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NUCLEAR POWER BACKGROUND

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AMERICAN PHYSICAL SOCIETY REPORTS ON LIGHT-WATER REACTOR SAFETY

On April 28, an American Physical Society Committee released a year long study on the safety of American light-water reactors. Noting the "excellent" record for safety of these reactors so far (no major release of radioactivity), it failed to uncover any reasons for "substantial short-range concern regarding the risk of accident". It did, however, urge a continuing major effort to improve the safety of light-water reactors and to mitigate the consequences of possible accidents. And it was confident that a better assessment of the issues would then become possible with consequent improvement in safety over the next decade.

The Committee did not examine all of the many possible accident possibilities but did study in detail the possible failure of the primary reactor pressure vessel. It concluded that such catastrophic rupture was not likely to be "an important contributor to accident initiation". This can, however, be read to mean only that other likely accident scenarios are more likely—which was argued also in the Rasmussen report sponsored by AEC.

With regard to that giant study, the APS committee noted that it had not been able to carry out an independent evaluation of the AEC study (draft WASH-1400) but that it did "not now have confidence in the presently calculated absolute values of the probabilities" of the various accident sequences. It criticized the licensing process for focusing on highly stylized accidents in too great detail while other possibilities were insufficiently examined.

Lack of Quantification of Risk

The study noted the lack of well-quantified understanding of engineering safety systems precisely because there was only limited operating experience with them. For example, it worried about whether the reactor could be shut down in case something went wrong simultaneously with a massive electrical failure that would prevent a shutdown (SCRAM) of the reactor. Would the emergency on-site diesel power sources work?

Special attention was provided to the emergency core cooling system (ECCS) designed to provide emergency cooling in case of a loss of fluid. The Committee concluded: "We have no reason to doubt that the ECCS will function as designed under most circumstances requiring its use." But it deplored the present understanding of the situation. However, it noted that inadequacies in the data base and calculational codes made a more precise quantitative statement impossible. It would take several years of effort to achieve consensus in the technical community on such statements and the Committee believed that improvements in the safety program would be required.

In particular, the Committee considered it of great importance to determine whether Draft WASH-1400 was correct in predicting a rapid decrease in probability of accident with increasing accident severity. If this were correct, as it is with airplane failures, then experience could be depended upon to be a practical method of learning about reactor safety—followed by improvements.

It was noted that under present philosophy that emphasizes protection against worst plausible cases, manufacturers had no incentive to build in further protection and, indeed, worked in apprehension that their improvements in safety technique (which can always themselves fail) might simply be added to the worst plausible case as a possible plausible failure against which further efforts of protection would have to be made.

Concern Over Transients Remains

Departures from normal operating procedure—called transients—remain a serious concern; evidently study of the many different possibilities is not yet satisfactory. In addition, the Committee found "no objective and quantitative measurements" of the present system of quality assurances effectiveness. It encouraged and outlined a suitable program.

The Committee noted that 15% of abnormal occurrences resulted from operator errors. It felt that the control rooms were insufficiently well designed and could be improved as had been air traffic control rooms, etc. It also called for more automation and more use of simulators.

The Committee called for means to assure that the reactors were shut down before unauthorized persons could gain control of any area near any item of vital equipment. It felt that the consequences of sabotage would not exceed the consequences of the worst type of accident caused by equipment failure. And it felt that significant countermeasures to sabotage could be implemented at reasonable cost and without interfering with normal operations.

Although the Committee does not mention it, the AEC was extremely slow in carrying out experimental tests of the Emergency Core Cooling System and, indeed, never completed such a test. As this report notes, AEC relied, as ERDA is relying, upon computer models to simulate what would happen. Conservative assumptions are made in these models but whether the entire model is a fair (and conservative) replica of reality is unclear. The Committee reports:

> In any case, it is important to recognize that no computer code now exists which will adequately describe

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> the detailed flow field in a reactor in abnormal circumstances. The description, if it is to come in the foreseeable future, must be derived from a sensitive and interactive parallel development of code and experiment, the latter providing the framework in which one can resolve the hydrodynamic problems into components that are tractable. *Such success is not to be expected in the very near future, but is not out of the question.* (italics added).

Later it notes:

> . . . many (if not most) of the scientists and engineers involved with reactor design feel that the requirements of the ECCS Acceptance Criteria are excessively conservative and would be relaxed if better quantitative data were available. Nevertheless, the lack of a quantifiable basis for estimates of the ECCS safety margin appears to be the cause of much of the debate over reactor safety. In our opinion, there is a substantial need for quantification of ECCS adequacy.

and:

> Despite qualitative indications of general conservatism within the ECCS Acceptance Criteria, we feel that the experimental data are not adequate to demonstrate convincingly that the integrated ECC systems effects are conservatively prescribed, even if all of the individual pieces were demonstrated to be independently conservative (which they have not been).

Among other methods of containing an accident, the Committee encouraged underground siting and "Core Catchers" which would prevent the molten core from melting through the base of the containment.

Calculations Hard to Interpret

In computing the consequences of an accident, the Committee used the standard assumption that deaths due to cancer were related linearly to the exposure. It considered an accident to which the WASH-1400 report assigned a probability of once in every 500,000 years per reactor or once in every 500 years if and when 1,000 reactors are functioning. For such an unusual accident, deaths due to cancer induced by the exposure would cause such individual a one-chance-in-a-thousand of dying of cancer. This would be a very small addition to the one chance in five that he already has; indeed, studies after the fact might never be able to prove that the accident had actually caused any additional cancer, so small would be the perturbation and so shaky is the entire theoretical model. The Committee notes that if an individual values his life at $1 million then, in the very unlikely event of such an accident, he would be effectively taxed at about $50 a year.

In general, the Committee added substantially to the estimates of consequences derived in WASH-1400 but, nevertheless, did not produce large human costs in terms of the very large exposed population. For example, it suggested 3,000 to 20,000 genetic defects instead of 310 such defects. But in a population of 10,000,000, even the upper bound of 20,000 is one in five hundred and it would occur over a period of decades. One of the largest contributors to impaired health and mortality would be thyroid damage which could range from 20,000 to 300,000. But this particular problem seems to have a partial solution in that, for $1,000,000, it would be possible to stockpile enough potassium-iodine pills around the country to provide a "blocking" dose that reduces damage by a factor of 10.

It was recommended that more attention be given to siting policy, decontamination and evacuation. A comprehensive strategy involving these factors "may make it possible to reduce considerably the health and economic consequences of a major release of radioactivity."□

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AN ECOLOGIST'S PERSPECTIVE ON NUCLEAR POWER

Paul R. Ehrlich, Stanford University

The January FAS Report described the nuclear power debate in terms of three schools and called upon members for comment and further discussion in the March issue. Professor Ehrlich was out of the country at the time and, upon his return, requested an opportunity to present a fourth and more fundamental point of view which we present exactly as he provided it to us. No one has better credentials to provide the ecological point of view.

