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# PHYSICS & SOCIETY

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## Editor's Comments

Do you read us? As you know by now, we have changed from a quarterly paper *and* web journal to a semi-annual paper *and* web (January and July) plus semi-annual pure web journal (April and October). The switch was made to save money which could then be used for other Forum purposes. However, one of the major purposes of the Forum is the communication with its members, for which this journal is the main medium. Of what avail is saving money if we are not reaching, and extending, our membership?

The occasion for this lament is the apparently large discrepancy between the readership of our paper and of our web issues. The usual circulation of our paper edition is about 4500 to members and 300 to institutions, presumably libraries. As of mid–May, there were 1146 "hits" on the April web edition, 1520 on last October's issue. We don't know that each paper copy is read; on the other hand the

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## IN THIS ISSUE



## IN THE APRIL WEB ISSUE

*Physics and Society* is the quarterly publication of the Forum on Physics and Society, a division of the American Physical Society. It presents letters, commentary, book reviews and reviewed articles on the relations of physics and the physics community to government and society. It also carries news of the Forum and provides a medium for Forum members to exchange ideas. Opinions expressed are those of the authors alone and do not necessarily reflect the views of the APS or of the Forum. Contributed articles (up to 2500 words), letters (500 words), commentary (1000 words), reviews (1000 words), and brief news articles, are welcome. Send them to the relevant editor by email (preferred) or regular mail.

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library copies may have more than one reader. We don't know how much readership a "hit" represents either. Have we really lost two-thirds of our readership? If so, why, and what can we do about it?

We really would like to hear from you - the receivers of our paper, the "hitters" on our web. How much of each do you read and why? What can we do to facilitate conversations among physicists about the pressing problems at the interface between physics and society?

In this issue, we continue discussions initiated recently: nuclear energy and its risks; pseudoscience; religion and science; the implications of the historical physics-drama *Copenhagen*. We also present a timely article on the teaching of physics, and one on the restrictions of access to research data. We hope to continue with these and other problems in the near future. **And we hope to hear from you, our readers!** P.S. Given our difficult finances, it would be very helpful if those readers, who are not APS members, would send an annual $10 check, made out to APS, to the APS Special Publications Dept.

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# ARTICLES

## We can do better: A Report on Some Teaching Innovations.

*Peter Lindenfeld*

All of us are missionaries for physics. We are well aware of the many obstacles, both external and internal, to this work, but we don't have a great record of finding new and effective ways to deal with them. At Rutgers University we are trying to address several of the major problem areas: the declining number of physics majors, the dissatisfaction with the introductory courses, the barrier that physics courses represent for students who are not well prepared, the often marginal support system that we provide for our students, and the neglect of these problems by many members of the faculty.

We have the normal physics major curriculum with standard courses and provision for honors projects. It provides excellent preparation for graduate school. If this "professional" major were our only one, we would have of the order of ten graduates per year, as is true for comparable institutions. Some decades ago we added the "general" major, with a less demanding curriculum, based on the premise that we can provide substantive science-based education to students who do not intend to pursue a research career in physics.[1]

We instituted two new full-year courses to follow the introductory course and a year of calculus. One *is Advanced General Physics*, which includes parts of the normal junior and senior courses, but at a reduced level of intensity and mathematical sophistication. The course is "self-paced" in order to provide the flexibility to accommodate students with a wide variety of backgrounds. The other is a laboratory course with a substantial amount of computer use. We also require two further semesters in physics, which can be chosen from among our regular advanced courses, but can also be special courses (*Physics of Sound, Physics of Modern Devices*), which are less rigorous and problem-oriented. That leaves a block of time equivalent to six semester-courses that is used for a "coherent concentration" of courses, flexibly chosen in consultation with an advisor in the Department. The program facilitates double majors, and is used by pre-med and pre–law students.

Do the students learn everything that we want them to know? No – but then this is true also for most of our other students.

We also have a 5-year program in conjunction with the College of Engineering, and an applied physics major. This puts us in the rarified range of 45 graduating seniors this year. In the fall we are starting a major in astrophysics, a subject with the added feature that it seems to attract a much greater fraction of women students.

We have about 2500 students at any one time in our introductory courses. The traditional system of lecture (one-way and impersonal), recitation (problem drill), and laboratory (cookbook) is widely vilified, but only rarely reformed. We are trying to change each of these parts, as well as the interaction between them.

The lectures can now be more interactive, with the help of a student-response system [2], which allows the students to answer questions anonymously (or not), with immediate feedback. In my experience there is nothing that engenders discussion in a large class to the same extent. The questions are those that the students have just studied, and they have thought about them moments ago. When they see that the choices that they have made are controversial, they are eager to discuss them.

Modern technology allows homework to be computer-based [3]. This frees the recitation period from its former burden, and allows it to be used more creatively, for more life-like problems, group problem solving, minilabs [4], or other activities that reinforce or ex-

tend the material currently being studied. Similarly the laboratory, while it can take many forms, can be a place not only for "procedures" but for real learning. Above all, the different components of the course need to be closely coordinated. For each week there is a program, and during this time each meeting concentrates on the same topic, each supporting the others, each contributing to the student's engagement with that part of the subject that forms the week's program.

The reform of the courses is a work-in-progress, only gradually permeating the culture of the Department. The ideas described here were pioneered in our "extended" courses for at-risk students [5,6]. These are not remedial courses. Rather they provide more time (and commensurate credit), smaller classes, and other features that make them more personal and more student-friendly. Credit is given for every activity, including but not limited to tests and a final exam. (Yes, a minute fraction of the grade is given for attendance, and it has a disproportionate effect!) Each course has a coordinator, who gets to know the students and is available for a variety of support activities, and may or may not also be the lecturer. One of these courses is parallel to our first-year engineering course, the other to the course taken by biology students, pre-meds, and other science majors. One measure of success is that in their second year the engineering students from the extended course are in the regular course, with all the tests that the other students take, and their average grade is comparable to that of the rest of the class. The new courses have made it possible for students to enter the engineering and health professions, who would, to a large extent, have been prevented from doing so in their absence.

An essential role is played by the teaching assistants. Weekly meetings of all of the personnel in a course are the primary venue for coordination of activities, and for making the assistants active participants and vital colleagues.

We have a Math and Science Learning Center, which started as the Physics Learning Center [7]. It is a place for tutoring, review sessions, help and office hours, and some classes. Videotapes and old exams are available. Unlike most such centers it has museum-quality demonstration equipment that can be used by anyone, and as a result there is a lively atmosphere that can not be equaled by having only tables and blackboards. This equipment also forms the basis for some of the laboratory activities that are regularly assigned in our courses.

Does it take more time and effort to teach in these new ways? Perhaps. But whatever we do, if we are committed to it, if we want to do it well, requires that we give of ourselves, to the best of our ability. In return there is the much greater satisfaction, not only for the students, but also for us, the instructors.

Does it take more resources? It depends on how much you want to do. Today the need for such resources is widely recognized, and administrators, government agencies, and foundations are, more than ever (and often more than the departments), ready to support educational activities and educational reforms. It also depends on how you measure the cost. The cost per successful student is more appropriate than the more usual cost per entering student, if you wish to recognize a greater success rate. [5]

What about the old cynical view that effort spent on teaching is not rewarded? I think it is wrong. In all cases that I know of, vital and creative involvement in teaching activities has led to recognition and professional advancement. Sometimes the recognition has come slowly, and it is certainly not enough to say that the private and personal rewards are great. We need to provide more support, moral, professional, and financial for those who go beyond the old routine methods and who contribute with their time and their thoughts to new and more successful ways to teach. The atmosphere for acceptance of reform is now better than it has been at many times in the past. Our efforts have to continue, for the sake of the students, and for our own. We can do better!

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I would like to thank Suzanne Brahmia, Eugenia Etkina, Joe Pifer, Baki Brahmia, and Mohan Kalelkar for their contributions to this talk and to our programs. My special appreciation goes to George Horton, the creator and tireless advocate of many innovations, including the Math and Science Learning Center and the extended courses.

Based on an invited talk at the 2001 March meeting of the APS
1 P. Lindenfeld, AAPT Announcer 7, 78 (1977).
2 J. Shapiro, J. College Sci. Teach. 26, 408 (1997). We now use *Educue*, 351 Alplaus Ave., Alplaus, NY 12008, www.educue.com
3 *WebAssign*, Box 8202, NCSU, Raleigh, NC 27695, www.webassign.net
4 E. Etkina and G. K. Horton, Phys. Teach. 38, 136 (2000).
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# Access to Research Data through the Freedom of Information Act (FOIA)

*Mary Ellen Sheridan*

*This article is based on the author's paper originally presented at the American Physical Society National Meeting, Minneapolis, MN in March 2000 and on a panel presentation by the author, Kevin Casey of Harvard University and Susan Cornell, FOIA Officer, NIH at the National Council of University Research Administrators Annual Meeting, November 2000.*

The scientific community was caught unaware in late October 1998 when the voluminous Omnibus Budget Bill, passed by Congress in its final days of session, included two brief but sweeping sentences that called for public access to all data produced under Federal funds, using the Freedom of Information Act (FOIA) as the vehicle.(1)

This paper examines the political background that generated this statute, the the rule-making process in the Office of Management and Budget (OMB), the influence of extensive and aggressive public comment, and OMB's final publication of new rules granting

access to certain research data through FOIA. Given the scope of the statute and the focused modification of federal grant requirements, the tenure of OMB's approach is regarded as uncertain.

## I. Background

The Freedom of Information Act, passed in 1966, requires the government to provide its records to the public upon request. (2) Under FOIA, "agency records" must be disclosed unless covered under one or more of the nine exemptions that are specified in the law. There are no limitations governing who can make FOIA requests.

In a key decision in 1980, the Supreme Court ruled that a federal agency is not required under FOIA to make available research data funded by that agency if the agency does not have actual possession of the data. (3) While a grant term may stipulate that the granting agency has the right to request the data, data are not a "federal record" for FOIA purposes. From a refusal to share research data rose the political impetus to find a mechanism to have Federally-funded research data available for public scrutiny.

For over twenty-five years Harvard University scientists have been engaged in a massive longitudinal study (called the "Six Cities Study") tracking health/mortality data. Harvard's analysis supported a strong relationship between public health and atmospheric pollution, forging the lynch pin of the EPA's proposed updated clean air standards.

Smoke-stack states and industries were in favor of more relaxed clean air and water requirements, asserting that the data upon which EPA based its standards were flawed and should be re-examined by industrial scientists. By challenging the interpretation of the Six Cities data, those interested in lowering EPA proposed standards hoped to delay the implementation of the new standards. The EPA did not have the study data in its possession and neither did NIH, which had funded much of the data collection for the Six Cities Studies. Harvard University researchers refused requests from EPA to provide the data based on assurances of confidentiality that had been promised to study participants. Unless the Forsham decision (3) could be overturned, the agencies did not have the right to obtain and retain research data that could then be accessible under FOIA.

Senator Richard Shelby (R-Alabama) publicly had expressed his concern about the estimated $40-$150 billion cost to industry of the proposed EPA standards. He suggested that in the absence of availability of the study data that EPA had cited in promulgating its standards there was no public accountability of the government-funded researchers. In the hurried workings at the end of October, Senator Shelby inserted two critical sentences into Public Law 105-277. The new law directed OMB to amend OMB Circular A-110 *Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations* "to require Federal awarding agencies to ensure that all data produced under an award will be made available to the public through the procedures established under the Freedom of Information Act." Agencies were also given the opportunity to recover their administrative costs in obtaining and providing the data. These sentences are generally described as the Shelby Amendment (4).

