

C A R N E G I E I N S T I T U T I O N

At the Frontiers of Science

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August 28, 2007

Via Federal Express

Dr. Mohamed ElBaradei
Director General
International Atomic Energy Agency
Wagramer Strasse 5
A-1400 Vienna
AUSTRIA

Dear Dr. ElBaradei:

I am writing you in my role as Chairman of the International Nuclear Safety Group (INSAG). INSAG's terms of reference provide that it should make "recommendations and opinions on current and emerging nuclear safety issues" to the IAEA and others. This letter is one of the vehicles by which I, on behalf of INSAG, seek to fulfill this responsibility.

I shall first discuss the significance of nuclear safety in the current context and then shall turn to various issues that warrant special attention.

I.

It is apparent that nuclear power will play an even more central role in the future than today. Over 80% of the world's energy supply is currently derived from fossil sources and, as the world's appetite for energy has grown exponentially, the interest in nuclear power has expanded. This is driven by many factors, including rising and volatile fossil fuel prices, the geographic concentration of the remaining significant oil and gas reserves with resultant energy security concerns, and economic considerations. A factor that is growing in importance arises from the increased concentrations of carbon dioxide in the Earth's atmosphere, resulting in large part from the burning of fossil fuels. Carbon dioxide, of course, is a greenhouse gas. As shown by the most recent consensus assessment by the Intergovernmental Panel on Climate Change (IPCC), this increased concentration is already having a significant effect on the global environment.

Given the current trends in energy usage, the concentrations of carbon dioxide in our atmosphere will grow significantly in this century. As a result, the IPCC predicts that the adverse consequences of greenhouse gases will

become ever more severe over time. Indeed, we are not yet observing the full effects of even the existing concentration of carbon dioxide because the Earth's geosystem is not yet in equilibrium; we are being temporarily cooled by the oceans.

It may fairly be said that all are threatened by climate change. Indeed, the threat outlined by the IPCC may be more widespread, more difficult, and more devastating than any threat previously confronted by humankind. The response requires that we bring global carbon dioxide emissions under control. And this, in turn, requires radical changes in global energy policy. We must take these steps soon because the effects of greenhouse gases result from cumulative emissions and every year of delay enhances the challenge of responding to the threat.

Energy is an essential foundation for economic and personal well-being. Somehow the energy needs of the world's ever growing population must be met, as well as the legitimate demand for increased availability of inexpensive energy at a stable price by the world's developing nations. It is not an option to respond to the climate change threat by expecting that humankind will somehow simply reduce its energy demands.

Rather, the solution must derive from increased efficiency in energy usage and from reliance on energy sources with reduced greenhouse gas emissions. The response must include enhanced use of renewable and solar energy, the sequestration of emissions from carbon-based energy technologies, and hydro. But the mix must also include nuclear power. Nuclear power does not emit greenhouse gases and is the only base-load power source capable today of significantly reducing our reliance on fossil fuels. Although no technology by itself will provide a complete response to climate change, we will need every available option and enhanced reliance on nuclear power must be part of the response.

This situation reinforces the need for significant and increased attention to nuclear safety. To some extent, every user of nuclear power is hostage to the safety performance of other users because of the adverse consequences that would arise if there were a significant nuclear accident anywhere. Many countries are now expressing interest in nuclear construction, including many countries that previously did not employ this technology. But their enthusiasm for nuclear power would no doubt be dampened by the intensified public concerns that would result from a major nuclear event. Given the crucial need to deploy carbon-emission-free sources of energy, the stakes arising from a failure to achieve nuclear safety everywhere are growing. As a result, an increased focus on nuclear safety is an even higher priority than ever before.

We believe that these changed circumstances have implications for the IAEA. Nuclear safety has long constituted one of the pillars of the IAEA and the IAEA should be proud of its many contributions to the high level of safety that is being achieved worldwide. But the emphasis that has been given to nuclear safety has always been far less than that for the IAEA's other principal missions. For example, only about 8% of the IAEA's most recent total budget is allocated to nuclear safety. We do not view this as sufficient. We urge the Member States to help you to enhance the resource commitment to this vital function in this time of growing need.

II.

There are 442 nuclear power plants around the globe that contribute roughly 16% of the global production of electrical energy. These power plants are found in 30 different countries. Moreover, as discussed more fully below, there are many other countries that are now expressing interest in joining this group. We see a variety of needs relating to safety that deserve attention:

1. *New Entrants*. Many countries with no past experience with nuclear power have recently expressed interest in building nuclear power plants. These countries include Belarus, Egypt, Indonesia, Malaysia, Turkey, Poland, Vietnam, Nigeria, and various countries in the Middle East. Even if a foreign vendor is responsible for the design, construction, and commissioning of a plant, the recipient country has the obligation to ensure the existence of a strong infrastructure that can guarantee continuing attention to safety for a period as long as a century or more. There are many components of the necessary infrastructure, including legal and regulatory capability, educated and trained manpower, a stable electrical grid, access to financial and industrial resources, and the nurturing of an appropriate safety culture in the generating entity. In short, there are wide responsibilities that arise from a commitment to nuclear power and the new entrants must take appropriate and timely actions to fulfill those responsibilities. *See generally* IAEA, *Fundamental Safety Principles* (SF-1).