For this point of view—as we did indicate in January—the problem is "cheap and abundant" energy. It would evidently oppose also "cheap and abundant" solar power or "cheap and abundant" fusion power. Would this condemn the third world to levels of energy use per capita that would not support decent lives? If so, is it possible that mankind is so incapable of controlling the use of cheap energy or its noxious byproducts that billions of people must be kept in a state so unsatisfactory? Or can they be helped in some other way?

Is Professor Ehrlich right in arguing that cheap energy may destroy ecological systems "essential to the persistence of civilization"? We encourage readers to comment on this article and will try to summarize the response subsequently.

Readers who have not seen the January and March Reports to which this is an addition may receive them by sending $1 to FAS.

The January and March issues of FAS Public Interest Report contained an attempt at an even-handed evaluation of whether America's growing energy needs would best be met by the use of nuclear power reactors. The argument was presented as being primarily between individuals who see nuclear power as the only rational way to meet those needs and others who feel that the dangers of massive deployment of this relatively untried technology far outweigh its possible benefits. A third "fence-straddling" view was also presented—those who favor a partial deployment of nuclear power in order to see whether, in a large scale test, it would kill fewer people than fossil-fuel power technology.

I and some of my colleagues hold a fourth, more radical view. We contend that the position of the nuclear promoters is preposterous beyond the wildest imaginings of most nuclear opponents, primarily because one of the main purported "benefits" of nuclear power, the availability of cheap and abundant energy, is, in fact, a *cost*.

How can this be? Hasn't the AEC proclaimed that America will need 200×10^{15} BTU annually around the year 2000? Don't the projections show a quintupling of installed electrical generating capacity between 1972 and the turn of the century? Surely "cheap, abundant energy" is required to fill this need. The kicker, of course, is that this "need" has been generated primarily in the fevered minds of growthmanic economists and profit-hungry businessmen.

First I will examine the "need" for greatly increased energy supplies for the U.S. and then take a look at the probable costs of filling that need with *any* technology for mobilizing energy. *These costs, in my opinion, may run as high as the destruction of the ecological systems that are essential to the persistence of civilization.*

How badly does the United States need more energy per capita? According to the United Nations' *1973 Statistical Yearbook*, the 1972 per-capita energy consumption in the U.S. was 11,611 kilograms of coal equivalent. How does that compare with other major industrial nations? Sweden's per-capita energy use is 49% of that of the United States, West Germany's 46%, the United Kingdom's 46% and Japan's 28%. What about nations that in the eyes of the world are thought to have a high quality of life? Beautiful, peaceful, democratic Denmark uses 48% as much energy per-capita as we do, wine-soaked France (complete with its Force de Frappe) 36%, the notoriously well-off Swiss 31%, and New Zealand—which many people consider to have the highest quality of life on the planet—uses only 25% as much energy per-capita as the United States. Western Europe as a whole uses 34% as much, the world 17% as much.

The case of Sweden is especially instructive. By the measure much beloved of the growthmaniacs, per-capita GNP, this heavily industrialized nation in a cold climate has a standard of living slightly better than the United States. Yet it achieves this superiority while consuming about half as much energy per capita as we do! Sweden, by the way, recently postponed building 11 out of 13 planned nuclear power plants.

Sweden Lives Better on Less

Countries like Sweden are simply cleverer than the United States in extracting more benefit from less energy. Much of the "waste" heat from power plants in Sweden is used to heat buildings, for instance. Homes and buildings are well-insulated, automobiles small, and mass transit systems efficient. In Sweden people count for more than Cadillacs. The consumer dollar is distributed differently, a higher fraction being spent on schools, child care and hospitals as opposed to more energy-intensive activities and products.

A famous physicist and enthusiastic proponent of nuclear power recently stated that the rate of energy consumption was, in essence, a perfect measure of the quality of life. The figures given above show how ridiculous this notion is—unless the essence of a high quality of life is defined as living in a "plastic," internationally aggressive, inequitable, stressful, crime-ridden society dominated by technologists and governed by the incompetent, the corrupt, and the congenitally wealthy. Who could be so naive as to think that the average American is twice as well off as the average Swede (especially when one considers the 10 percent or so of the American population which is poverty-stricken, a group for which there is essentially no equivalent in Sweden)? Who could believe an average American was four times as well off as the average New Zealander or *fourteen* times as well off as the average French Polynesian? Anyone who has visited Tahiti could easily construct an argument to the effect that the people there had a *higher* quality of life when their per-capita energy consumption was even lower than it is today. One would merely have to weigh length of life and possession

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of material goods less heavily and such things as freedom from perceived wants, availability of leisure time, a low rate of violent crime, and a feeling of cultural belonging (absence of "identity crises") more heavily.

It would appear, therefore, that one can build an argument that per-capita energy consumption is *negatively* correlated with the quality of life at least as easily as one can build an argument for an almost perfect positive correlation. The argument depends on values, a subject alien to science except to the extent that the galloping technology based on science creates its own values. Consider the values being generated by the nuclear power industry. According to one nuclear proponent, physicist Alvin Weinberg, mankind should make a "Faustian bargain"—that is, consider creating a garrison world and selling its collective soul to the nuclear technologists—in order to enjoy the benefits of atomic power.

A lethal blow to the notion that vastly greater amounts of energy are required to maintain American prosperity has been dealt by the Ford Foundation's massive, detailed study of our energy options. They showed in their "zero energy growth" scenario—in which growth of energy consumption ceases in the year 2000—that the GNP then would be only 4 percent lower than it would be under a continuing high growth rate ("historic growth") scenario. Man-hours worked, however, would be 3 percent higher, giving some hope for reduced problems of unemployment. The Ford Study showed further that nuclear power could easily be dispensed with under this scenario. Indeed, determining that the problems of our society do not stem from a lack of available energy and that nuclear power is not required in the middle term to provide us with a more than adequate supply of power requires only a few simple calculations on energy wastage in the United States. About one-third of our present use per-capita could be saved with no significant effect on life-style; at least 50 percent could be saved by making changes that many people would consider improvements.

Improving Energy Efficiency and Reducing Impact

In addition, it is clear that if only a small fraction of the money programmed for nuclear research, development, deployment, and maintenance were put into improving the efficiency and reducing the environmental impact of the other energy technologies, their costs to society could be greatly reduced. So, not only is use of energy not a good measure of quality of life, but nuclear energy is *not* required in order to supply the energy needs of the United States in the foreseeable future—certainly not before we have done adequate research to determine whether a safe, dependable fission technology can be developed.