## Initial Reactions

In recent years researchers' accountability and the public's right to know has spurred growth in congressional regulations for federally funded research, including scientific integrity and financial conflict of interest. Supporters of the Shelby Amendment argued that providing access to data assures an opportunity for validation, re-interpretation and accountability. These goals seem worthy and even beneficial but raw data may also be misleading, misinterpreted and dangerous for both scientists and the public. In a letter to OMB Director Lew the president of the Association of American Medical Colleges expressed the sentiment of many academics that "although the intent of the legislation is appealing at first reading, …(it) fails to recognize the complexity of the research process and the nature of research data themselves." (5) The letter suggested that as the legislative language was inspired by federal rulemaking so access to research data should "be confined to research data that form the basis for regulations or other federal rulemaking." The letter also raised the cost burden to the grantee community. Cohen's letter did not comment on the additional burden on researchers' time and productivity that such responses to agency requests for data were certain to command.

## II. OMB's Proposed Implementation

When OMB published its proposed implementation in the Federal Register February 4, 1999, the sweeping statutory language was narrowed to "published" data used in "developing policy or rules." (6) However even OMB's wording raised questions in the absence of key definitions of terms. The research community's anxiety was directed to the choice of FOIA as the tool to access data held by grantees. (7) The exemptions of FOIA were presumed by congressional supporters of the Shelby amendment to assure that inappropriate release of data would be suppressed. It is not at all clear that these exemptions would protect intellectual property of researchers, assure obligations of confidentiality already promised to human subjects, or protect the confidential information shared with collaborators on research funded in part through federal support. No FOIA exemption appeared to protect organizations that may have divulged privileged institutional data in exchange for commitments of confidentiality. In any event, confidentiality would be breached in the process of data transmission from the grantee to the agency. The cost to the grantee of responding to the agency's request was not addressed in OMB's proposed rule-making.

## Significant Agency Responses

The National Science Board issued a statement on the sharing of research data that urged the repeal of the Shelby amendment.(8) NSF reminded OMB that it already had a publicly accessible data-sharing policy: it expects researchers to publish and share data and supporting materials. NSF was deeply concerned that the government-university-industry partnerships it had strongly advocated could be soured. NSF feared that productive, innovative scientists would steer away from federal research support, which could impede the development of new technologies.(9)

NIH posted a lengthy discussion paper on its website examining through model research scenarios many of the concerns and questions raised by the use of FOIA as well as OMB's implementing language. NIH reminded OMB that fees collected from FOIA administration went to the U.S. Treasury so that the financial burden of managing data access through FOIA would be the agency's.

## Research Community Responses

The community's comments reasoned that any implementation

had to balance the integrity of scientific inquiry with public accountability. The dangers of sharing preliminary data and the disruption of industrial collaborative research were common points. Access by foreign competitors to federally funded research could also result in a loss of competitive advantage, both scientific and economic. Letters to OMB from the Council on Governmental Relations, the American Association of Universities, the National Academy of Sciences, and the American Association of Medical Colleges sounded consistent themes of deep reservation with FOIA as the appropriate tool, the adequacy of protection of sensitive information under the exemptions as currently available in FOIA, the distractions of nuisance challenges designed to discredit scientists, and the burdensome costs both to scientific productivity and grantee institutions.(10)

## Senate Leadership Response

In a letter to OMB of April 5th, Senators Shelby, Nighthorse–Campbell, and Lott commented about the deficiencies in OMB's proposed narrowing of the intent of the statute.(11) The authors wanted OMB to assure that if pre-publication data had been used to support a federal rule or policy then "such data should be able to bear public scrutiny and disclosure." The Senators believed that academics' concerns about privacy of research subjects were unfounded based on agency experience to date with FOIA but that even if such problems arose they should addressed through amendments to FOIA.

## Corporate Responses

Burdened with the cost of compliance with EPA's clean air standards and concluding that EPA had been overzealous in its proposed strict standards, industries were enormously pleased with Shelby's amendment. On March 23, the Chamber of Commerce posted a 'call to action' on its website.(12) The site says, "if implemented properly this rule will do more for regulatory reform than all the legislation passed in the last 10 years. [It] ...will allow the public to challenge the agency based on the facts as determined by the research, not just on the information the agency selects as appropriate to support its policy position. With such data in public hands, agencies will have a much harder time imposing regulations on the business community without substantial evidence." The website described how challenges to a wide variety of data underlying various EPA policies could be used to slow down or actually eliminate such regulations, extending to all areas of federal regulation.

## The Press Weighs In

The contentious dialogue between researchers and companies attracted considerable press attention. A *Washington Times* editorial said, "OMB should insist on releasing tax-funded scientific data from its regulatory fetters."(13) AAAS suggested that they should not only support sound science but also that "Congress should hold hearings in the light of day so that all interests are openly discussed …proving public access to data while ensuring the continued flow of benefits from scientific research" (14) The *Los Angeles Times* urged OMB to find a balance, saying "The White House should find a middle course, implementing Shelby's law in a way that encourages freedom of information while not jeopardizing patent and privacy rights."(15)

In an editorial of June 7th, 1999 the *Wall Street Journal* described the scientific community's concerns about access to raw data and the potential for harassment, concluding that "if scientists [have] to take taxpayer money to conduct research, they should know that one of their main obligations is to make certain the public has full confidence in the way those results are used."(16)

## III. OMB's Response to Comments

In August of that year, OMB published a second version of implementing regulations.(17) OMB's response examined case law governing FOIA and access to federally funded research in the process of responding to concerns about the potential for the FOIA exemptions to provide protections for research data. The revised regulations expanded A-110 to confirm that the government has the right to obtain research data from grantee organizations in response to a FOIA request under certain definitions and circumstances. OMB defined "data" and "published" but ultimately the key to access was tied specifically to that data "used by the federal Government in developing policy or rules."

In developing its definitions, OMB concluded that some limitations of access were necessary to assure the integrity of the research process. Access to data should not disrupt the research process by forcing premature release of data before a study is completed; but if data are sufficiently sound to support a federal policy or rule, then they should be able to bear public scrutiny and disclosure.

OMB also raised several questions regarding the financial burdens such FOIA requests would impose on Federal agencies, their recipients, and applicable subrecipients in carrying out the proposed revision. OMB sought comment about the mechanisms available to recipients to charge to their awards the costs that they would incur.

## Response to OMB's Revised Regulations

The scientific and university communities received OMB's second version of implementing regulations with general satisfaction.(18) Limiting access to data used by the federal government in regulation and rule making excluded most basic research data from FOIA access. Typical comment letters from the research community described the proposed regulations as the best implementation of a poorly considered law (19)

Responses to OMB's call for comment about the cost of response to a FOIA request typically noted that these costs are unpredictable. They concluded that only a fee structure based on the specific FOIA request offered the opportunity for reasonable reimbursement.(20)

## OMB's Final Regulations

OMB's final revision, published in the October 8th Federal Register, confirms the applicability of access to data produced with federal support that are "used by the Federal Government in developing an agency action that has the force and effect of law."(21)

Scientists should be familiar with key definitions and parameters of the public's new FOIA rights.

*"Research Data" is defined as the recorded factual material commonly accepted in the scientific community as necessary to validate research findings, but not any of the following: preliminary analysis, drafts of scientific papers, plans for future research, peer reviews, or communication with colleagues. This "recorded" material excludes physical objects (e.g. laboratory samples). Research data also do not include:*

*(A) Trade secrets, commercial information, materials necessary to be held confidential by a researcher until they are published or similar information which is protected under law; and*

(B) Personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study.

"Published" is defined as either when "(A) Research findings are published in a peer-reviewed scientific or technical journal; or (B) A Federal agency publicly and officially cites the research findings in support of an agency action that has the force and effect of law."

*No FOIA request for research data is governed by this new rule unless the data has been cited in support of an agency action that has the force and effect of law, and any such data has to have been produced since the effective date of the new rule.*

## V. Agency Implementation

On March 16, 2000, the agency implementation was published in the *Federal Register*.(22) Agencies adopted OMB's language essentially verbatim. The new rules apply only to new awards and continuation awards made after the effective date, April 15, 2000.

Since NSF incorporates A-110 by reference into its Grant Conditions-1(GC-1) (and NSF was satisfied with the final OMB implementing language), it was effective as stated in the Federal Agency, i.e. November 8, 1999.

NIH which has consistently been opposed to a broad-based interpretation of the Shelby Amendment, has been the leading grant funding agency to advise scientist and grantee organizations of the impact of the new A-110 rules. NIH posted guidance on its web site www.nih.gov/grants/oer/htm, reviewing the definitions and providing an overview of the FOIA process (23)

The burden to agency FOIA offices, agency program staff and grantee institutions and researchers is a serious problem. Cost reimbursement is a complex matter for all the involved parties. How are fees calculated and recovered? How are fees paid to agency distributed? No guidance is currently available on this subject.

## VI. Challenges to the Regulations

The *Boston Globe* reported that William Kovacs, vice president for environmental and regulatory affairs at the Chamber as saying "OMB decimated the congressional intent by limiting the information that has to be made available."(24) Many believe that eventually OMB's narrow interpretation of the statutory language will be litigated. Should EPA, DOT or other agencies introduce new expensive regulations for clean air, clean water, auto emission or other transportation safety measures, and the affected parties are denied access to underlying research data, the challenge would be inevitable.

If or when that happens, and if OMB's regulations were to be overturned, the debate over the rule-making process would begin again.

## VII. Prospects for Grantee Organizations/ Researchers

Some researchers are already concerned about direct requests from public groups or private corporations in anticipation of such inquiries being allowable through FOIA. Scientists are advised to refer any inquiries to institutional research administrators, legal counsel or other senior administrative officials before sharing any data. (24) When FOIA requests are legitimate, they will come to the scientist and the grantee organization from the Federal agency that supported the research, not the public requestor.

Institutions are advised to develop data retention, sharing and usage policies. Such policies should provide guidance to investigators and research staff about the institution's expectations in these critical areas. Case studies about what kind of research may have regulatory impact should be developed and disseminated. Studies with obvious links to public policy, such as harmful drugs, atmospheric pollutants, auto safety, gun control, are likely candidates. PIs whose work has been cited by government agencies in past rule making may be good resources to research colleagues as data retention policies are evaluated and implemented.

Clear and direct policies for responsible data maintenance will assist researchers and grantee organizations in complying with future A-110 requirements and FOIA requests for data. Scientists should be careful to retain data in formats with appropriate documentation, to archive data or to place data in other publicly accessible forums, facilitating reasonable access, without excessive financial and productivity consequences. Support for these data options is an allowable direct cost in a grant budget.

FOIA Officers at federal agencies should be considered a resource for administrators. They have been managing the FOIA process for many years and have experienced counsel to offer about how the law is interpreted.

## Conclusion

As long as FOIA is the vehicle for access, grave reservations about the disruption of research productivity within Federal grantee organizations will persist. This is likely to be a long and contentious process involving the definition and redefinition of public policy. Increased public accountability and access to research data are inevitable. The path, however, is still convoluted and quite muddy with no evidence of a viable alternative to FOIA.

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## References

1. 1998 Shelby Amendment to the Treasury Omnibus Bill (PL 105-277): "Provided further that the Director of OMB amends Section .36 of OMB Circular A-110 to require Federal awarding agencies to ensure that all data produced under an award will be made available to the public through the procedures established under the Freedom of Information Act: Provided further, That if the agency obtaining the data does so solely at the request of a private party, the agency may authorize a reasonable user fee equaling the incremental cost of obtaining the data:…..

2. Freedom of Information Act (5 U.S.C. section552). FOIA exemptions are discretionary in that an agency can choose to release records even after it has determined the record falls within one or more of the exemptions. Individual research funding agency FOIA rules indicate how that agency has interpreted the exemptions. Links to agency FOIA web sites can be found at www.usdoj-gov/foia/other-age.htm

3. FORSHAM v. HARRIS, 45 U.S. 169, 63 L.Ed. 2d 293, 100 S.Ct. 978 (1980)

4. OMB Circular A-110 implements agency obligations for the administration of grants and cooperative agreements. The Shelby amendment directed that A-110 be modified to require access by agencies to grant-funded research data through FOIA. A-110 has no applicability to contracts. Federal Acquisition Regulations governs contracts, including access and retention to data developed under federal contracts.

5. Jordan J. Cohen, M.D. on behalf of American Association of Medical Colleges, letter to OMB Director Jacob Lew, December 9, 1998.

