead times and/or which would not otherwise receive attention from the government or private sectors. The microwave power transmission system, one candidate, has a sound technology base, but the committee is concerned with adapting this technology to the severe SPS requirements of low-mass, high efficiency, very long life, and high temperature operations.

The position of the IEEE Energy Committee with respect to the SPS is that it is an option for a base-load source of electrical power that should be kept open, but that it is premature to commence such a capital intensive system development until (1) the biological and ionospheric impacts are clearly defined and found to be acceptable, (2) the interactions with other users of the primary frequency and its harmonic bands have been identified and any conflicts resolved, and (3) the research and development on the space segment of the microwave power system is brought to the point of validating the design assumptions.

It would therefore seem prudent to invest in those SPS research efforts that are needed to decide whether or not to proceed with SPS developments.

Energy From Municipal Solid Waste

U.S. households and commercial sources generate about 135 million tons of municipal solid waste annually. This constitutes a valuable and available type of fuel with approximately one third the energy content of coal by weight, or about the equivalent of lignite. Today, more than ninety percent of this is dumped in landfill to become a discarded energy resource with the inherent energy of almost one tenth of our present oil imports.

For many reasons, technical, economic, and institutional, only a fraction of this resource will be a candidate for energy recovery in the near future; yet to capture a significant portion of this capability in the form of heat, electricity or synthetic fuel is a challenge of major proportions. The U.S. has been lagging behind Europe, Japan, and other energy-hungry areas, not because of technical deficiency, but rather from public apathy, the availability of relatively inexpensive open land for dumping and tolerance of environmentally unsound landfill. In the face of more than one hundred large refuse-energy plants worldwide, the U.S. can boast of only a handful.

In this area, it is the IEEE position that technical development is well advanced, to the point that massive, government sponsored research and development is not required as much as a program of encouragement and of removal of institutional barriers, with moderate tax or other economic incentives. Principal recommended actions are the following:

1. Encouragement by regulatory authorities of interconnection between municipal or privately owned refuse fired generating plants and utility power grids, with energy sales contracts recognizing the appropriate contribution to both fuel savings and long term impact on capital requirements for generating capacity.

2. Provision of appropriate tax incentives where electricity, heat, or synthetic fuel are recovered from refuse with a net reduction in the consumption of fossil fuel. These should be available both to the utilities involved and to private enterprise constructors and operators of refuse-energy plants or production facilities for refuse derived fuel.

3. Provision of economic support and encouragement by federal, state, and local government for the installation or extensison of urban district heating systems to provide the opportunity for co-generation of electricity and low pressure steam for heating or air cooling, as is common in most large cities in Europe. Such systems can be fed by exhaust steam from conventional generating plants in combination with refuse fired power production facilities, and can significantly increase the usable energy from both fossil fuel and refuse.

4. Estabishment of a strong government commitment, federal, state, and local, to initiate and enforce sound environmental regulations affecting solid waste landfill operations. This should include development of regional and statewide plans for maximum feasible utilization of the energy potential of municipal solid waste.

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