For the sake of argument, however, let's give the devils their way and consider what would happen if we made Weinberg's Faustian bargain. Suppose that the United States and then the world were carpeted with nuclear power plants, that they worked very economically, and all direct nuclear hazards had been reduced to the vanishing point. Assume further that the portable fuels problem were solved with a minimum of dislocation. Now mankind has available the abundant, cheap, clean power that the nuclear establishment envisions, and that power is being consumed. What happens then? Possibly the end of civilization as we know it.

To understand why, it is necessary to understand that humanity is still utterly dependent for its existence upon the functioning of immense and complex ecological systems. The conditions that make Earth hospitable to human life result from complex and perhaps fragile balances among the great chemical cycles—water, nitrogen, carbon, oxygen, phosphorus, sulfur—all powered by the energy of the sun. Deadly ultra-violet is filtered out of the sun's radiation by a minute trace of ozone in the atmosphere, and traces of carbon dioxide and water vapor keep the surface temperature of the planet within limits tolerated by present-day organisms. Some of those organisms, in turn, regulate the environmental concentrations of nitrites, ammonia, and hydrogen sulfide, all poisonous to most forms of life. Over the long term, organisms also control the atmospheric concentrations of oxygen and nitrogen.

Today the human population depends on such free "service" functions of ecosystems for the preservation of the atmosphere, for the bulk of its waste disposal, for most of the nutrient cycling that is essential to the production of all its food, and for the maintenance of a library of genetic information from which new crops, domestic animals, biological pest controls and antibiotics will come. Furthermore, almost all potential pests of our crops are controlled by nature, not by man, and almost all fish and shellfish—the source of perhaps 10 to 20 percent of the animal protein consumed by mankind—are produced by natural ecosystems. Natural vegetation reduces floods, helps prevent erosion, moderates local weather conditions, and affects the albedo (and thus the global weather balance). Soil itself is a product of the interaction of an enormous variety of organisms with inorganic particles which they help to fragment from rocks.

Complexity Being Lost

As incomplete as our knowledge may be concerning the vital operation of the natural systems that support human life, one cardinal principle seems clear: the ability of present-day systems to persist and perform their functions in the face of inevitable environmental change is related to the complexity of these systems. The more species of plants, animals, and microorganisms that have coevolved to share the energy flowing through an ecosystem, the more stable the system is likely to be—in other words, the less likely it is that small changes in conditions will cause major disruptions.

Mankind has been a relentless enemy of coevolved complexity in ecological systems—and hence a destabilizing force—at least since the agricultural revolution (the hunting activities of human beings may have been a factor in the extinction of many large mammals even earlier). Agriculture itself is the practice of replacing coevolved natural ecosystems with simple artificial ones based on a few strains of highly productive crops. These croplands ordinarily require constant vigilance and inputs of energy (in the form of cultivation, fertilizers, pesticides, and so forth) to stave off the collapse to which their biological simplicity makes them susceptible. Even with prodigious effort, however, it is unlikely that mankind could maintain this perilous enterprise for long without support from natural systems.

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Earth is now littered with the remains of other civilizations that failed to come to grips with the ecological constraints imposed upon society. The hydraulic civilization of the Tigris and Euphrates valleys, the classic Mayans, the ancient Khmers, and the Roman Empire are only a few examples. While history books sometimes tend to credit these collapses to mystical life-styles within the civilizations themselves, the record of silted irrigation canals, salted and laterized soils, deforestation, erosion, and the like is clear for those who know how to read it. Fortunately, the civilizations that fell victim to earlier ecocatastrophes were relatively localized. Today so-called "Western" civilization embraces the entire planet.

Many ecologists believe that an essential accompaniment to the intensively exploitive activities of mankind on land and increasingly in the oceans must be preservation of extensive, lightly exploited natural communities to serve as ecological buffers and reservoirs of diversity. Failure to establish such preserves and to protect our agricultural resources as carefully as possible could spell the end of our civilization as surely as a full-scale nuclear war, though perhaps less quickly.

Energy Use Measures the Threat

It turns out that today one of the best measures of the assault humanity is mounting against the all-important natural systems that support it is the level of society's energy consumption. The simplifying processes of agriculture are increasingly powered by inanimate energy, and so is the destruction of farmlands through paving and "development." The processes that lead to the release of hundreds of thousands of new synthetic compounds into the environment are energy-intensive—and these compounds often have profound effects on the living organisms of Earth, which have no prior evolutionary experience with them. One can also regard per-capita energy consumption as an index of the physical activity of a society—its moving of materials and people, its transforming of materials, its changing of temperatures, etc. In virtually all circumstances, these activities exact a cost from natural environmental systems.

In MIT's prestigious *Study of Critical Environmental Problems (SCEP),* a majority of the global problems considered were directly involved with energy use. The most fundamentally intractable problem, that of thermal polution, is shared by both nuclear and fossil-fueled power technologies (at present nuclear is somewhat worse in this regard). If the "historic growth" scenario of the Ford Foundation's Energy Report (3.4% energy growth per annum, the 1950-1970 U.S. average) is applied to the world, extremely serious ecosystematic effects from global weather modification could be expected to occur in about a century. According to some experts, they could begin to be felt in much less time than that.

With a shift to cheap, abundant nuclear power, some of the environmental problems considered in *SCEP* would be abated. Carbon dioxide concentrations in the atmosphere would drop, as would particulates from direct energy use, and the problems of oil pollution would be reduced. Under any reasonable scenario about the uses to which superabundant energy would be put, however, one would expect other problems (most considered in *SCEP*), to be exacerbated: atmospheric particulates from farming marginal land, particulates from mining lower-grade ores (including perhaps common rock), particulates from off-road vehicles, formation of contrails, injection of synthetic organic poisons into the biosphere, destruction of estuaries, and so on. (I don't mention *SCEP*'s concern about nuclear wastes here, since, for the sake of argument, we're postulating a miraculous "fix" of the environmental hazards of nuclear power.) In fact, giving society cheap, abundant energy at this point would be the moral equivalent of giving an idiot child a machine gun. With cheap, abundant energy, the attempt clearly would be made to pave, develop, industrialize, and exploit every last bit of the planet—a trend that would inevitably lead to a collapse of the life-support systems upon which civilization depends.

Such a collapse could take many forms. One might be the complete loss of oceanic fisheries through overfishing, marine pollution, and the destruction of estuaries. This in turn could lead to global famine as a key source of protein was removed from a world already on a nutritional knife-edge. On the other hand, the end of civilization might be triggered by weather changes induced by worldwide attempts at "development"—weather changes to which agricultural systems could no longer respond because the decay of genetic variability of crops (one of today's most serious environmental problems) had proceeded too far. Or the end might be heralded by the rapid destruction of the ozone layer, posing a direct lethal threat to *Homo sapiens as* well as to all the ecosystems of the planet. Or, as has often been predicted, the accumulation of poisonous wastes might simply swamp the natural disposal systems, making air unbreatheable and water unpotable.