6. Federal Register, 1999, 64, 5684-85.

7. Science, 2/19/99, "Public Access to Data," page 114, editorial by Mark Frankel; C&E News, April 12, 1999, "Research Data Disclosure," L. Raber.

8. "On Sharing of Research Data", Statement of the National Science Board, adopted February 18, 1999 at the NSB's 352nd meeting in LosAngeles, CA.

9. Rita Colwell(Director of NSF) letter to OMB Director Jacob Lew, February 22, 1999

10. Milton Goldberg, on behalf of Council on Governmental Relations, letter Mr. F. James Charney, OMB, March 17, 1999; Bruce Alberts, President, National Academy of Sciences, letter to F. James Charney, OMB, April 5, 1999. Jordan Cohen, American Association of Medical Colleges, letter to F. James Charney, OMB, March 24, 1999; American Chemical Society, Science & Society Project, "Regulatory Issues: Access to Scientific Information" June 8, 1999. Mark Frankel, Charles Fromm (Center for Regulatory Effectiveness), MES, Joanne Tornow AAAS Fellow, OSTP

11. U.S. Senators Richard Shelby, Ben Nighthorse-Campbell, and Trent Lott, letter to Jacob Lew, OMB, April 5, 1999.

12. U.S. Chamber of Commerce/GAIN (Grassroots Action Information Network) web site.www.uschamberoorb/policy/6-environment/issues1737/ac990323.htm

13. "Secret Science," Washington Times, February 11, 1999

14. "Give the Release of Research Data a Second Look," Mark Frankel, Washington Times, February 22, 1999

15. "Finding Research Balance" Los Angeles Times Editorials 2/27/99

16. "Science's Belated Complaint" Wall Street Journal, Editorial, June 6, 1999. (and in response "Scientists Need Privacy Too," Thomas J. Price, Executive Director, American Association of Engineering Societies, Letter to the Editor, Wall Street Journal, June 28, 1999)

17. Federal Register, 64 43786-43791, August 11,1999, Request for Comments on Clarifying Changes to Proposed Revision on Public Access to Research Data.

18. Milton Goldberg, Council on Governmental Relations, letter to F. James Charney, OMB, September 1, 1999; Robert Zimmer, University of Chicago, letter to F. James Charney, OMB, September 8, 1999; Jack Lowe, Cornell University, letter to F. James Charney, OMB, August 31, 1999.

19. U.S. Senators Ben Nighthorse-Campbell, Trent Lott, Richard Shelby and Phil Gramm, letter to Jacob Lew, OMB, September 10, 1999.

20. COGR letter *vida supra*

21. Federal Register, October 8, 1999 64 195, 54926-54930,Final Revision to OMB A-110, - .36 Intangible Property, required by provision contained in Public Law 105-277.

22. Federal Register, 65, March 16, 2000 Agency Implementation of A-110

23. Susan Cornell, Freedom of Information Officer, NIH, in presentation "Public Access to Research Data: recent Changes to OMB Circular A-100 and the Freedom of Information Act(FOIA), National Council of University Research Administrators National Meeting, Washington, D.C., November 6, 2000

24. "Suit likely over Research Done with Federal Funds" Aaron Zitner, Boston Globe, 12/10/00 page D01

25. American Physical Society, March 21, 2000. Invited Paper "Public Access to Federally Funded Research Data: How New Freedom of Information Act Requirements Affect Academic Researchers" Mary Ellen Sheridan Session E5: Physics and the Law.

# Proliferation and Pollution Risks from Naval Nuclear Activities in Northwest-Russia

Morten Bremer Maerli[1]

August 12, 2000 Kursk, a state-of-the-art nuclear submarine, sank in the Barents Sea with the loss of all 118 crew-members. The accident was a dire reminder of the state of Russian naval nuclear affairs. The Northern Fleet is in heavy sea, with severe local pollution hazards and global proliferation risks in the wash of their nuclear prolusion activities.

The coastal regions of the Northwest Russia, including the Kola Peninsula, have the greatest density of nuclear reactors on earth. Due to the extensive activities of the Russian Northern Fleet, almost one fifth of the world's reactors are located in this area. In addition to military submarine operations, several nuclear-powered naval surface vessels are in operation.

This article gives a snapshot of the proliferation and pollution potential associated with these naval reactor activities, including some background to and causes of today's problems. Russian nuclear policies and foreign nuclear safety and security assistance will be discussed. While important progress has been made, much of the foreign support came with some hard-learned experiences. All lessons learned, good and bad, should be used to improve new rounds of cooperative efforts to limit the persistent nuclear security and safety risks in the region.

## History and future of the Northern Fleet

To catch up with the United States, the Soviet Union started building-up a modern fleet in Northwest-Russia at the end of the 1950s. Six new naval bases, some with nuclear submarine facilities, were built on the Kola Peninsula from Zapadnaya Litsa in the west to Gremikha in the east.[2] A number of smaller navy bases for other types of vessels were also established at the Pechenga Fjord in the west, Belomorsk to the east and Novaya Zemlya to the north. At the same time, five large naval yards were built on the Kola Peninsula and in Severodvinsk for the construction and maintenance of nuclear submarines.

Since 1958, the Soviet Union and Russia have constructed 249 nuclear-powered submarines, representing more than half of the submarines produced worldwide.[3] Two thirds of these vessels were delivered to the Northern Fleet, the rest were destined for the Pacific Fleet. In addition to the combat submarines, five research and development submarines and several full-size land-based

submarine-training facilities have been produced.

Additionally, the eight ships in the Russian icebreaker fleet are nuclear propelled, each with one or two reactors, accompanied by four battle cruisers and a communication ship with twin reactors. Most Russian submarines are equipped with two reactors. The overall number of naval reactors produced by the Soviet Union/ Russia is therefore at least 480.The vessels use fuel enriched from below 21% to 90%.[4] Of these, a total of 24 reactors are believed to have been designed to use uranium enriched to 90% U-235.[5]

Deployment reached a highpoint in 1989, when approximately 196 submarines were in service.[6] However, Russian submarines are now at an all-time low in terms of deployment and readiness. As of 2000, Russia had 44 active submarines.[7] Russia's latest nuclear submarine, an Akula-class vessel, had its first test in November 2000. It was the first submarine to leave the Sevmash production facility in Severodvinsk in three years.[8]

The severe budget crunch has forced the Russian Navy to retire older submarines prematurely, and to concentrate its limited sources on maintaining only the most modern assets. Russia is likely to maintain a limited number of modern submarines (SSBNs) in the coming decade.[9] Consolidation of strategic operations to northern areas could be likely if not enough new submarines are deployed.

The majority of the constructed submarines have now reached the end of their service lives and have been decommissioned. The vessels await dismantlement, a process with huge safety (pollution) and security (proliferation) challenges.[10]

## Pollution risks

The use, maintenance and decommissioning of all nuclear reactors generates radioactive waste that must be processed, transported and stored. Existing storage capacities for spent fuel is stretched to the limits, with nuclear assets sometimes kept in the open.[11] The situation threatens accidents and leakages to the environment, with subsequent exposures to populations and contamination of the environment.

Almost all the radioactivity resides in the spent nuclear fuel. However, liquid radioactive waste is generated during refueling operations, and the reactor compartments, control rods and tailings from the reactor tank must be regarded as radioactive waste. Other potential sources of pollution include dumped radioactive (liquid and solid) material, naval nuclear accidents, and possible import of nuclear waste. An overview of radioactive waste, fuel and decommissioned submarines in Northwest-Russia is given in table 1.

## Decommissioned Submarines and Spent Naval Fuel

By the end of 2000, 184 Russian nuclear submarines have been decommissioned. Of these vessels, 48 have been dismantled, 28 are in the process of being cut up, and 112 are still waiting the initiation of work at piers and quay structures. Most of the vessels still have loaded reactors.[12] At eight different locations, there are now inactive nuclear submarines stored and awaiting dismantling, or dismantling activities are under way.

33,600 assemblies are stored in land-based storage sites and in a variety of run-down service/storage vessels in the northern region.[13] An equivalent number is still onboard inactive submarines, and the total amount of the fuel assemblies will likely increase to as much as 100,000 over the next decade. [14] This will include spent fuel from submarines still in operation, submarines earmarked for retirement and the civilian nuclear powered icebreakers in Murmansk.

The Russian navy has clearly shown its inability to deal with the fuel backlog. A civilian ship is collecting spent fuel from a naval service vessel to help defueling a nuclear powered submarine.[15] In Soviet times, excess or spent nuclear fuel would have been transported by rail to the Mayak complex for reprocessing, but reprocessing activities are erratic. Even if an optimistic view is taken of the capacity of the Mayk plant to reprocess fuel, storages for more than 100,000 spent fuel assemblies are needed.[16] Moreover, transportation of the spent fuel is long and costly, and calls have thus been made for intermediate storage facilities in the northern region. [17]

## Dumping of Radioactive Material

According to Russian sources, about one PBq[18] of liquid radioactive waste have been discharged by the Russian Navy directly into seawater within five allocated areas of the Barents Sea and in the Kara Sea.[19] 10 reactors without fuel and 6 reactors with fuel have been disposed at the east cost of the island Novaya Zemlya and in allocated areas in the open Kara Sea. In addition, 17 vessels with solid radioactive waste have been sunken, together with 6,508 containers with radioactive waste.[20]

Generally, in the open sea dumping regions, no contribution from the dumped radioactive waste can be found in the waters, sediments and biota.[21] However, enhanced levels of artificially produced radionuclides in sediments collected in the very close vicinity of almost all localized dumped objects demonstrate that leakages occur. The dumped material represents long-term pollution hazards.

## Accidents

As tragically evidenced by the Kursk, nuclear submarines are accident-prone. Most accidents have occurred while submarines have been on patrol, although some happened during refueling or repair operations (see below). Kursk is the fourth nuclear powered submarine from the Northern fleet to sink. All of the wrecked vessels had twin nuclear reactors, and two of them were carrying nuclear missiles. Long-term radioactive releases are likely. At the end of 2000, the Russians expressed interest in a joint Russian-Norwegian environmental impact assessment and surveillance programs to track radioactive releases from Kursk.[22] However, Russian officials recently claimed that the wreck will be hauled late summer 2001.[23]

The risk of criticality accidents during the handling of the highly enriched fuel may be pronounced. Some of the spent fuel is stored in uncontrolled geometry (e.g. at Andreeva Bay), and a moderator like water is provided accidentally.[24] Other possible causes of criticality accidents are collisions, fire or explosions. In 1985, during refueling, a criticality accident occurred with a new core, contaminating the area surrounding a Pacific Soviet naval base in Chazhma Bay.[25] The releases are likely to primarily have local impact, but a similar criticality accident with a depleted core on the Kola shore could release quantities of radioactivity into the air and the Barents Sea, with effects on neighboring states.[26]

## Imports of Nuclear Waste

Prospects of badly needed revenues have made Russia consider import of high-level radioactive waste. The powerful Ministry of Atomic Energy (Minatom) claims that the plan could reap $ 21 billion over the next decade, vault Russia into the global nuclear service-industry and provide cash to clean up radioactive hot–spots.[27]

Others have raised concern that the import revenues will be used to boost the Minatom nuclear weapon complex, with the production of new and modernized warheads.[28] The import, likely to have a devastating effect on already critical and strained Russian storage capacities, awaits further considerations as the Russian Duma postponed voting on the nuclear fuel import bills March 22, 2001.[29]

## Proliferation Risks

Highly enriched uranium and plutonium are the essential ingredients of any nuclear device. Russia alone may hold as much as 80 to 85 metric tons of HEU for naval propulsion.[30] The radiation levels of the fresh fuel are low and the enrichment levels make it potentially attractive in nuclear weapons. Fresh fuel diversion and possible exports of naval HEU and reactor technologies thus both represent proliferation risks.

Naval technology exports are of concern as nuclear arms control treaties have very limited ability to control transfers of fresh naval fuel.[31] Russian sales, civilian or military, can thus create new HEU-markets outside international control, and possibly a back-door to clandestine weapons-production.