In this connection, the IAEA has produced an important guidance document, entitled *Milestones in the Development of a National Infrastructure for Nuclear Power*, that describes the range of activities that a new nuclear country must undertake, as well as a discussion of the sequencing of those activities. It provides a very useful roadmap for a new entrant. *See also* IAEA, *Considerations to Launch a Nuclear Power Programme*. We also urge each new entrant to seek at an early stage to become actively involved in the global nuclear safety regime – the web of relationships that support the achievement of safety. This regime is described in a recent INSAG report entitled *Strengthening the Global Nuclear Safety Regime* (INSAG-21). At the same time, other INSAG documents, including the recent INSAG report entitled

Stakeholder Involvement in Nuclear Issues (INSAG-20), may be helpful in identifying appropriate processes and standards for nuclear decision-making.

In light of the substantial challenge that establishing the necessary infrastructure will present to a new entrant, we conclude that the IAEA should provide such countries with enhanced assistance. In particular, the IAEA should ensure that its review services are configured effectively so as to assist an emerging nuclear state to put in place the necessary capabilities that will enable it to succeed in the deployment of nuclear power. Indeed, it is in the self-interest of the entire nuclear community to help the new entrants to understand and fulfill their obligations.

2. *Poor Performers.* The safety performance of nuclear power plants as revealed by objective indicators is reassuring, at least at first glance. There has been reasonably steady improvement in a variety of measures – for example, capacity factor, unplanned shutdowns, radiation exposures of workers, radiation releases to the environment – over an extended period, albeit with some leveling off in performance in recent time. But the average in safety performance does not tell the whole, or even the most crucial element of the story. The web of nuclear safety is no stronger than its weakest link and it is the laggards in safety performance that deserve careful attention.

We are concerned that some facilities and countries could fall behind in safety performance. This is increasingly worrisome as worldwide dependence on aging nuclear facilities grows, with the commensurate need for strengthened monitoring and surveillance in order to preserve safety margins. In some cases, the reasons for poor performance may relate to limited resources or the reluctance or inability to make upgrades to old equipment. In other cases, poor performance may result from an inability to establish and maintain an appropriate safety culture – an indispensable element in maintaining safety. Other factors include the failure to overcome the complacency that can result from satisfaction with the status quo, cultural challenges in bringing about fundamental change, or even from a lack of awareness of deficiencies. We believe that each facility and country should forthrightly confront and compare its performance with international norms and make radical changes where its performance falls short. This applies not only to the performance of the generating company, but also to the effectiveness of the regulator and of the host government in ensuring adequate attention to safety. The examination arising from the Review Meeting of the Convention on Nuclear Safety can be helpful in this effort. Similarly, the review services offered by the IAEA and WANO can help nations and generating companies to identify weaknesses and to correct them.

3. *Operational Experience Feedback.* Operating experience from existing plants can provide important lessons from which all should benefit. It

is widely observed that serious accidents are nearly always preceded by less serious precursor events. If the lessons can be learned from the precursors, the probability of a serious accident could be significantly reduced. The overall success of the international system for operational experience feedback is dependent on input from national authorities and synthesis at the international level. Although the need to enhance the system for operational experience feedback has been discussed in recent years, little tangible progress is seen as yet. This matter deserves increased attention.

Reporting by national authorities is uneven and sometimes tardy or lacking clarity. Equally importantly, there should be emphasis on identifying and distributing the important lessons to be learned and the actions to be taken to respond to those lessons in a user-friendly fashion. A truly effective program would capture information about all significant corrective actions, regardless of the precipitating justification, as well as important research results that identify or resolve an important safety concern. As new construction commences in many countries, it will also be important that construction experience is shared so that all may learn from any problems that arise.

The development of a more effective system for feedback of operating and construction experience will require investments by operators and regulators, as well as by the international community. The analytical capability at the IAEA (and, as appropriate, the NEA) needs to be augmented so as to allow the analysis of the reports and the distillation and distribution of the lessons in ways that are readily accessible. We believe that a comparatively slight investment in enhanced capacities could have a meaningful payoff in accident avoidance.

Philosopher George Santayana once observed that those who do not learn from the past are condemned to repeat it. We should exploit the knowledge that can be gained from careful and thorough efforts to learn from existing operations. The availability of a strong international feedback system may be of critical importance to those countries with limited experience or only one or a few nuclear plants. In these cases, national feedback systems will clearly not suffice and an international system must fill an important need. INSAG plans to provide recommendations to improve the feedback network over the coming year.