Pied Pipers of Technology

Most likely, of course, is a combination of such events as mankind, largely ignorant of both the functioning of ecological systems and the nature of human attacks upon them, follows the pied pipers of technology to destruction. Those who believe that science will pull a technological rabbit out of the hat to save us at the last minute simply suffer from an inability to learn. Technological rabbits tend to create more problems than they solve—they usually have large appetites and abundant noxious droppings. The "green revolution," broadcast use of antibiotics and chlorinated hydrocarbon pesticides, dependence on the automobile for personal transportation, and nuclear power are prime examples.

The further deployment of today's incompetent fission technology is thus reminiscent of other culs-de-sac into which we have enthusiastically plunged, led by tunnel-visioned technologists. If our society is to persist, it must learn to evaluate thoroughly the risks and benefits of such adventures *before* embarking on them. To the extent that the debate over nuclear power is part of that learning process (and assuming that the ultimate decision will be to build no more nuclear plants and to decommission those plants not in service as rapidly as practicable), mankind will have benefitted.

The probabilities for a favorable outcome have recently been increased by the release of the report of the Ameri-

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can Physical Society's study group on light water reactor safety. Careful analysis of this report shows that the AEC's latest reactor safety study (the Rasmussen Report) had underestimated the consequences of a major reactor accident by a large factor. The APS report also calls into serious question the AEC's analysis of the probability of such an accident. It would be poetic justice if we were saved from the consequences of having cheap, abundant power, not by a general understanding of its manifold dangers, but by the continued fumbling and bumbling of the nuclear power establishment!

For some scientists, like myself, something more than survival is involved in the nuclear power controversy. It affects our view of science itself. At the moment I cannot say whether I think science will prove in the long run to be a net benefit for mankind. It has freed a minority of human beings from want, and it does have the potential, given an appropriate global population size and social milieu, of greatly improving the lives of all human beings. But the cultural and ecological costs imposed on humanity by science and technology have thus far been enormous and, like the benefits, unevenly shared. And the potential for disaster generated by science seems today to outweigh considerably the potential for good.

There are many desperately important tasks for scientists and technologists to undertake now—tasks such as developing high-yield, labor-intensive, ecologically sound agricultural technologies for poor nations. In our own country, we must find ways to convert from the automobile as the prime device for personal transportation and to employ the skills of auto workers to build badly needed mass transit and mass housing. In a million situations the scientific community must devise techniques that extract more good for mankind from natural systems at less cost in energy, materials, and ecological destruction. Such enterprises are not as glamorous as technological circuses like the nuclear power boondoggle, but they do carry the potential not just for societal survival but, eventually, for providing a decent quality of life for all.

It is clear to me that a rational set of priorities is unlikely to be generated within the scientific-technological community itself, or in a government whose main scientific advice comes from the leaders of bureaucratized "big" science—many of whose first contacts with government were in connection with weapons programs. We have tried the experiment of "follow-those-leaders" and the results are about to engulf us. What remains to be seen is whether mankind will exercise any control over the gallop of technology or whether it is too bedazzled by its new religion to take effective action. If our society is unable to control science to the extent of at least rejecting the false salvation of fission power and then insisting on progress towards nuclear disarmament, I for one will find it hard to take pride in being part of the scientific enterprise.□

ERRATA

It was earlier reported that Victor Weisskopf was a signator of the Bethe petition in favor of nuclear fission reactors; this was incorrect. FAS regrets the error.

UDALL HEARINGS EXPLORE NUCLEAR POWER

On April 28–May 2, The Subcommittee on Energy and the Environment of Congressman Morris Udall held extensive hearings on issues relating to nuclear power. Virtually all of the witnesses' testimony is summarized here. One exception is the lead-off witness, William Anders, who provided a very long and quite empty summary of the Nuclear Regulatory Agency's duties. The Udall subcommittee plans further hearings on breeders on June 2, 5, and 6.

Testimony of Ralph Nader

Nader began by charging that the NRC had only adopted the rhetoric of reform concerning the old AEC habits of suppression of information and criticism. He reviewed earlier AEC internal discussions in which it was realized that a reactor accident might kill 45,000 people with a probability that was felt to be very unlikely—but which could not be proved to be so—and uncertainty reigned over how to handle the public relations aspects of this. A pattern of such AEC activity was described.

He criticized the Rasmussen report (WASH-1400) noting among other things that it concluded that people living near reactors had a much greater chance of being struck by a meteor than of being killed by a major reactor accident. The study was termed "deeply flawed" and too controversial to be used as a basis for building hundreds of nuclear power plants. In addition, it only presumed to cover the reactors themselves, and not the transportation of radioactive materials, disposal of wastes, risks of sabotage, theft or terrorism, fuel reprocessing plants or the uranium mining processes.

He noted the controversy over the method used to develop the probabilities (fault free analysis), and its reliance on evacuation. Observing that the report gives a one in ten thousand probability per reactor year for a "very serious core meltdown", he suggested that one would occur every other decade if the 1000 reactors were built as planned and that persons living in their vicinity, at best, would have to run for safety. Furthermore, he charged that its underestimates of casualties, as shown by independent studies, vitiate the fundamental conclusions about reactor safety.

Nader considered the experience with leaking tanks at Hanford as indicative of the problems that might arise with commercial radioactive wastes for which no permanent solution for their storage had yet been found. Except in utmost desperation, society should avoid embracing plutonium as a fuel in light of its toxity.

The decision to use plutonium ought not be a bureaucratic one but a social and elective one. Alternatives to nuclear power included geothermal energy if the "hot dry rocks" resources proves to be practical and solar energy which could be producing 35% of the nation's building, heating and cooling load.

Congress should do these four things: halt issuance of new construction licenses for nuclear power plants (H.R. 4971); decide itself whether plutonium should be recycled in nuclear reactors; stop funding the breeder reactor; and repeal the Price-Anderson Act.

Gravel Reports on Nuclear Legislation

Senator Gravel noted that 500,000 Californians had signed the nuclear Safeguards Initiative which will put it on the ballot; it calls for a nuclear phase out if certain problems are not resolved and full nuclear liability insurance provided. Fifteen states have initiatives or legislative bills pending to control nuclear power growth.

PSE&G Favors Nuclear Power

Robert I. Smith, President of Public Service Electric and Gas Company (PSE&G) noted that use of electric power has been doubling every decade for the past three and now consumes 27% of primary energy—due to rise to 50% by the year 2000. While electric growth stopped in 1974, due to conservation, economic slowdown and mild weather, a 5% increase is expected in 1975 if the national economy begins to pick up in the third quarter. In general, Edison Electric Institute is joined in predicting thereafter an approximate rate of 6% by: IEEE Energy Forecast Working Group, National Economic Research Associates and Project Independence.