## Naval Security Upgrades

Russian naval fuel has been particularly exposed to the thefts in the past (see table 2), prompting the Northern Fleet to seek assistance to upgrade the security at its facilities. Now, the U.S. Material Protection, Control and Accounting (MPC&A) program for Russian naval fuel has made good progress in reducing the vulnerability of large amounts of HEU and nuclear weapons to theft or diversion.[32] Most of the Russian fresh naval fuel in the region is consolidated into a central facility.[33] In addition, the U.S. has assisted in developing physical protection upgrades for service ships involved in refueling operations.[34]

However, spent fuel is not covered by the upgrades. Long cooling periods and thus reduced radiation levels may make this material attractive for separation to would-be proliferators due to the residual plutonium and HEU in the fuel.[35] Moreover, the U.S. has just stared assisting the Russians upgrading the 42 naval sites where nuclear weapons are stored. According to the U.S. Department of Energy, these sites contain 260 tons of nuclear material.[36]

## Naval Reactor Technology Exports

Existing infrastructure, technical expertise, and potential markets inside and outside Russia has lead to innovative suggestions for naval reactor technology use.[37] Floating nuclear power plants using naval reactors and HEU fuel has been a long-term goal. Minatom announced March 2001 that it will build a floating nuclear power plant in Severodvinsk.[38] Exports could give a badly needed boost to Russian nuclear industry.[39]

Military nuclear naval cooperation also takes place. In 1988, India leased a Russian Charlie-class nuclear submarine for three years. Late 2000, India again wanted a Russian SSN, and in March 2001, press reports indicate that Russia is ready to sell the Indian navy e.g. a Russian-built nuclear submarine.[40] Such sales, and future civilian exports inevitably will involve transfers of HEU. Russia has supplied fuel outside comprehensive safeguards in the past.[41]

## Russian Naval Nuclear Policies and International Support

Russia has come a long way since the beginning of the 1990s. The country has adhered to the London Dumping Convention and abandoned its nuclear dumping,[42] and has opened up for several bi– and multilateral nuclear safety and security initiatives. Domestically, the control over decommissioned submarines, spent fuel, and radioactive waste has been transferred from the navy to Minatom.[43]

Though not yet publicly available, Minatom has developed a conceptual plan for the management of radioactive wastes and spent fuel up to 2020.[44] The new policy involves interim storage of the spent fuel and is a significant, if temporary departure from a long-term closed cycle approach (reprocessing) to the management of spent fuel.[45]

Funds for submarine dismantlement now create "oases" of revenue within the Russian naval complex.[46] The U.S. aid focuses on strategic threat reduction with assistance for missile elimination, warhead security, strategic ballistic-missile submarine (SSBN) dismantlement, and the mentioned security upgrades at facilities with proliferation attractive fresh nuclear fuel and nuclear weapons.[47]

Neighboring countries, like Norway, give local assistance to stop contamination, and to spent fuel and radioactive waste management. In response to concerns over Russian radioactive waste contamination of Norwegian fisheries in the Barents and Kara Seas and general worries over nuclear safety on the Kola Peninsula, Norway initiated its Plan of Action for nuclear issues in 1994.[48] In addition, several European Union Countries are involved in joint security and safety projects under the Tasic-umbrella.[49]

However, while Russia, on one hand, is taking the problems seriously, and accepts international assistance where available, most of the problems persist. Mutual mistrust, cold war thinking and a relentless bureaucracy have hampered parts of this important cooperation. The most prominent cooperation deficiencies on both sides are summarized below.

## Naval Nuclear Safety and Security Policy Deficiencies

While the project support has been fragmented, with a *lack of coordination* and an overall plan for the assistance on the donor side,[49] the receiver end has not been ready to meet the requirements and expectations following the international nuclear cooperation. To optimize resources allocated (avoid redundancy and duplication of efforts), assure that priority needs are made known to the international community, and to provide points of contact to facilitate cooperation, efforts of coordination on behalf of the donor countries need to be strengthened. An important development is the Contact Expert Group for International Radwaste Projects in the Russian Federation.

The current fragmented international "band–aid" approach is in part due to the *lack of prioritizing* of program areas Russia wants to emphasize, making concerted efforts harder. The overall Minatom-plan under development for waste management is definitively a step in the right direction, once it is made public. The cooperation has been characterized by *lack of facilitation* on the Russian side. This is evidenced by access denial, stringent Russian licensing and certification requirements, liability problems and taxation on the aid provided.

*The lack of supervision* is a serious problem. Limited access hinders assessments studies and progress reporting, and endangers future international funding. The current storage conditions violate both international and Russian nuclear regulations, but no navy facilities are subjected to independent

domestic supervision. In July 1995, President Yeltsin signed an order depriving the Russian Federal Inspectorate for Nuclear and Radiation Safety, known in Russia by the acronym GAN, of control functions at defense ministry facilities. The summer of 2000, Minatom pushed through a government decree eliminating the rights of GAN to license and supervise any military-related facilities.[50]

After almost a decade of assistance the bulk part of the problems remains. Of the 184 decommissioned submarines, the U.S. has allocated funds for the dismantling of 36 SSBNs. However, there is a *lack of funds* for dismantling the remaining ones, including all general-purpose submarines, of which the majority still has fuel onboard.[51] Moreover, plans for building storage facilities for the naval fuel have stranded, without even intermediate solutions for the high level waste. Thus, again, there is a need for international donors to contribute and coordinate efforts.

## Conclusion

Solving the problems associated with Russian naval activities is a sole Russian responsibility. However, the remediation of naval bases and the safe interim storages of spent fuel in Northwest-Russia is in the interest of the international community. The pollution is a cross-border problem and the possible proliferation of navel HEU fuel a global security risks.

With serious nuclear safety and security challenges remaining, the international interest in solving the problems stands at risk of declining due to the lack of progress and persistent cooperation difficulties. Thus, there is a definitive need for Russia to further open up, and to the widest extent possible, facilitate the assistance given. Increased access while respecting Russian security concerns can be accomplished, as evidenced by the unique progress made in the joint U.S.–Russian security upgrades on the sensitive naval fresh fuel.

To renew and expand the interest amongst a widest possible range of future sponsors, the need for a political "resell" of both challenges and opportunities for concerted nuclear safety and security efforts in Northwest-Russia should be anticipated.

## Acknowledgments

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***Table 1 Overview of radioactive contamination in Russia's Northern bases.[53]***

| *Establishment* | *Role* | *Potentially dangerous assets* |
|---|---|---|
| Zapadnaya Litsa/Andreeva Bay | Naval base | 26 operational nuclear submarines<br>2 inactive nuclear submarines, one with spent fuel<br>22,700 spent fuel assemblies<br>2,000 $m^3$ liquid radioactive waste<br>6,000 $m^3$ solid radioactive waste |
| Vidyayevo (Ura Bay and Ara Bay) | Naval bases | 4 operational nuclear submarines<br>14 inactive nuclear submarines with spent fuel<br>Small amounts of solid radioactive waste |
| Gadzhievo (Skalisiti) | Naval base | Unknown number of nuclear submarines<br>200 $m^3$ liquid radioactive waste<br>2037 $m^3$ solid radioactive waste<br>Occasional service ships with radioactive waste and/ or nuclear fuel on board |
| Saida Bay | Storage facility | 12 submarine hulls with reactors |
| Severomorsk | Naval base | 3 decommissioned nuclear powered battle cruisers |
| Gremikha | Naval base | 17 inactive nuclear submarines<br>767 spent fuel assemblies,<br>6 liquid metal cooled reactor cores<br>300 $m^3$ solid radioactive waste<br>1960 $m^3$ liquid radioactive waste |
| Nerpa | Shipyard | 1 submarine being decommissioned<br>Periodic visit of service ships with spent fuel or liquid radioactive waste on board<br>300 $m^3$ solid radioactive waste<br>170 $m^3$ liquid radioactive waste |
| Shkval (Polyarny) | Shipyard | 1 submarine in for maintenance<br>2 service ships with spent nuclear fuels or radioactive waste<br>7 inactive nuclear submarines with fuel<br>Storage facility for solid radioactive waste<br>150 $m^3$ liquid radioactive waste |

| *Establishment* | *Role* | *Potentially dangerous assets* |
|---|---|---|
| Sevmorput | Shipyard | 2 inactive nuclear submarines<br>Occasional service ships with liquid radioactive waste<br>Storage for solid radioactive waste |
| Severodvinsk (Zvezdochka, Sevmash) | Shipyards | 12,539 $m^3$ solid radioactive waste<br>3000 $m^3$ liquid radioactive waste<br>4 nuclear submarines for maintenance<br>Dismantlement<br>12 inactive nuclear submarines<br>4 reactor compartments from submarines<br>already decommissioned |
| Atomflot (Icebreaker fleet) | Harbor | 8 nuclear powered icebreakers<br>Fresh and spent fuel stored afloat<br>Liquid and solid waste stored afloat and on-shore. |
| Russian Navy Nuclear Weapon Sites | 42 sites (in Northwest-Russia | About 260 metric tons of nuclear material<br>Number of nuclear warheads and locations are unknown |
| Kara and Barents Sea | Dumped nuclear waste | 10 reactors with fuel<br>6 reactors with spent fuel<br>17 vessels with solid radioactive waste 6,5 containers<br>with radioactive waste |

***Table 2 Overview of registered thefts of highly enriched uranium from Northwest–Russia.[54]***

| *Location* | *Date* | *Theft* | *Enrichment* | *Perpetrators* | *Notes* |
|---|---|---|---|---|---|
| Andrejeva Bay | July 1993 | Two fuel assemblies (each element weighed 4.5 kg) | 36 percent | Two sailors from the Navy's radiation protection department | Two more officers charged, but the charge was withdrawn on account of insufficient evidence. |
| Sevmorput storage installations, Murmansk | November 1993 | Three fuel elements with 4.3 kg HEU | Approx. 20 percent | Three officers | The material was recovered and the perpetrators sentenced. |
| The shipyard Serverodvinsk | July 1994 | Uranium dioxide 3.5 kilos | 20-40 percent | Four businessmen from the area, in connection with workers on the shipyard | On-going |
| The shipyard Sevmash, Severodvinsk | October 1994 | Fuel elements | Highly enriched | No information | Arrests in Arkhangelsk, no prosecution. |
| The shipyard Zvezdochka, Severodvinsk | July 1994 | Fuel elements | No information | Employees hired on contracts from the Northern Fleet | The accused were seized before the uranium was removed from the shipyard. |
| The shipyard Zvezdochka, Severodvinsk Gremikha | January 1996 | Fuel elements | No information | Employees hired on contracts from the Northern Fleet | Uranium removed from the shipyard.Arrests in Severodvinsk. |

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[2] On the past production and the current problems of the Northern Fleet, see Thomas Nilsen, Igor Kudrik, and Alexandr Nikitin,

"The Russian Northern Fleet", Bellona Report Volume 2:1996.

[3] 92 ballistic missile submarines (SSBNs), 67 cruise missile submarines (SSGNs), 90 attack submarines (SSNs).

[4] Oleg Bukharin and William Potter, "Potatoes were guarded better," *The Bulletin of the Atomic Scientists*, Vol. 51, No. 3, May/June (1995), p. 48.

[5] Oleg Bukharin, "Analysis of the Size and Qualities of Uranium Inventories in Russia". *Science and Global Security*, Vol. 6. (1996), p. 63.

[6] Oleg Bukharin and Joshua Handler, "Russian Nuclear-Powered Submarine Decommissioning", *Science & Global Security*, Vol. 5, No. 2 (1995), p. 246.

[7] 18 SSBNs, 8 SSGNs and 20 SSNs. Richard Sharpe,ed., Jane's Fighting Ships 2000-2001, 103rd edition (Surrey: Jane's Information Group Limited,2000), p. 552.

[8] Agence France Presse, "Russia to Test New Nuclear Submarine, November 15, 2000.

[9] William Arkin and Hans Kristensen, "Dangerous Directions" *The Bulletin of Atomic Scientists*, March/April (1998), p. 29.