4. *Skilled Staff.* In most parts of the world other than Asia, nuclear opportunities have been limited in recent years. This has resulted in a smaller cadre of qualified nuclear experts, fewer graduates in nuclear disciplines, and less global financing of safety research. For countries that do not contemplate new construction, the challenge of finding suitable manpower is a steadily growing challenge. And even those countries in which there has been a recent resurgence of interest in new nuclear construction are confronting manpower

problems. Although the new opportunities have created incentives that draw students to the nuclear field, there is an inevitable delay between the demand for nuclear experts and the buildup of supply.

There is no easy way to solve this dilemma. Along with stronger efforts to rebuild the cadre of skilled personnel, there is a need to ensure that existing capabilities are deployed efficiently. The expansion in international businesses engaged in providing world-wide nuclear services will facilitate the availability of the necessary capabilities to some extent. But the deficit in knowledgeable personnel deserves careful monitoring, especially in those countries in which there is no immediate prospect of new nuclear construction. Safety is ultimately dependent on the attention and capabilities of skilled people and the shortfall in capable staff could have grievous effects.

5. *New construction.* It appears that major construction of new nuclear power plants will commence around the globe in the coming years. This effort will be spearheaded by a small group of major international enterprises seeking to sell standardized nuclear power plants in numerous countries. There is a strong interest among these enterprises and the affected regulators to harmonize safety approaches.

Some of the affected regulators are working together in an effort to explore the harmonization of regulatory requirements through the Multinational Design Evaluation Program. This is an extraordinarily valuable development: harmonization will allow greater efficiency and effectiveness in safety reviews, enable each country to benefit from the experience of others in the conduct of reviews, and encourage the development of consistent regulatory positions. Although nuclear licensing will no doubt remain a sovereign activity, harmonization will allow greater international standardization, which serves both safety and economic objectives. As a result, the ongoing efforts to achieve harmonization of nuclear safety approaches should be strongly encouraged and, ideally, should be ultimately reflected in IAEA safety standards.

One aspect of the internationalization of the nuclear business – indeed, one dimension of the flattening of the world's economies as a whole – is the immediate reality that the supply of nuclear parts and components may come from many places on the globe. As a result, no one regulator can readily have scrutiny over the quality of all those parts and components. As a result, there is a need for careful coordination by regulators around the globe to ensure that there is consistency in the standards applied by different countries and that those standards are satisfied. It would be most unfortunate if the nuclear renaissance were to be derailed by parts and components that fail to meet specifications.

6. *Safety-security synergy.* One of the outgrowths of the experience of 9/11 has been a heightened focus on security at critical infrastructure of all types, including nuclear plants. Many countries have taken steps to prevent terrorists from causing a significant nuclear release. But modifications of a plant to ensure security can also have impacts on safety – positive impacts in some cases, and negative in others. For example, enhanced bunkering of safety equipment can strengthen security and can serve to limit the safety consequences of malfunctions (fires, explosions), but also can make safety-related monitoring and maintenance more difficult. There is a danger that the synergy/antagonism between safety and security is not always fully appreciated, particularly in those countries in which the responsibility for safety is vested in a separate organization from that with responsibility for security.

Safety and security intersect with each other. The impacts of each on the other should be assessed with the aim of achieving an appropriate balance and ensuring the optimum level of protection against all potential threats to safe operation of the facility. INSAG is now undertaking a review of this subject.

7. *Reengineering the Fuel Cycle.* Reconsideration of the nuclear fuel cycle is underway in many countries. Indeed, the construction of additional fuel cycle facilities will be an inevitable consequence of the anticipated growth in nuclear power around the globe. But approaches to the fuel cycle are pushed in different directions as a result of conflicting objectives. Some countries seek enrichment capability in order to assure fuel supply. Others want to pursue recycling in order to extend fuel supply, to recover the energy value in used fuel, or to reduce the challenge of waste disposal. But the construction of new enrichment facilities and the recycling of used fuel raise serious proliferation concerns. Other important factors also bear on the issue, including concerns for economics and for safety and security both in installations and in the transport of nuclear materials and highly radioactive waste.

The identification of the appropriate path forward will require a reconciliation of many partially conflicting objectives. Technology and new international arrangements may offer opportunities that reduce the conflict among objectives, but no doubt will not eliminate them entirely. Although we do not believe that any one objective should be viewed as predominant, no approach will survive the test of public acceptability if safety and security are not assured. We welcome the reexamination of the fuel cycle, but urge that all factors be given appropriate weight. Moreover, there are international issues that deserve early and priority attention by the Member States. Research to develop recycling technologies that would facilitate the reconciliation of the competing objectives should be aggressively pursued. At the same time, efforts should be made to strengthen the international non-proliferation framework before the construction of new facilities for enrichment or recycling diminish the opportunities to chart a better course.

Dr. Mohamed ElBaradei

August 28, 2007

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I hope that these insights are helpful to you. As always, INSAG would be happy to respond to questions or to assist on any particular issues that are of concern to you.

Best regards.

Very truly yours,

A handwritten signature in black ink, appearing to read "Richard A. Meserve". The signature is written in a cursive style with a large initial "R".

Richard A. Meserve

cc: Tomihiro Taniguchi
INSAG members