How to cope with low-probability risks of large-scale catastrophes? : a critical examination of the Japanese nuclear “governance” 

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German sociologist Ulrich Beck points out in his seminal book on risk, which is geared towards nuclear technology, recombinant DNA research, reproduction technology, and synthetic chemistry, that contemporary advanced sciences and technologies are running out of control. [Beck, 1986] Whether they are really running out of control or not, his diagnosis reflects and vividly brings out the acute but amorphous fear many contemporary people feel towards the present state of science technology. No doubt, new “risks” (the potential of harms) that did not exist in earlier time have been created. [Adams, 1995: 180] New risks resulting from the rapid progress of sciences and technologies are distinct from older dangers, by virtue of their scale and nebulousness. In fact, such phenomena as radiation contamination, genetic recombination, and chemical toxicity, affect not only the life and health of present generations but also those of future generations in addition to the ecosystem as a whole. Their effects are not confined either to a certain specific life-space or to a specific historical time. Furthermore, such risks are, unlike many of the old dangers, neither visible nor touchable, at least for ordinary citizens: precision instruments and sophisticated scientific knowledge are required to fully understand their nature and probability. How is the government to cope with risks of this kind? Is trial and error an appropriate guide for policy choice? Or, is a more conservative approach recommended? With such questions that are at once practical and theoretical in mind, this essay focuses on the history of Japanese nuclear “governance”.

1. The worst ever nuclear accident in Japan

At 10:35 a.m. Japanese Standard Time on September 30, 1999, there was a nuclear accident at a uranium processing plant operated by JCO Co. Ltd. in the village of Tokai (140km north-east of Tokyo). Initially, neither the plant workers nor overseers were able to fully understand what was happening at the site. A substantial amount of time was also required before the local government became fully aware of the exact nature of the accident. Though an atmospheric radiation count of 0.84 mSv/hour, which was approximately 10,000 times of the annual dose limit, was monitored, the local government announced that the radiation count would soon be back to normal. Gradually, however, it became clear that it was the worst type of nuclear accidents ever experienced in Japan, a criticality accident. According to the National Police Agency, the accident exposed at least 55 people

* This essay is partly based on my article “Can the Japanese Nuclear Sector Survive?” I contributed to Seisaku Kagaku (Policy Sciences) vol.9-2, 2002.
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to significant doses of radiation: 45 workers, three firefighters, and seven people at a nearby golf range. Three JCO employees working at the accident site were taken to a local hospital, later to be transferred by helicopter to the National Institute of Radiological Sciences in Chiba City. One of those three was exposed to 8 to 17 Sv of radiation. Thirty-nine households were evacuated and the area within a 200m radius of the site was declared off-limits. In addition, all roads within a 3km radius of the site were closed and 310,000 residents within 10km of the site were advised to stay indoors.

Sixteen hours after the accident (2:30 a.m. on October 1), a team of volunteer JCO workers, whom the media people called a “suicide corps”, went to the space underneath the floor of the accident site, extracting coolant water in order to contain the criticality reaction. The criticality condition ceased at 6:00 a.m., which was nearly twenty hours after the accident. At 4:30 p.m. the same day, the request to residents to stay indoors was lifted. At 6:30 p.m. of the following day (October 2), the Japanese government issued a “Declaration of Safety” and called off the evacuation request. Several months later (December 19, 1999), two of the three most seriously exposed JCO workers died in hospital notwithstanding a series of the most advanced available medical treatment.