PSE&G had burned coal until 1967, shifted to oil to comply with environmental requirements and is now switching to nuclear because it cannot control the price of the oil it needs. With nuclear power, 70% of the cost is fixed whereas with fossil fuel plants only 40% is fixed and the rest is subject to fuel price fluctuations. Also PSE&G finds that its nuclear capacity generally accounts for twice as much of its energy produced—i.e., 10% of its capacity is nuclear, but that capacity is actually providing 18% of its energy because baseloaded and run around the clock.

Economics of Nuclear Power

Daniel F. Ford of the Union of Concerned Scientists (UCS) reviewed the economics of the nuclear industry. Planned to grow at 20% per year through the year 2000, the projected course was followed until the early seventies when delays and poor performance caused reactors to be labeled as "atomic lemons". Postponements and cancellations in 1974, and fall off in electric demand, left the industry in chaos. It is now unlikely that the American economy will achieve the previously anticipated major dependence on nuclear energy.

Capital costs for nuclear reactors have been rising exponentially from $100 per kilowatt hour to $700 in the last eight years. Projecting these estimates would suggest $1500-$2000 per kilowatt hour for plants coming on line in the early 1980s. The rate of escalation is considerably higher than for coal plants and capital costs are now 20% to 50% higher than for coal. There is reason to believe that nuclear costs will continue to escalate because there is reason to expect continued major design changes and changes in construction practices, stemming in particular from NRC regulatory guideline changes.

To compete with coal, nuclear plants would have to end this cost escalation *and* dramatically improve in nuclear plant performance; meeting both of these conditions appears nearly impossible. The industry is now quietly preparing to ask for subsidies.

The U.S. needs a stable energy source and the extreme precautions that have to be taken to assure nuclear plant safety raises fundamental doubts about the viability of nuclear power as a major source. In sum, the U.S. nuclear power program faces, on economic grounds, a grim future.

Rasmussen Defends WASH 1400

Dr. Rasmussen, defended his report WASH 1400 and its method of assigning probabilities to failure rates. He noted that A. E. Green and A. J. Bourne had reported in a book "Reliability Technology" that failure rates had been correctly predicted to within a factor of four, 96% of the time.

With regard to the recent fire in the Browns Ferry nuclear power station started by a workman using a lighted candle, Dr. Rasmussen argued that this incident validated, rather than undermined, his analysis. While his study had obviously not described, and was not supposed to describe, individual accidents, it had predicted that the two safety systems that had failed simultaneously as a result of the fire would fail simultaneously for 1 hour in every 50,000. Since there have now been 300,000 hours of boiling water reactor operation, and since the fire caused these systems to be out of operation for five hours, the experience here showed one hour out of operation for every 60,000—very close agreement indeed. Evidently no other such simultaneous failure is known.

Dr. Rasmussen said that changes in his conclusions, as a result of various inside and outside reviews, would lead to some increases in estimated risks and some decreases. Increases would result from: more realistic evacuation scenarios; use of better data on Cesium 137; and thyroid illness estimates on adults. Decreases may result from: more realistic treatment of weather conditions; new values relative to radiation exposure from ingested radioactivity; and a better model on land use resulting in reduced property damage costs. A small increase in the largest consequences at very low probabilities may result from examining specific sites rather than averaging.

However, Dr. Rasmussen saw no changes large enough to alter the basic conclusion of the report which was that "the [risks of] operation of nuclear power plants of the type being installed in the U.S. today are very small compared to other risks which society accepts".

Henry W. Kendall

Dr. Kendall called for "convincing evidence of full resolution" of safety issues as a prerequisite for public acceptance. He noted that two years of AEC hearings on ECCS had established:

1) that present reactor emergency core cooling systems have never been tested experimentally under the conditions in which they are intended to function;
2) that the AEC relies on unverified computer predictions to determine the effectiveness of reactor emergency core cooling systems when it licenses nuclear power plants;
3) that there were important gaps in technical knowledge concerning the events that occur inside a reactor during a loss of coolant accident and that important aspects of needed research programs have been improperly and incompletely done or not done at all; and, finally,
4) that, based on extensive and impressive testimony, a large number of the reactor safety experts available to the AEC and the nuclear industry had serious

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concerns over a number of basic aspects of reactor safety assurance.

Dr. Kendall criticized the Rasmussen report for its treatment of evacuation, cancers and genetic defects and proposed these consequences in place of the Rasmussen results:

Consequence	RSS Result	Corrected Result
Prompt fatalities	62	620-990*
Lethal cancer	300	10,000-20,000
Genetic defect	300	3,000-20,000
Thyroid nodules	about 25,000**	22,000-350,000

*Using AEC, EPA, UCS/SC estimates of error
**Inferred from RSS results

The probability of the accident in question being estimated by Rasmussen as 5 in 1,000,000 per reactor year with uncertainties of a factor of ten in either direction. Thus the highest assessment given by Rasmussen is 5 in 100,000. A thousand reactors would therefore give rise to such an accident once every twenty years.

Referring to the Browns Ferry fire, he observed "Had this fire been coincident with a loss of coolant accident, a meltdown accident with the possibility of major radioactive release would have been a near certainty."

Dr. Kendall concluded that the Rasmussen study fails "to provide the required assurance that nuclear plant risks are satisfactorily low". He concluded by recommending a "halt to the initiation of new reactor construction until such time as the required safety assurances are convincingly established and the present controversy between the nuclear industry and the independent scientific community is resolved."

Safety Tests Beginning

Herbert J. C. Kouts, Director of Safety for NRC said that a substantial program to provide information and methodology for better assessment of ECCS now existed. The first LOFT tests will begin later this year. He described the ECCS problem and said he hoped and expected that the programs now underway would lead to a different kind of quantification of the conservatism of the methods of engineering analysis of ECCS, but admitted that absolute certainty would not be possible, as it is not possible elsewhere in the physical world.

Waste Disposal

Dr. James L. Liverman, ERDA's Assistant Administrator for Environment and Safety observed that the highest projected U.S. cumulative inventory of high-level solid waste for the year 2000 is about 80,000 one-foot diameter by ten-feet-long canisters. (This is the number of cubic feet in a cube with 200 feet on a side.) Permanent disposal of the high-level wastes in a deep stable geological formation is still under active consideration despite the fact that problems arose with the Lyons, Kansas site first chosen. An effort is being made to construct a pilot facility in bedded salt elsewhere. The pilot facility would install waste in such salt beds but in a way that would permit retrieval until laboratory work on the safety of the method was confirmed—after that time the pilot site would become permanent. Initial operation would occur in the early 1980s and conversion to an operating disposal facility would occur in the late eighties or early nineties.