[10] For descriptions of the challenges related to the decommissioning of the Russian submarine fleet, see e.g. Oleg Bukharin and Joshua Handler, "Russian Nuclear-Powered Submarine Decommissioning", James C. Moltz, and Tamara Robinson, "Dismantling Russia's Nuclear Subs: New Challenges to Non-proliferation", *Arms Control Today*, June (1999), and James C. Moltz, "Russian Nuclear Submarine Dismantlement and the Naval Fuel Cycle," *The Nonproliferation Review*, Spring (2000), pp. 76-86.

[11] One example is the 32 containers with a total of 200-220 spent fuel assemblies being stored at an open area at Andreeva Bay. Thomas Nilsen, Igor Kudrik, and Alexandr Nikitin, "The Russian Northern Fleet", Bellona Report Volume 2:1996, p. 102.

[12] Of the 110 nuclear powered submarines taken out of service by August 2000, 72 of them still had spent nuclear fuel onboard. Igor Kurik, "Russian Navy contracts civilians to manage spent fuel", August 31, 2000. www.bellona.no/imaker?id=17720&sub=1

[13] Contact Expert Group, "Working Material of the 11th Meeting", volume II, Cherbourg, France, 25-27 October 2000, p. 248.

[14] Thomas Nilsen, "Mayak spent fuel storage moves to Kola", March 20, 2000, www.bellona.no/imaker?id=15894&sub=1

[15] Igor Kudrik, "Russian Navy contracts civilians to manage spent fuel", August 31, 2000, www.bellona.no/imaker?id=17720&sub=1

[16] Contact Expert Group, "Working Material of the 11th Meeting", volume II, Cherbourg, France, 25-27 October 2000, p. 248.

[17] Bellona estimates the price for transportation, storage and reprocessing per trainload to be at least $500,000, and has made several calls for an intermediate storage.

[18] 1 Ci = $3.7 \times 10^{10}$ Bq (or $3.7 \times 10^{10}$ transformations/s).

[19] From the White Book No.3, "Facts and Problems Related to Radioactive Disposals in Seas Adjacent to the Territory of the Russian Federation. Materials for a Report by the Government Commission on Matters Related to Radioactive Waste Disposals at Sea, Moscow, 1993.

[20] Al J. Venter, "Soviet nuclear legacy poses deadly threat", *Jane's Intelligence Review*, October (1999), p. 15.

[21] Per Strand, Alexander I. Nikitin, Bjorn Lind, Brit Salbu and Gordon C. Christensen, "Dumping of Radioactive Waste and Radioactive Contamination in the Kara Sea", Joint Norwegian-Russian expert Group for Investigation of Radioactive Contamination in the Northern Areas, 2nd edition, May, 1997, p. 49.

[22] The Norwegian Radiation Protection Authority, "Norwegian-Russian Monitoring of Kursk" (in Norwegian), December, 2000.

[23] NTB, "Everything ready for Kursk rescue" (in Norwegian), April 11, 2001.

[24] Contact Expert Group, "Working Material of the 11th Meeting", volume II, Cherbourg, France, 25-27 October 2000, p. 250.

[25] Ten workers were killed immediately. The total amount of material released has been estimated as $1.85 \times 10^{17}$ Bq, not including $8.1 \times 10^{16}$ Bq of noble gases. If these figures are correct, the radioactivity released was approximately one seventh of the total released in the Chernobyl accident. From http://ds.dial.pipex.com/cndscot/trisaf/ch4.htm

[26] Morten Bremer Maerli, Sigurd Boerresen, Knut Gussgard, Steinar Hoibraaten, and Matylda M. Sobieska, "Criticality Considerations on Russian Ship Reactors and Spent Nuclear Fuel", Norwegian Radiation Protection Authority, StrålevernRapport 1998:7 (1998).

[27] Fred Weir, "Russia as Nuclear Garbageman?", *The Christian Science Monitor*, February 21, 2001.

[28] Pavel Felgenhauer, "Why Russia Wants Waste", *The Moscow Times*, January 4, 2001,

[29] Vladislav Nikiforov, "Duma postpones fuel import bills reading", March 23, 2001, www.bellona.no/imaker?id=9995&sub=1

[30] Mark Hibbs, "Czech Find May Be Re-Enriched Repu to Naval Fuel or Research Reactors", *Nuclear Fuel*, Vol. 20, No.1, p. 12.

[31] Morten Bremer Maerli, "Deep Seas and Deep-Seated Secrets: Naval Nuclear Fuel Stockpiles and The Need for Transparency", Disarmament Diplomacy, Issue No 49 (2000) www.acronym.org.uk/49fuel.htm

[32] United States General Accounting Office, "Security of Russia's Nuclear Material Improving; Further Enhancements Needed", GAO-01-312, February 2001. See also Oleg Bukharinm Matthew Bunn, Kenneth N. Luongo, Renewing the Partnership: Recommendations for Accelerated Action To Secure Nuclear Material in the Former Soviet Union," Russian American Nuclear Security Advisory Council, August (2000), p. 60.

[33] For the Northern Fleet, the fuel is to be consolidated at Site 49 at Severomorsk. However, fresh fuel remains at at least two additional locations in the Northern region: At the civilian Icebreaker fleet and at the Sevmash submarine production facility in Severovinsk.

[34] Clay J. Moltz and Tamara C. Robinson, "Dismantling Russia's Nuclear Subs."

[35] Knut Gussgard and Ole Reistad, "Russian Spent Marine Fuel as a Global Security Risk", paper presented at the International Conference on Security of Material - Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radioactive Sources, Stockholm, Sweden, 7 - 11 May 2001.

[36] United States General Accounting Office, "Security of Russia's Nuclear Material Improving; p. 32.

[37] Examples, still only on the drawing-board, include e.g. nuclear floating water desalination stations, the use of nuclear submarines for the shipment of commercial cargoes and underwater sea and gas production, and unattended self-regulative nuclear power sources for autonomous sea vehicles, all based on naval reactor technologies.

[38] Associated Press, "Russia Plans Floating Nuclear Power Plant", March 14, 2001

[39] Possible exports, pollution and proliferation concerns are described in Kuznetsov, V.M. et al., "Floating Nuclear Power Plants in Russia: A Threat to the Artic, World Ocean and Non-Proliferation

Treaty," Nuclear and Radiation Safety Program, Socio-Ecological Union, Greenpeace Russia, Center for Russian Environmental Policy

[40] IPR Strategic Business Information Database "Russia ready to sell India nuclear submarine", March 13, 2001

[41] Reuters, "India Defends Importing Nuclear Fuel from Russia", February 20, 2001, and Mark Hibbs, "China, Russia Challenge NPT Review over Full-Scope IAEA Safeguards," *Nuclear Fuel*, Vol. 2, No. 8. April 17 (2000).

[42] The Convention on the Prevention of Marine Pollution By Dumping of Wastes and Other Materials, commonly known as the London Dumping Convention.

[43] Jurisdiction is transferred according to a May 28, 1998 governmental decree.

[44] Contact Expert Group, "Working Material of the 11th Meeting", volume II, Cherbourg, France, 25-27 October 2000, p. 247.

[45] Ibid., p. 247.

[46] James C. Moltz, "Russian Nuclear Submarine Dismantlement and the Naval Fuel Cycle", p.78.

[47] U.S. assistance is provided by the Cooperative Threat Reduction program and the U.S.-Russian cooperation on Nuclear Material Protection, Control and Accounting See Partnership For Nuclear Security - United States/Former Soviet Union Program of Cooperation on Nuclear Material Protection, Control and Accounting (September 1998). <www.nn.doe.gov/mpca/pubs/fr_inmm.htm>. The CTR-program has also approved funding for a small-scale reprocessing program to reduce the backlog material at various shipyards, due to its harmful impact on submarine dismantlement rates. James C. Moltz, "Russian Nuclear Submarine Dismantlement and the Naval Fuel Cycle", p.78.

[48] Through this plan, funding for construction of a spent fuel transport vessel and spent fuel railcars, improvements in liquid radioactive waste storage at Severodvinsk, and construction of a mobile liquid radioactive waste processing facility for the Northern Fleet have been made available. James Clay Moltz and Tamara C. Robinson, "Dismantling Russia's Nuclear Subs", p. 14.

[49] See http://europa.eu.int/comm/external_relations/ceeca/tacis/index.htm

[50] Interview with The Norwegian Deputy Secretary of State, Espen Barth Eide, Aftenposten, January, 24, 2001.

[51] Cristina Chuen and Elena Sokova, "Russia Risks Another Chernobyl", International Herald Tribune, December 22, 2001.

[52] Cristina Chuen & Michael Jasinsk, "Russia's Blue Water Blues," *The Bulletin of the Atomic Scientists*, Vol. 57, No. 1, January/February (2001), p.69.

[53] Based on Al J. Venter, "Soviet nuclear legacy poses deadly threat", *Jane's Intelligence Review*, October 1999, p. 15, and updated and extended with more recent information.

[54] From R. Lee, "Recent Trends in Nuclear Smuggling" in P. Williams, ed., in *Russian Organized Crime: The New Threat* ? (London: Frank Cass, 1996), p.118-119, with minor additions.

# LETTERS

## Sunday Schools versus Science?

In his recent commentary, Karl H. Puechl opines that religious education may be damaging the scientific education of American children. A few points should be made about this.

•It is noteworthy that Mr. Puechl does not even attempt to provide evidence correlating religious education with scientific literacy.

•Historically, modern science originated in a culture which accepted unchanging and objective theological and philosophical truths and which therefore was inclined to seek unchanging and objective truths in the physical world as well. This is scarcely a coincidence.

•It seems likely that parents who are concerned about their children's religious education will also be interested in their academic education. Uninvolved parents surely pose the greatest threat to a child's education.

•Widespread religious education seems not to have hindered previous generations. In fact, American dominance in the sciences came when there was more religious education – even prayer in public schools.

•As a "Sunday School graduate", I can assure Mr. Puechl that the lessons tend to be much more about the Ten Commandments and about the Golden Rule than about any scientific theory. On the other hand, "thou shalt not bear false witness against thy neighbour" is exactly what must be demanded of scientists when they are called in as expert witnesses in criminal trials or congressional hearings. Likewise, the more general principle "thou shalt not lie" is **absolutely necessary** for science; a "no-holds-barred" approach that permits fabricating data is no longer science at all. Finally, the principle of informed consent is nothing more than a specific application of the Golden Rule. Historically, of course, some researchers have felt handicapped by the principle of informed consent. These researchers have brought us such abominable "science" as the Tuskegee Experiment.

•Since Mr. Puechl wants "no-holds-barred questioning students", would he favor the policy of the Tangipahoa Parish Board of Education's policy of requiring teachers to urge students "to exercise critical thinking and gather all information possible and closely examine each alternative toward forming an opinion" regarding "the origin of life and matter"? Somehow, I suspect that he would instead side with the Fifth Circuit Court of Appeals, deciding that in *this* case, it is better for the student to be told *five* days a week that evolution is "an absolute truth that cannot be questioned".

•Finally, although the commentary targets Christian religious education, its content is no less an attack on the religious education of Jews and Muslims.

I doubt that a similar opinion piece making the absurd claim that America's poor performance in science and math is due to a supposedly too-large percentage of racial minorities would be graced by the imprimatur of the Commentary section. However, whereas bigotry against racial minorities is beyond the pale, bigotry against religious believers is clearly accepted by the editors of *Physics and Society*, their disclaimer notwithstanding. After all, *Physics and Society* is not simply a bulletin board or chatroom.

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## Science and Goodness.

I wish to thank Todd Duncan for his insightful and important commentary "The Perceived Conflict between Science and Meaning". His analogy regarding the dehydrated damsel in distress was particularly helpful. Desperate people need to have their desperation, and not just the cause of their desperation, recognized and heard.