Cost of Breeder Delay $1 Billion

Robert D. Thorne, Acting Deputy Assistant Administrator for Nuclear Energy (ERDA) observed that five tons of plutonium were dispersed over the globe from atmospheric testing (and has essentially now settled to the ground) but that no cancer found in man can be confidently attributed to plutonium. No civilian had yet been injured by the reactor safety program and there was no evidence of a successful theft of plutonium. The LMFBR would produce economically competitive electricity when the cost of uranium reaches about $25 per pound, the present price of contracts for delivery in 1980. A conservative estimate on the penalty for delay of LMFBR is about $1 billion in benefits lost per year of delay.

Breeder Condemned

Dr. Thomas Cochran, staff scientist at Natural Resources Defense Council, condemned the breeder program on the grounds that it was: expensive, premature, would absorb disproportionate amounts of capital, would exacerbate the safeguards problems, and was being done just when non-fission energy altenatives were poised for major breakthroughs. He criticized AEC projections that LMFBRs would become competitive through a learning curve reduction in cost that was not apparent (or projected) for light water reactors. In his view LMFBR would not be commercially competitive with existing energy sources until one or two decades after the turn of the century.

Testimony of Hans A. Bethe

Dr. Bethe argued that the energy problem of the U.S. and of all the Western World could not be solved without "full use" of the nuclear option. He urged a high priority to a careful geologic survey of uranium but noted that, with present estimates, there is only enough uranium to fuel—during their entire lifetime—600 light water reactors. These would be built by about the year 2000 if one constructed plants at about the rate proposed by President Ford—200 by 1985—a rate that Bethe considered reasonable.

He urged study on breeders to extend the uranium supply by a factor of about 100 (and indeed much more, by utilizing low grade ores); thus it would "ensure energy supply for essentially all the future".

Dr. Bethe gave historical experience in support of the Westinghouse data estimate that its Clinch River 350 megawatt demonstration plant could be inexpensively scaled up to 1500 megawatts and indeed would benefit from cost cutting experience. In essence this projects a cost of $795 million for such a large plant or less than the $850 million (constant dollars) he noted for construction of the Clinch River plant.

However, he noted that GAO had estimated the cost of a 1000 megawatt Liquid Metal Fast Breeder Reactor (LMFBR) to be $1500 million or 2.75 times the cost of a Light Water Reactor—at such costs, he conceded the breeder would never be built by industry.

The total cost of developing a commercially useful LMFBR was estimated at over $10 billion of which perhaps $4 billion involved inflation escalation. He examined the cost of building the French Phenix breeder in America to show that it would not, in fact, have been much cheaper than Clinch River.

Bethe noted that spent fuel from breeders contained more plutonium than light water reactors but that the difference was not important since, in both cases, the reprocessing plants would have to be heavily guarded and could be—he referred to techniques for detecting very very small quantities of plutonium without body search; in answer to question he noted that small and harmless neutron flows could be used to excite the plutonium in ways that made its presence known.

Factors making breeders safer than light water reactors were: lower pressures in the reactor, coolant well below boiling point, high heat conductivity of coolant improving core cooling prospects, and the Doppler effect lowering reactivity of the reactor as the fuel heats up.

Factors making breeder more hazardous were: loss of coolant does not automatically lead to reactor shut down as in the Light Water Reactor case; sodium reacts violently with water with which it might come into contact; loss of coolant might produce a critical mass though not a nuclear explosion.

Surveying the safety features, Dr. Bethe noted that the manufacturer believes that the probability of failure of them is less than one in a million per year of reactor operation.

Large accidents were estimated as being "much, much milder" than the equivalent of 150 pounds of TNT and "easy to contain" in the reactor vessel.

Substitutes for the breeder should be pursued if it were not and they included: molten salt thermal breeder; light water breeder; high temperature gas cooled reactor (HTGR) and the heavy water reactor in Canada called CANDU. He recommended continuing Clinch River and authorizing design of a full scale prototype. He also recommended a joint development of the advanced CANDU reactor by Canada and the U.S. This option would, he felt, have smaller total cost than the breeder with firmer price estimates; a shorter time scale for development; and the substitution of U-233 for plutonium with consequent advantages.

Peaceful Nuclear Explosives

Wolfgang K. H. Panofsky testified on peaceful nuclear explosives (PNE's) and observed that all of the goals of these projects could also be attained with conventional explosives. PNE's are characterized by larger yield, lower explosive cost, radioactivity, damage claims from large ground shocks, problems of prediction and performance, and problems of nuclear security. Exploitation of PNE's would usher in an entire new era of environmental, safety and other problems and would require the creation of a major industrial base.

Considering the threat of proliferation of nuclear weapons to be one of the largest dangers facing this world today, Dr. Panofsky would urge critical scrutiny to, and resistance to pressure for, making PNE's an exception to future agreements restricting nuclear weapons.

International Reprocessing Urged

Mason Willrich noted that the number of countries with operable nuclear power reactors will double to 30 by 1980, assisted by the world oil price explosion of 1973. If these nations were to move toward nuclear independence, they would have to seek uranium enrichment facilities—either gaseous diffusion plants or gas centrifuge plants. But the former are only economically efficient if they service about 40 1,000 megawatt plants; the latter would require at least ten. This provides an economic reason for multinationally owned and operated centralized facilities which could also be better guarded.

Terming these two possibilities "economic efficiency and international security" on the one hand and "economic nationalism and global insecurity" on the other, Dr. Willrich said the evidence was conflicting on the way in which the world was moving. A British/Dutch/West German combine was cooperating on a centrifuge with URENCO and a Eurodif project was planning gaseous diffusion. But South Africa was pressing ahead with its own enrichment capability based on an undisclosed process.

Plutonium recycle has not yet begun on a commercial scale in any country, and is now being debated here and in Europe. But reprocessing plants for recovering plutonium and uranium are planned in several industrial countries.

He urged co-location of nuclear fuel cycle support facilities—enrichment, fuel fabrication and chemical reprocessing plants—to eliminate the transportation links most vulnerable to nuclear theft.

U.S. policy should be to encourage the worldwide development and use of nuclear power on a sound economic basis. In particular, it should offer to provide its most advanced uranium enrichment technology for large facilities that would be built outside the U.S. under multinational ownership. Enriched fuel provided by the U.S. should be reprocessed only in U.S. facilities or in those multinationally owned. Similar restraints should be placed on fuel used and produced in reactors we provided, or which incorporate major components we provided. Special conditions should be applied to enriched material exported for research. And U.S. exports should be subject to a requirement that the nuclear materials be protected no less well than they would be in the United States.

Dr. Anne Cahn urged that Congress veto any agreement for cooperation between the Governments of the United States and Iran that did not deal with reprocessing in a regional or international framework. She also urged no use pledges by nuclear weapons states against non-nuclear weapons countries party to the Treaty.

Protective Measures Increased

Commissioner Victor Gilensky of the NRC observed that new protective measures were put into effect in 1974 at all 19 facilities licensed for the possession of over four pounds of plutonium or eleven pounds of enriched uranium. These included armed on site security organization; two barriers, rigorous access control; radio communication between guards and arrangements for quick response of local law enforcement.

NRDC Opposed Plutonium Recycle

J. G. Speth of the Natural Resources Defense Council argued that a halt to plutonium recycle—not yet begun—would keep plutonium relatively immune from theft. But recycle for light water reactors, and later for breeder reactors, would initiate a "plutonium economy" that would change the picture dramatically. He expressed concern also about the introduction of High Temperature Gas

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Cooled Reactors, which use weapons grade uranium as their input, and about new and far cheaper methods for enriching uranium such as laser enrichment or enrichment by gas centrifuge. The latter would put the technology to enrich natural uranium into the reach of small nations and subnational groups.

Mr. Speth argued that adequate safeguards of plutonium could not be achieved because they would have to be essentially infallible, because experience with present safeguards was not good, and because the measures proposed have been strongly opposed by the nuclear industry. There were also conflicts between safety and security that made it impossible to ensure either except at the expense of the other. Prudence dictated that plutonium be considered only a last and desperate resort for commercial applications.

Concern was expressed with regard to civil liberties that might be lost if police powers were strengthened. In conclusion the use of plutonium fuel was simply a technology that was "too risky and too demanding" to be pursued.

Safeguarding Nuclear Materials

Dr. Theodore Taylor discussed the principle of "containment" in which all nuclear industry materials that might be used for making bombs would be kept behind certain barriers. In particular, fuel reprocessing and fuel fabrication plants would be co-located. Another possibility would dilute separated plutonium by slightly enriched or natural uranium before the material was transferred to a fabrication plant. This would not interfere with its use as fuel but would make reprocessing necessary before the material could be used as a bomb and would, in addition, increase the weight of stolen material necessary by a factor of 100.

Spiking of plutonium (or highly enriched uranium) with intensive gamma ray emitters in sufficient quantities to require massive shielding would prevent theft but would require use of such shielding thereafter—this might not therefore be cost effective. But spiking with gamma ray or neutron emitters to make stolen material more easily dedectable could lower the threshold for detection to less than one gram without increasing exposure dramatically.

Use of special shipment vans, or very heavy rail containers, and the establishment of a Federal protective service are all under consideration.

Preliminary studies of the capital and operating costs of a rather massive security system, with routine recycle of plutonium would correspond to less than 1% of the cost of nuclear electric power produced by the system. Eight hundred physical security personnel (150 on duty at any time) could safeguard 80,000 megawatts of light water reactor fuel cycle with 20 separately sited plants.

Spent Fuel Piling Up

A. E. Schubert, President of Allied-General Nuclear Services which is building the Barnwell, South Carolina nuclear reprocessing plant testified that spent fuel was piling up in the storage pools of reactors to the point where they may have to close down, increase their pool capacities, or build new large pools, unless reprocessing plants come on line. Two years would be required to enlarge existing pools, six years to open large new pools. Opening the Barnwell plant as scheduled in 1976 is the only alternative, according to ERDA, that does not require shutting down some reactors in the next few years.

Marvin Resnikoff

Dr. Marvin Resnikoff, a member of the Sierra Club, questioned the cost-effectiveness of reprocessing spent fuel to recover the uranium and plutonium contained in it. He noted that General Electric and Nuclear Safety had reached similar conclusions that the reprocessing expense was not justified at this time though it might become so, possibly 15 or 20 years off, when uranium became more scarce. One reason why the recovered uranium was not worth the cost of its recovery was its association with uranium-236, produced in the reactor, which tends to absorb neutrons without fissioning and, therefore, requires still higher U-235 enrichment of the recovered uranium before it can be used again. Evidently, AEC was buying the recovered uranium back at full price although it was only worth half as much as natural uranium; this subsidy encouraged reprocessing plants.

Dr. Resnikoff noted, also, that not much radioactivity waste is emitted from a reactor, unless an accident takes place, whereas these wastes do become mobile in the reprocessing plant where the fuel elements are chopped up and dissolved in nitric acid.

Noting that the most serious problem at a reprocessing plant was worker health and safety, he observed that, on occasion, large numbers of young workers were used for exceedingly short periods, until they had received the allowable dose, paid for a night's work, and then laid off.

At the Nuclear Fuel Services plant, in 1971, 2,366 person-rems had been received to process only 69 metric tons of fuel elements. How, he asked, could Barnwell be expected to process 1,500 metric tons with only 350 person-rems when the fuel would be much more highly radioactive? He complained that the NRC regulations do not require that a study of health of workers be performed and therefore that his request for such a study had been denied by the licensing board and the worker records were not available.

With regard to high-level wastes, he noted that their planned storage in stainless steel tanks would pose a problem of maintaining continued cooling. If the electricity and cooling water involved were somehow cut off, the wastes can boil in less than a week and melt through the tank.

Dr. William D. Rowe of ERDA discussed its radiation program and its new program for the development of plutonium standards. AEC has investigated plutonium for over thirty years spending in excess of $100 million; as a result more is known about plutonium than many other more common, if shorter-lived, contaminants. Plutonium has induced cancers in laboratory animals but none yet identified in humans, even for some exposures in the upper ranges of current limits. Possibly the adverse effects have been overestimated or the induction period for humans may be quite long. NRDC has asked for lower standards on the "hot particle" theory that damage from a localized intense radiation source in the lung was that much greater than an equal dose averaged over the entire organ. The generally accepted consensus was that the averaging method was appropriately conservative but the matter is under review.□

INQUIRIES INTO BUREAUCRATIC REVIVAL

Boffey on National Academy of Sciences

The shutters are rising on the National Academy of Sciences, just as its business is picking up. More and more often, society is adopting Boffey's main message: that scientific pronouncements be "subjected to the same intense scrutiny and questioning the public applies to political pronouncements".

The Academy is a bureaucratic and parkinsonian nightmare; reading Boffey's book makes it surprising that it functions at all. In the first place, its members are elected on honorific grounds only distantly related to their capacity to advise the Government and not at all related to their willingness to do so. They and other scientists working on committees do so without pay and on a parttime basis that makes committees hard to organize, the reports often late, and encourages superficial work. The work is supported ultimately by Agency and Congressional contracts; the former links inhibit the Academy from challenging Agency conclusions under either kind of contract. The scientists themselves tend to be of enormously varying political consciousness and since the reports must satisfy the entire Committee, the conclusions are watered down and provide a bland, if not inscrutable, appearance.