It occurred to me while reading Duncan's piece that scientists can do far more than just acknowledge, and/or sympathize with, religious views that owe their urgency to the need for meaning. Scientists can quite rightfully point out that science allows the realization of one of the most important components of Judeo-Christian morality, viz., the performance of deeds of goodness. If providing food to the hungry and care for the sick are deeds of goodness, then science enables such deeds to a far greater extent than any person, church, or nation has ever done. Because of science most, if not all, of the people reading this letter will probably not worry about obtaining food for their family's next meal, nor are they likely to die of sickness prior to the age of 45 years.

It is certainly true that science is a two-edged sword, and some people (religious and otherwise) might point out that science has been used in the creation of destructive, and even genocidal, tools (e.g., Zyklon B,thermonuclear bombs). However, science has much to recommend it in the list of tools that allow for the performance of deeds of goodness. We should all be ready to recite from that very long list.

I'd like to summarize by paraphrasing both Duncan and myself: In dealing with deeply religious people we scientists need to develop far better bedside manners, and we also have to point out the efficacy of science in the performance of that which is perceived to be Divine Will.

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## Depleted Uranium and Leukemia

Bernard Cohen states near the end of his April article (*Physics and Society*) that no excess leukemia has been reported among 78,000 uranium mill workers [as of 1979]. But a review by Archer in 1977 states that mill workers show excess lymphoma (Cancer 39(4)).Also, a study of several thousand US mill workers by Dupree-Ellis, et al, found various excess cancers, as well as chronic nephritis, an expected DU symptom (Am.J. Epidemiology, 2000, 152, 91-95). It seems possible the study cited by Cohen merely reflected good plant management and thus low worker exposure. Uranium miners have reported increased rates of cancer since the 19th century. Modern nonsmoking miners likewise (Gilliland, et al, Health Physics, 2000, 79, 365 - 372;J. Occupational & Environmental Medicine, 2000, 42, 278 - 283). Miner lung cancer has been attributed to radon, a component of natural uranium (See http://ccnr.org/bcma.html#lung; also, Field, et al, Am. J. Epidemiology, 2000, 151,1091 - 1102). Various regulatory limits are at http://www.antenna.nl/wise/uranium/utox.html.

The logical conclusion would seem to be that depleted uranium (DU) dust is less effective in causing leukemia than other cancers. Thus, in my opinion, Cohen's analysis should have passed off leukemia at once and focussed on, say, lung cancer. In the lab, we find that DU and tungsten both are carcinogenic in cultured human osteoblast tissue (Miller, et al, Radiation Research, 2001, 155, 163 - 170;Carcinogenesis, 2001, 22, 115 - 125); that skin contact with soluble DU salt can be acutely fatal (Lopez, et al, Health Physics, 2000, 78, 434 - 437); and, that alpha radiation seems to damage cells neighboring those absorbing the radiation

(Little,2001, http://www.med.harvard.edu/publications/Focus/2001/Feb9_2001/radiobiology.html).

Looking at the physical form of a dose of DU, the expected harm from a macroscopic fragment of alpha-emitter, even one merely held close to the skin, is far greater than that from the same number of U-238 atoms dispersed widely in the body (e. g., Giannardi & Dominici, physics/0103047; Fetter & von Hippel, http://www.princeton.edu/~cees/arms/vonhippe.pdf). DU has been reported to cause cancer when implanted as small fragments in the muscles of living rats (F.Hahn at http:/www.medscape.com/reuters/prof/2001/01/01.25 20010124scie002.html; free registration with MedScape required).

As for Cohen's calculations, he claims that, according to Health Physicists (sic),"inhalation of 1000 mg of any dust causes death by choking." This is absurd. Here is some regular physics: A bottle of instant coffee contains 340 g and about 180 1-teaspoon servings. So, there is about 1000 mg = 1 g in half a teaspoon of powdered instant coffee. Should we trust any calculation starting from a premise off by at least two orders of magnitude?

Cohen says that Health Physics would expect no more than 1 surplus death from leukemia in all the NATO troops sent to the Balkans. However, correcting his calculation by two orders of magnitude would suggest actually 1 such surplus death in each 1000 troops, a level above the casualty rate from direct combat. "Health Physicists have procedures for calculating exposures", Cohen claims, soon endorsing a UNEP assertion that "picked up pieces of DU, carried in pocket for weeks, would cause no skin burns [or] important health problems". He then recites NATO press conference figures showing that no one in service in the Balkans provably has gotten sick from DU. To ensure that the point has been thoroughly missed, Cohen adds that no excess of leukemia has been reported in Russia or the Ukraine as a result of Chernobyl. But, Chernobyl caused clouds of neutron-activated beta and gamma emitters and little or none of the alpha of DU. Why not mention thyroid cancer?

We have, then, a few dozen wounded veterans and 78,000 mill workers free of excess leukemia. My question is, is this enough justification for Cohen to add the P&S voice to the "We Don't Worry About DU" NATO chorus?

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## Depleted Uranium and Leukemia –a Rejoinder to Williams

The very title of my article in the April P&S was Leukemia from military use of DU. It dealt with leukemia only because:

(1) Reports of supposed excess leukemias was the driving issue

(2) Leukemia was the subject of all the media publicity, and of the various international and national investigations

(3) Other types of cancer than leukemia are not expected to develop so soon after exposure in the Balkan wars; they develop only after about 10 years.

If one is concerned about other cancers, the universally accepted scientific approach is to estimate the dose to various body organs, and use the risk vs dose data for those organs. That is the procedure accepted and used by the National

Academy of Sciences BEIR Committees, by the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR), the International Commission on Radiological Protection (ICRP), the U.S. National Council on Radiation Protection (NCRP), and similar groups in every technologically advanced country. All of these groups are composed of very distinguished scientists. This procedure is illustrated for radiation exposure of bone marrow to induce leukemia in my April *Physics and Society* paper, and it is straightforward to extend it to exposure to other organs to induce other types of cancer. The principal difference is in the risk vs dose information; gathering such data is a major endeavor of the BEIR and UNSCEAR Committees. They evaluate thousands of research reports, including those cited by Williams, to reach their conclusions. The rat study referred to by Williams will be considered if and when it is published in a scientific journal (as of now it is a newspaper story), but it will be just one of numerous papers and given less weight than studies on humans.

Given sufficient space here, I would be happy to provide a calculation for lung cancer as Williams suggests. This would have to include models for dispersal developed by ICRP. My quick calculation indicates that the risk would be trivial.

I must confess that I have no experience with deriving dose estimates from implanted fragments of DU (although that was treated by the UNEP and other investigations I cited), but that is a trivial part of the problem. Anyone close enough to an exploding shell to be hit by fragments would have a much greater risk of being killed by other aspects of the explosion. Surely the problems much more worthy of consideration are (1)inhalation of finely dispersed dust which can travel many miles and after settling down can be resuspended by the wind, and (2) ingestion with food or water contaminated with DU thus transported. These are the problems I am experienced in treating and they predict trivial effects from DU used in the Balkan wars.

As for Williams remarks about powdered coffee, my statement about"1000 mg" is derived from medical experience, not from Health Physics.( The "100 mg" is from the United Nations Environmental Program report as was the "20 mg" that I used in the calculation.) Of.course the dust must be fine enough and well enough suspended in air to be inhaled, get past the filtration in the nose and pharynx (from which deposited dust is rapidly cleared) and enter the bronchial region.

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# FORUM AFFAIRS

# Introduction of FPS 2001 Awardees:

## The Joseph Burton Forum Award, the Szilard Lectureship Award, and the FPS Fellowships.

I am Aviva Brecher, outgoing Chair of the FPS, the FPS unit that for 30 years has brought to the fore at annual meetings, and in our Physics and Society newsletter, the major societal impacts of Physics and phyicists. Chairing the annual Forum on Physics and Society Prize session is both a privilege and the reward of the outgoing FPS Chair. After we welcome, introduce and hear from our awardees, I will be giving the Chair's address, a very short goodbye. Before I recognize the awardees, I want to acknowledge extraordinary service from the FPS Fellowship Comm. Chair, Laurie Fathe and from Anthony Nero, the FPS member of the APS awards comm., as well as the Burton and Szilard selection comm. Members, all of whom are former FPS leaders, such as David Hafemeister, Philip Goldstone and Bevery Karplus Hartline. Our warm thanks to you all!

First I call on this year's APS Fellow nominated by FPS, Professor Priscilla Stanton Auchincloss. She is currently Dean at the University of Rochester and Director of its program for Women in Science and Engineering (WISE), and a former Forum officer. Her Fellowship certificate citation reads:

"In recognition of her exemplary record of service to the APS and for her ongoing effective work to improve the climate for women physicists and to ensure gender equity".

Congratulations, Priscilla!

Next I want to introduce the 3 Burton Forum Awardees, George Lewis, David Wright and Lisbeth Gronlund, who are sharing the 2001 prize for their "creative and sustained leadership in building an international arms control physics community and for their own excellence in arms control physics". Their recent work was also prominently featured in the Dec 2000 Physics and Society issue, where they co-authored a well referenced and illustrated article entitled "The Continuing Debate on National Missile Defense"

They will each speak about 15 min as listed in the program, and each will have a 5 min Q&A, reserving general floor discussion to the end. (see full bios on the APS awards website)

1. Prof George Lewis, Assoc Dir of the MIT Securities Studies Program (read bio and talk title "The Patriot Experience in the Gulf War") …

2. Dr. David Wright will speak on " The North Korean Missile program" and

3.Dr. Lisbeth Gronlund whose paper is entitled " What would an adequate NMD test program look like?"

The latter two speakers are senior staff scientists at the Union of Concerned Scientists in Cambridge, MA and also research fellows at the MIT/SSP.

4. The Leo Szilard lectureship award this year recognizes Prof. John Harte of UC Berkeley, where he is distinguished professor of Energy and Resources. His citation is "for his diverse and incisive efforts utilizing physical reasoning and analytical tools for understanding environmental processes and for his teaching and writing to encourage this approach among students and colleagues". His talk is entitled "A look at life from both sides: Newtonian and Darwinian perspectives on global change".

# Forum on Physics and Society (FPS) Outgoing Chair's Report (2000-2001)

*Aviva Brecher*

This has been a very active and eventful year for me and the FPS, a year of change and growth. By way of intro, my recent term as Chair elect and Chair was like coming home,: I first joined the FPS ExCom (and moved up to Program Chair) after my 1983-84 year as an APS Congressional Science Fellow, when I wanted to bring the skills and insights gained on the Hill to serve the FPS activist ideal and agenda… After a hiatus of 15 years, during which I served on various other professional societies committees (like AAAS COSEPP for 6 years, on POPA for a productive term that resulted in an energy paper and statements on EMF and helium) and on some Fellowship selection comm's, I decided to return. Not surprisingly, I found the same old timers, a hardened bunch of idealists and activists still running the FPS because they care!

My chair-line term was compressed from a 3 years gradual crescendo to 2 years and became "a trial by fire" when Priscilla Auchincloss stepped down in mid-term as Chair elect and I had to take over the Program Chair last year and the Chair this year, ably assisted by a dedicated group of idealists who serve on the FPS ExCom (which stands for Executive Committee, not excommunicated physicists!). The ExCom works cooperatively and builds consensus: we communicate and consult via frequent e–mails on policy issues and session topics, speakers, etc quite often, openly, contentiously and productively…(but don't get caught in the crossfire, though ExCom is a democracy!)

Here's a brief report on some of FPS key accomplishments since last April:

1. **FPS website now hosted by the APS server:** We adopted the home page "look and feel" of the APS and transferred our website to the APS host computer, with hard work by Marc Sher, our webmaster and Joan Fincham , APS webmaster. All files, including P&S archives were transferred from Marc Sher's Williams and Mary University host. This gives us **greater visibility**, a **simpler URL** (aps.org/fps) and by mainstreaming we are taking advantage of APS services, more easily hot-linked and integrated with other APS websites. The transformation also **improved FPS transparency:** all our officers, their bios, even some photos, their roles and responsibilities are now posted on the web, along with the Forum history, recruitment posters, a questionnaire for members; our By laws, meeting programs, speakers presentations and P&S issues are all very attractively and clearly organized, presented and accessible.