The Academy was founded in 1863 and was, for a time, considered to be part of the Legislative Branch. It

The Brain Bank of America, McGraw Hill, $10.95 Philip Boffey

now considers itself an independent non-governmental organization. But the official Government Organization Manual lists it among "quasi-official" organizations. It is struggling to avoid having applied to it, the provisions of the Federal Advisory Committee Act requiring, among other things, open committee meetings.

The Academy elections process seems relatively free of bias against persons who have expressed political views but has the expected amount of interdiscipline rivalry in assessing scientific accomplishments. Members are drawn heavily from the best schools but since it is not clear to what extent this should be so, it is correspondingly unclear to what extent the result is due to the "old boy" network. Boffey quotes some evidence suggesting the latter influence at work and proposes allowing anyone to submit nominations, rather than only Academy members.

Boffey concludes that the Committee staff is a weak point of the Academy with most doing no more than handling bookkeeping, correspondence, travel arrangements and other administrative chores. For this and other reasons, the reports seldom have new ideas in them. Recently, a review procedure has been institutionalized to ensure that reports receive criticism from members not on

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ON ACADEMY RITUALS

It was really fantastic as these days passed to see how this group of America's most celebrated scientists meeting together could be so dominated by the question of just how to increase their membership and ways to remember their dead.

—*Stephen Smale,* 1971

Medvedev on Democracy in USSR

The Medvedev twin brothers, Zhores and Roy, are—apart from Academician Sakharov—the best known of the spokesmen for the democratic movement in the USSR. Zhores, a biochemist now exiled in Great Britain, is the twin who was briefly imprisoned in an insane asylum in reprisal for his dissidence. Roy, a historian in Moscow, has now published a five year old manuscript, insisting that socialism can be combined with democracy. His program is one of strict compliance with Soviet laws but of constant legal and political pressure and agitation.

Even for those who know the Soviet Union only too well, the book provides a well-written and revealing insight into the present stultifying state of affairs. The greatest ally of concerned U.S. military strategists is undoubtedly the over-control of the Soviet economy and body politic; totalitarianism moves fast at first but then bogs down when the going gets complicated.

As Medvedev puts it: "An enormous contradiction now exists in our society: rapid scientific, technical, and economic progress is being blocked by an excessively centralized bureaucratic system. The structure is too unwieldy even to formulate the right questions at the right time, leaving extremely important problems with no solutions."

On Socialist Democracy, Knopf, $10.00 Roy Medvedev

The hypocrisy of the Soviet press and its apologists assumes an almost ludicrous form in his quotations. As a skilled historian, he notes how often Soviet practice is based on emergency provisions more than four decades old, rather than on the constitutional practices and Leninist injunctions which those emergency provisions were meant to displace only temporarily.

Inside party trends, he sees Stalinist factions whose appetite to crush opposition is insatiable; moderate conservatives in a centrist role, chiefly interested in avoiding any appreciable shift in any direction (but more likely to shift to the right under pressure than the left); and party democrats of which Medvedev is one. The last is the weakest trend, "almost completely unrepresented in the highest organs of the party". He "dares to predict" that it will gain "very widespread support" in the seventies but is less sure that the movement will be coherent rather than chaotic. But he sees a "tightening of the screws" as still more likely than a systematic development of socialist democracy.

Outside the party, he sees one group increasing rapidly: Westerners who equate Marxism with Stalinism and see capitalism as somewhat reformed. Less significant are the "ethical socialists" who consider the central core of socialism to be certain ethical norms rather than certain economic relationships. There are also Christian Socialists awaiting a spiritual revolution and legalists—led by Academician Sakharov who emphasize adherence to law.

Most in the West do not realize how petrified the Soviet Government is of nationalist trends in its culturally diverse regions. Medvedev says that these centrifugal tendencies are on the rise and even has the temerity to suggest

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NATIONAL RESEARCH COUNCIL OF THE ACADEMY UNDERSTANDS ECONOMICS

NRC (at 5 p.m. urgent call): "We must have 15 copies of your FAS Report on nuclear energy by tomorrow morning.
FAS: Can do.
NRC: Is there any charge?
FAS: No charge.
NRC: In that case, we will take 20.
—Note: NRC is probably 100 times wealthier than FAS.

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the committee. But the Academy rarely comes into open conflict with government policy. And a continuing struggle is necessary to keep the committees free of bias in dealing with industrial issues.

The whole operation has been held together by adopting safe business-as-usual stances. The posture is one of asserting that the Academy could not become more aggressive without abandoning its scholarly traditions. But according to Boffey, "the chief reason is undoubtedly the Academy's orientation toward serving rich and powerful institutions that do not generally encourage activism in behalf of reform". He argues that the present internal reforms will seek to maintain objectivity but do not change the Academy's financial subservience to Government agencies. Boffey would like the Academy to function only on the basis of endowment—which would mean, at present, a budget of about $5 million a year compared to its present $50 million. He would also urge that scientists be allowed to nominate themselves to serve on academy committees perhaps in response to advertisements. He urges "ferreting out all relevant dissenting viewpoints" in an active way noting that letters to organizations and individuals do not, evidently, serve the purpose.

The whole purpose of the Academy should be, Boffey argues, to serve the public, not to advise the Government agencies what kind of research they should be doing.□

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referendums every ten years to permit self-determination if any wish to break away! Meanwhile, Russian nationalism is also on the rise and becoming a kind of "great power chauvanism" in which minorities are slighted.

Inner-party democracy is a shambles and even editors of Pravda have to call the Central Committee to decide whether an obituary of an Old Communist should be printed with signatures of his comrades or without. The Supreme Soviet has never disapproved a single decree, although they are often reversed later as misconceived. Judges take breaks in trials to call for instructions. And authors are never allowed to meet the censor but only deal through the editor.

Medvedev points out that the Academy of Sciences has a special resolution, suggested by Lenin himself, freeing its publications from censorship. Everyone has been afraid to modify it, Lenin having been its inspiration, so it has just been ignored for the last 45 years. Recently censorship has become more rigid still in most spheres of science and literature to the extent that no significant work can now appear.

One of the problems in Medvedev's own view of the problem arises from the impracticality of having "some" censorship. He envisions a gradual shift in these rules. But it was this same half-way approach that opened the door to present Soviet practices. Lenin himself said:

> Every artist, every person who considers himself to be one, has the right to create freely in complete independence according to his own ideal. But, you understand, we are communists. This means that we cannot stand by, arms folded, and let chaos develop where it will. We must give full and systematic guidance to this process and shape its results.

Every American who understands the first amendment to our Constitution understands where such a posture would inevitably lead—and has led.

Here it is:

> As we all know, in our country every person who considers himself an artist has the right to work freely, to write as he sees fit, without the slightest limitation. But by the same token, our party and state institutions also enjoy full freedom in their choice of what to print.
> —I. Bodyul, at the 23rd Congress of the CPSU□

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