2. **FPS budget status and Web publication of the Physics and Society (P&S) newsletter:** Because the FPS was in the red last April, we could no longer afford to print and mail 4 issues of P&S to about 4700 members and libraries. Therefore we decided and implemented 2 web-only P&S issues (spring and fall), preserving mailed paper copies for the January Ballot issue (as APS ByLaws requires) and for July. In addition, we introduced more topical variety, publishing 2 Science Fiction in Oct 00 and one this April, (as well as a resource bibliography of teachers of science concepts via SciFi). We publicize each issue with an e-mail listing the TOC, and structured the web posted issues so that either the full issue or only selected entries are easily printable in Adobe. However, we count the number of "hits' and noticed that relatively few readers take the time to access (and presumably print and read) the web issues. Of course, we don't know how many do read the hard copy P&S issues, or just pile them in the corner or carry them around, but we are worried about the small readership. We try to get interesting themes and contributions, so tell us what and why you read or don't read… As a real breakthrough, I tried to convince Martin Blume, the Chief Editor of APS publications on the web, to include all Units newsletters, including P&S, among the posted and linked Society's publications, a further step towards mainstreaming and integration of Forum activities…

3. **Membership and Budget:** The Forum currently has about 4500 members, about 11% of the 41,570 APS membership, which is a lower share than in '97. However, FPS is the second largest Forum of 5 after FIAP (5800 or 12.7%). We have lost members in absolute number (from 4750 in 97 to 4500 in 01) and we must grow, since our funding share is proportional. To increase membership. for the past 2 years I have strategically placed "Join the FPS" leaflets near our sessions and in the registration area, but saw little progress. To attract more student members, the FPS has sponsored this year 2 "Students Lunch with Experts" tables at both the March and the April meeting, to afford interested students personal contact with speakers featured in FPS sessions. While we were in the red last year, under Mike Sobel's able budget management, we are now in the black and have some margin to fund new initiatives like the student lunches and perhaps renew the Forum Technical Studies. However, the margin is slim and precarious and the only viable long- term solution is to increase membership, while controlling expenses.

4. **E-mail Messages to promote FPS Web access:** Of our members, 94% are known to be reachable by e-mail; therefore, I have used APS e-mail member services more frequently and to good effect this year, in order to announce meeting highlights, to call for volunteers to serve as officers, to remind members to vote on time, publicize elections results, etc.

5. **Topical, Timely and Interesting FPS invited sessions:** These remain the key to attracting more members, as well as arousing their interest and participation. The core of our mission is to communicate, educate the community and explore policy and funding issues, as well as timely physics and society issues ranging from arms control (like this session's NMD and national security sessions we sponsored) to environment and energy policy (like Transportation, Energy, Environment, last year and the Climate Change session this year). In the past 2 years we have diversified the range of traditional Forum topics to include also: effective communication with the Congress (co-sponsored with FEd and to be repeated), science and anti-science or voodoo science, physics and the law, a session on hot local Physics topics, like this year's Seattle in Physics

and Physics in Seattle; and a series on Successful Physicists Writers (I organized 2 so far) to encourage physicists to write and communicate both the beauty and excitement of science, as well as remold the public mad scientist image…

6. **FPS Leadership:** The FPS needs broader-based membership involvement and I invite you to get involved. Each year we scout for willing members to serve on a Nominating Committee, which must come up on a very tight timetable with a slate of interested candidates for FPS Executive Committee or Chair-line positions. We also must appoint a Fellowship Committee (headed by the Vice-Chair), a Program Comm. (chaired by the Chair Elect) and an Awards Committee, and the P&S Editorial Board members who rotate off. Finding candidates was usually a small circle of social activists and friends, perhaps a "buddy" system or "old boys network", but in effect there were and are few willing, dedicated enough or with the time to serve on FPS committees.

This year I am proud of the fact that- as an exercise in democracy- I issued an e-mail calling for volunteers interested in serving on FPS Bylaws Committees and got a gratifying response. In addition, from respondents to the FPS questionnaire on the web, designed to gauge the range of members' interests, yielded more names of interested volunteers. This pool of past and future candidates that will make the task of Nom Com and easier and provide us with a core of people interested in making the FPS more representative and serving broader based membership interests.

*Please get involved! Volunteer to serve, or to organize and chair a topical session. Write to the FPS officers whose e-mail is posted on the web and let us know what we are doing well, not so well, or should be doing more of in the future. Please join the Forum and let others know about it at your university, lab or company. We need a more representative set of officers, from government, academia, industries and the Congress. For the first time two currently serving APS Congressional Science fellows were elected and will serve on the ExCom, promising to bring a breath of fresh air to our program offerings and activities. The old guard is changing, retiring, or just served long and hard enough- we thank them and invite the younger generation to take over the helm. Dear FPS colleagues, thank you for the opportunity to serve with you and learn from you, it is time to let the incoming Chair, Philip Bo Hammer take over the helm (it's a hot seat, Bo!)*

# Comments from the New Chair

*Bo Hammer*

The Forum on Physics and Society has begun to redefine itself due to an interesting interplay among the Forum's long-active leadership, its new generation of leaders, its traditional issues, and the myriad forces at play in the physics community. Two of these forces are worth noting: bachelors degree production in the US is below pre-Sputnik levels and there is a new APS Forum on the books – The Forum on Graduate Student Affairs (FGSA). I have been reflecting on these issues, particularly as they relate to the long-term health of physics, as well as to the future of FPS and our ability to continue impacting public policy debates.

The mission of FPS is to explore the intersection of physics and major physics-based societal issues, and to take action where appropriate through symposia, this newsletter, studies, and by educating and encouraging our membership about their role in society. Traditionally, FPS has focussed on arms control and energy because of the ongoing importance of these issues and because these are areas where our membership has had aggregate expertise and interest. These issues remain important and timely, particularly as the Bush administration begins its initiative for a layered national missile defense coupled to strategic arms reductions, and as the administration develops its energy policy. These issues are steeped in physics and FPS is well-positioned to have an impact on the scientific aspects of the policy debate. Yet, as the APS membership ages and as younger physicists seek new outlets for their concerns, FPS must explore whether its traditional agenda resonates with younger physicists. Are there other physics-and-society issues which the FPS should be pursuing so that the Forum remains both populated and relevant? Recognizing that FGSA will be, to a large extent, a pass-through organization, FPS has an opportunity to reach out to early-career physicists by addressing the connections between many of their professional concerns, the evolving role of physics in society, and the overall health of our field.

To understand how FPS can reach out effectively to younger APS members, we should start by recognizing that the basic social unit of the physics community is the physics department, and that in many ways the future of physics depends on actions taken at the departmental level. Furthermore, I suggest that we adhere to and promote the fundamental notion that society benefits from physics and physicists. Therefore, I propose that the Forum on Physics and Society expand its thinking about physics and society to include the following two inter-connected perspectives:

Physics and Society - The External Perspective, or how physics departments prepare physicists to have an impact in society. The education and professionalization of future physicists — *regardless of degree level* — are important to society in both quantitative terms (society needs more physicists) and qualitative terms (society would benefit from improvements in the education and professionalization). Currently, physics education largely ignores the intersection between physics and policy. Physicists generally are not exposed to techniques for applying their quantitative and problem-solving skills to policy issues such as risk, national defense, energy, and transportation. Plus, our educational culture typically does not expose students to important concerns such as professional ethics and integrity, social responsibility, and the role played by taxpayers in our fundamental professional well-being.

If we agree that these issues are critical, then FPS should

encourage appropriate programmatic reforms at the departmental level. But that's not all. FPS should embrace these ideas and encourage graduate students and early-career physicists to take leadership roles in defining the Forum's agenda so that physics education becomes more student-centered and society-focussed. These are the sorts of pan-issue, nuts-and-bolts kinds of physics-and-society ideas that younger physicists might embrace as they prepare to enter the profession and before they have defined which specific issues light their fire.

Physics and Society - The Internal Perspective, or a look at our professional society and physics departments, and their relationship to students. The basic state of, and departmental culture surrounding, graduate student education is obviously a concern to grad students and others. Hence the emergence of FGSA. And FGSA is not simply a result of grad student self-interest. Our whole enterprise will suffer if future generations are disgruntled. Indeed, declining degree production indicates that students are voting with their feet. It would seem that physics ain't where it's at anymore. Why? Where's the disconnect? The physics profession has some very serious problems as indicated by our precipitous loss of market share on campus and our continuing inability to attract under-represented groups in a significant way. Perhaps these demographics reflect a perspective that physics is no longer relevant for meeting the career goals of students; or that physics is not doing enough to address the workforce and technical needs of industry; or that physics is no longer a player on the global policy front.

In understanding and addressing these suppositions and the overall health of our field, we may want to examine them and take action *from the grad students' perspective*. Doing so would extend discussions related to the relevance of physics to a dialogue on the education and treatment of grad students. As above, I suggest that the Forum actively engage these concerns and do so in a grad student-centered way. We should give grad students and early-career physicists the authority to take the lead on defining the issues and setting the agenda, and we should cultivate them as our future leaders. In many ways, the health of physics is as much in the hands of the next generation of physicists as it is in those of department chairs.

APS, physics departments, and FPS should candidly address their connections to undergraduate physics majors, to graduate students, and to early-career physicists, as well as to those who employ physicists or require the benefits of physicists' expertise. If the Forum does so, then our ability to impact positively major societal issues will improve, as will the health of physics overall.

The above perspectives provide an approach that FPS should consider taking. Externally, we should contribute to improvements in the way physicists are trained, so that they can enter the professional world poised to succeed, regardless of career choice; and so that physicists are well-prepared to have a positive impact on whatever societal issues they may choose to tackle. Internally, FPS and the physics community should confront our declining market share and make changes that revitalize the profession and bring students back into the field. Physics departments are the key to reform, but the Forum can play a complementary role by involving graduate students and early-career physicists in setting the FPS agenda, organizing symposia, and by cultivating them as leaders.

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# REVIEWS

## The Unanswered Question

*by Thomas Powers, a review of Michael Frayn's* Copenhagen*; L.A. Times, May 25, 2000.*

Thomas Powers' review of Michael Frayn's *Copenhagen* is a fine overview of what he and Frayn fanticize to have been the mysterious circumstances of the famous meeting, in September 1941, between Niels Bohr and Werner Heisenberg. But there is no mystery regarding the purpose and course of that meeting. The mystery is why Powers and other authors persist in blinding themselves as to the actual purpose and course of that meeting and insisting it is "The Unanswered Question". Contemporary documents and statements of persons closest to Bohr have answered the question, long ago. They make it clear that the Copenhagen visit was an intelligence mission approved and arranged as a "cultural visit" at the highest levels of the Reich.

Powers and the others who have constructed, literally, a Bohr/Heisenberg "industry" give lip service to the intelligence facet, but avoid recognizing it. They owe their livelihood to Robert Jungk's 1956 *Brighter than a Thousand Suns*. He spoke for Heisenberg's close friend Carl von Weizsacker, the progenitor of the Copenhagen myths. In all fairness, Jungk was deceived; eventually, he came to recognize and confess that. In a December 1988 Berlin lecture, after reading more accounts, Jungk did confess his great mistake. Not long after that, he wrote to me that "it is true that Weizsacker *misled* and *used* (Jungk's emphasis) me to propagate his version of the German A-bomb history. But you [in *The Griffin*, Houghton Mifflin, 1986] make it sound as if that lie came from me, whereas I was made to believe in it by somebody I have since learned to see as an unscrupulous opportunist."

There was no moral dimension to the conversation, as Jungk had written. Immediately after the meeting, Bohr told his son Aage. In 1967, Aage wrote that Jungk's account had "no basis in the actual events" (*Niels Bohr*, North Holland Publishing Company, 1967). So, what did transpire? Robert Oppenheimer was the first person Niels and Aage Bohr saw at Los Alamos after their escape from occupied Denmark. In a series of lectures, given in 1963 and 1964, Oppenheimer said, "Heisenberg and Weizsacker came over from Germany… Bohr had the impression that they came less to tell what they knew than to see if Bohr knew what they did not. I believe it was a standoff" (*New York Review of Books*, December 17, 1964).

Clearly the "visit" was an intelligence mission, nothing more or less. But, why at that time? Credit Dr. Paul K. Schmidt, the clever

and ambitious head of the German Foreign Office's Press Branch. He was a favorite of the Foreign Minister, Ernst von Weizsacker, father of Carl von Weizsacker. The Foreign Minister was impressed with the speed Schmidt exhibited in obtaining American newspapers via the Lisbon photographer contracted to microfilm the papers for the American Embassy. In similar manner did the Press Branch reach Schmidt from other countries.

On September 4, 1941, Carl von Weizsacker received, from the enterprising Schmidt, a published report from a Stockholm newspaper to the effect that: "in the United States scientific experiments are being made on a new bomb… The material used in the bomb is Uranium, and if the energy contained in this element were released, explosions of heretofore-undreamed power could be achieved. Thus a five-kilogram bomb could create a crater 1 kilometer deep and 40 kilometers in radius…"

That was an astonishingly accurate statement for that period. It reflected more of the British than the American thinking—and was more accurate than Heisenberg's thoughts, at the time. Carl von Weizsacker immediately forwarded the Schmidt report to the Abwehr, the intelligence arm of the German High Command. The next day, he sent the report to Education Reichsminister Bernhard Rust, who was funding the physicist's research. Already, von Weizsacker had been writing, for Rust, a report on nuclear research in the United States. A fortnight later, Heisenberg had his now-famous chat with Bohr, who refused to meet with Carl von Weizsacker, waiting outside.

In October, Carl von Weizsacker's father was still asking Schmidt for reports on the American uranium program. Ironically, the program did not receive a full go-ahead from President Roosevelt until December 6, 1941—the day before Pearl Harbor.

Six months after the Copenhagen meeting, a young associate of Bohr's, Christian Moeller, visited Lise Meitner in Sweden. She wrote to the Nobel Laureate Max von Laue:

I had Dr. M with me one evening and that was very nice and pleasing. He told me much about Niels and the institute, and most was comforting and satisfactory. Half amusing and half depressing was his report about a visit of Werner and Carl Friederich…. I became very melancholy on hearing this; at one time I had held them to be decent human beings. They have gone astray [Meitner papers; Churchill College].

Had the two spoken of atomic bombs, no physicist would have been surprised. Had they discussed control of the bomb, Meitner would have been pleased. "They have gone astray" because Heisenberg asked his old friend and teacher to betray the Allies who would free his beloved Denmark from the yoke of Heisenberg's masters. Could there have been a more treacherous betrayal? Whether or not Heisenberg talked about atom bombs, whether or not he raised moral issues, the betrayal of a thus-far enduring friendship was paramount. The perceived treachery, more than any other factors, real or imagined, was cause enough for the friendship to "have gone astray".

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## Atomic Fragments: A Daughter's Questions

*By Mary Palevsky University of California Press, Berkeley & Los Angeles, 2000; unpriced; 289 pages*

Every author who writes about the Manhattan Project and the decision to use nuclear weapons against Japan views the events through his own prism, colored by his own experiences and beliefs. Fairness requires me to state up-front that my father was assigned to command a Seabee unit in Operation Olympic (the planned U.S. attack on the Japanese homeland), and because Japan surrendered when it did, he didn't have to go. That, alone, would be enough to make me approve of the bombing of Hiroshima and Nagasaki, but a great deal more reading in the past five years has reinforced that judgement.

The U.S. government has finally declassified the decrypted Japanese communications from the months leading up to August 1945, and those messages show unambiguously that the Japanese military had every intention of prolonging the war and retained the capability to do so, at enormous cost to the Japanese people. Herbert Bix's masterly study of the emperor in his book *Hirohito* shows conclusively that Hirohito was a hands-on commander-in-chief and a leader of the war faction well beyond the date when revisionist historians concluded, without access to internal Japanese documents, that he had urged peace but was frustrated by the militarists.

My prejudices having been noted, I can proceed to Mary Palevsky's memoir of her quest for answers and opinions about her parents' work at Los Alamos. Physicists remember her father, Harry Palevsky, as a top experimentalist at Brookhaven National Laboratory and an early leader in the Pugwash movement; her mother, Elaine Sammel Palevsky, had a bachelor's degree in physics from the University of Chicago. The two met and began dating at the University of Chicago's Metallurgy Lab and married in Santa Fe, New Mexico just nine days after the Trinity nuclear test. We are accustomed to books by and about the men who were the top echelon at Los Alamos; the Palevskys were in the great middle group, working on electronics (he) and optics (she), and for that perspective alone their daughter's book is worth purchasing.

The new Palevsky family made useful contributions to the bomb, but neither was a great supporter of its use in combat after the German surrender. Both Palevskys supported the Franck Report and its suggested option of a demonstration of the bomb on an uninhabited site, an idea ruled out by the government, with Robert Oppenheimer in concurrence, for a myriad of good reasons with which many still disagree—foremost among them Edward Teller.

Mary Palevsky's greatest inheritance from her parents was her quest to bridge the generations from the scientists at Los Alamos to their children, most now far older than their parents were in the crucible that was Los Alamos during World War II. Rather than simply report on her own feelings about the bomb, the peace movement, and the intervening fifty years, Ms. Palevsky sought out the surviving leaders of the Manhattan Project to interview them and record their own views, pro, con, and ambiguous. Her decision to do so has done physics, physicists and history a great service, for we hear, almost unfiltered, the voices of the men whose research shaped the strategic environment of our own day.

Thanks to Mary Palevsky's work we have Edward Teller in his own words discussing a "demonstration" of the atomic bomb over Tokyo Harbor, a blast at 6:00 AM and six miles altitude that would kill nobody and would merely blind those who were looking straight at it. Palevsky also presents Harold Agnew's blunt dismissal of the idea because six miles was at the service ceiling of the B-29, and there would have been no way for the aircraft and crew to escape if the burst were high enough not to affect the ground. Since Teller recommended that the demonstration come without warning, one may also wonder how many influential Japanese would actually have seen it at six in the morning, his favored time because few people would be about.

More important for history are Bethe's remarks. Hiroshima and Nagasaki, Bethe believes, were the right decision in July and August of 1945; a demonstration without casualties would have been ineffective because "I think you had to see the center of Hiroshima leveled—completely destroyed. ...The victims of Hiroshima died so that other people could live," a sentiment with which this reviewer is in full agreement. And lastly, most importantly, that Hiroshima and Nagasaki can never be repeated in a future war because nuclear use will escalate out of control, "the destruction of both countries."

I have walked the dry lakes and the tunnels of the Nevada Test Site periodically since my eighteenth year, seen close hand the buildings and other objects exposed to nuclear blasts, and have been exposed all my life to pictures of nuclear tests and the devastation of Hiroshima and Nagasaki. I think you have to see the destruction first hand.

Palevsky also presents close looks at the goodness and talent of Phillip Morrison and Robert R. Wilson, the self-righteousness of Pugwash founder Joseph Rotblat, and the brilliant analysis of scientist-diplomat Herbert F. York. It is good to have these informal, oral commentaries, even edited for publication, for they illuminate the work and views of Palevsky's subjects who helped shape the world of 2001. None of these men is young; Bob Wilson died shortly after Palevsky spoke with him. Palevsky should make her recordings available to an oral history project such as those of the AIP.

Mary Palevsky poses elegantly her own question, one undoubtedly shared by many of those who form the nucleus of today's anti-science and anti-technology movements: "Why was it, I wondered, that I had this almost blind reaction against scientists working in defense? I thought of York and his scientific colleagues who, in addition to doing their research, have dedicated their lives to using their technical expertise for what they deeply believe is the good of the nation."

Palevsky's *Fragments* is a useful and important contribution to understanding the origin and the central problems of the nuclear age. I recommend it despite some serious flaws: digressions into personal experiences of little relevance, an annoying tendency to fragment her narrative with interspersed short pieces, and most infuriating, a failure to answer her own poignant question.

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## Sleeping with Extra-Terrestrials: The Rise of Irrationalism and Perils of Piety

*By Wendy Kaminer. Pantheon, New York, 278 pages, $24.*

I offered to review this book, because its title gave me the impression it would describe *and explain* the hold of pseudoscience on the American public. This hold seems irrational since that public has had more formal education in science than any other public, past or present. I also hoped for clues to the cure of this malevolent epidemic of irrationality. Or is it an epidemic? I sought information as to whether it really has been growing, as would be expected of an epidemic, and as many of my colleagues believe. I found a quite complete description of the current state of irrationalism in public and private life, in church, state, the health professions, and the web. But I found no remedies, little comparison with past or other present societies, and no "whys."

Perhaps this concentration on the "what" — the phenomena — while ignoring the "why" is a necessary first step. This is much in the spirit of Galileo's admonition to concentrate on getting the "what" right before attempting the "why," which was the beginning of modern science. But I suspect that many of the readers of P&S are already familiar with the phenomena, because of the concern shown by joining the Forum. They, like myself, are really seeking the explanations.

Most scientists who have been in the public arena, and had experiences similiar to mine when I shared a platform with a woman who had been abducted by extra-terrestrials and taken for a UFO joyride, will find most of this book sadly familiar. The anecdotes — and that's all there are here — are well written and presented with overwhelming detail. Rationalists will accept all that is said here; anti-rationalists will dismiss it. Neither will understand the lengthy set of irrational phenomena. The latter have no need, even a repugnance, for "understanding" of the type advocated by the former. Rationalist readers will be convinced, if they aren't already; anti-rationalist readers will maintain their convictions.

Chapter 1 is one long complaint (justified, I think) about the unfairness of the treatment of atheists by government and society. Kaminer is so into personal responsibility that she refuses to consider any reasons (hence understanding), environmental or genetic, for the failure of responsibility. In chapter 2, the rise of the "Christian right", against liberal Christianity and secular humanism is described. She points out that the teaching of creationism, *in the public schools*, is wrong, not because it is bad science but because it is sectarian religion (p.76). Chapter 3 discusses the opposition between "Christian Right" exclusivity and the inclusivity of "New Age sects while Chapter 4 is devoted to the worship of charismatics, and the alliances between "pop-culture" and religion and between feminism and "New Age". She is very explicit about the role of gurus and their misuse of science in, e.g., the "war on drugs."

The author does raise an important point, in passing, not previously obvious to me: the cross-over from "New Age" thought to membership in the militias, the relation between all-loving cults and weapons based, all-encompassing suspicion and hatred (p.128). She also makes some very good points about the difference between legal and scientific goals (p.187) and gives a very nice definition of "rationalism" (p.190).

Kaminer condemns the irrationalist for argument by exclamation and repetition, but then engages in it herself: "...you cannot love someone you've never met....you cannot love some one with whom you have no actual relationship..." (p.132) She never defines "junk science", though she has a whole chapter (5) with that title. As she eventually admits (p.187). junk science seems to be that which results in displeasing her biases (which I share!). Scientists will accept her demand for reasoned dismissal of irrationalism; it is doubtful that non-scientists will. Chapter 7, "Cyberspacy", posits that hypertext destroys logic and that cyberspace replaces God.

There is a great deal of repetition between chapters. I assume they were originally written independently for different journals and it shows. Still, each chapter is separately fairly worthy in both content and writing. Giving up on the search for understanding junk science and its prevalence, there is a lot of good stuff here. One example is the defense of free speech versus "political correctness" in "The Therapeutic Assault on Reason and Rights" (Chapter 6). Another example is the tension between freedom and safety, based upon the writings of John Dewey and H.L. Mencken, in "The Strenuous Life" (Chapter 8, the last chapter ).

This book is less a study of irrationalism than an extended vindication of (the author's own) atheism and a harsh critique of religion and cult. She writes a great deal about the virtues of rationalism , but doesn't display its power to, for example, deal protectively with our environment, internal and external. She doesn't analyze rationality, what it does, or what it requires. I'll keep looking for a study of "pseudoscience".

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