The Science and Technology Agency (STA) officially announced that the accident was level 4 on the IAEA International Nuclear Event Scale, which has a range of 0 to 7. CNIC (Citizens’ Nuclear Information Center), an active nuclear watchers’ organization with a reputation for reliable nuclear-related information, however, claims that it was in reality a level 5 accident on a par with the 1979 Three Mile Island accident in US and the 1957 Windscale fire in UK. The notorious 1986 Chernobyl scored a full 7. CNIC estimates, on the assumption that roughly 1~10 grams of uranium-235 underwent fission and 1/100 of the produced $10^{16}$ to $10^{17}$ Bq (becquerel) fission materials (radioactive materials) were released, that the amount of radioactive materials released was $10^{14}$ to $10^{15}$ Bq, serious enough to classify this accident as level 5. [CNIC, 1999]

The JCO Tokai plant normally deals with low enrichment (5% or lesser enrichment) uranium for light water reactors. At the time of the accident, however, workers were processing highly enriched uranium to be used to fuel Joyo Fast Breeder Test Reactor (MARK 3). They poured 16kg of uranium-235 enriched to as high as 18.8% into a precipitation basin that was supposed to be filled with no more than 2.4kg of uranium of this enrichment concentration. Thus was triggered the criticality accident.

To date, the world has witnessed more than 50 criticality accidents. Most of them, however, were in the 1950’s and 1960’s. It has long been an established rule for nuclear fuel processing not to bring too much enriched uranium together in one place. When making this mistake, the uranium goes critical, triggering a chain of reactions that will generate heat and radiation. In the worst case, it may explode like an atomic bomb. JCO as an organization broke this rule in an incredible fashion, causing the criticality accident. Herein lies the direct cause of the disastrous accident.

Why did JCO instruct, or at least tolerate, such risky processing procedures as
using a larger precipitation tank (35-pound capacity) instead of a proper smaller one, or transferring uranium solution in a stainless steel pail with bare hands, fully aware of the risk of causing criticality? The reason is quite simple: these techniques are more cost (time)-saving. JCO is reported to have been in urgent need of substantial cost reduction.

Since the deregulation of the electricity industry in 1995, major electric power companies operating nuclear power plants have come to rush to lower-price fuel. This deregulation of the electric industry proved to be a serious blow to Japanese fuel processors, which were not strong enough in competitiveness vis-à-vis foreign counterparts. Thus cost-reduction and organizational restructuring have become an overriding necessity for Japanese fuel processors. JCO was no exception. In 1996, JCO cut back on personnel in the manufacturing section from 68 to 38 persons. As a result, the annual output per one employee skyrocketed from 10 to 19 tons. In spite of such tremendous restructuring efforts, however, JCO continued to lose its market share. The 1998 sales were only 1.7 billion yen, half of its 1993 peak sales of 3.3 billion yen. JCO was on the verge of falling into deficit operation when the criticality accident occurred. (Asahi Shinbun, October 30, 1999) There seems to be good reason to believe, therefore, that deteriorated working conditions due to organizational restructuring led JCO to instruct, or at least tolerate, cost (time)-saving but risky uranium processing procedures.

The Basic Guidelines for the Licensing of Nuclear Facilities put into effect on July 2, 1980 clearly stipulate that all facilities in Japan dealing with nuclear fuel materials must set up counter measures to prevent criticality reactions under all possible scientifically conceivable conditions. However, there proved to be no installation for criticality control in the precipitation basin where the reaction occurred. The Guidelines also require nuclear facilities to establish contingency plans to respond effectively to a criticality accident. JCO, however, was unable to take any effective measures to stop this criticality and left it alone. It is obvious that JCO was in violation of the national Guidelines.

All of these facts clearly indicate that a number of risky and illegal operations on the part of JCO resulted in the disastrous accident, which must bear primary responsibility as an organization. This, however, never implies that STA and the Nuclear Safety Commission (NSC) are free from any blame. They have hitherto justified their regulatory authority over the nuclear industry on the assumption that private companies are not trustworthy, often tending to sacrifice safety for profits if left alone, the cogency of which was demonstrated once again in tragic manner by the criticality accident at Tokai village. In other words, they have made tremendous efforts to impress politicians (and the general public) that nuclear safety would be ensured were they trusted with stout regulatory authority, and have been successfully appropriated an enormous amount of public funds each year. It would probably not be too much to say, therefore, that they must take responsibility for the accident to a greater extent than JCO.

The STA and NSC have yet to explain satisfactorily why they ever licensed such an illegal plant. JCO is reported to have maintained in a document forwarded to government regulators in 1983 that criticality reactions could never
occur in their plants. (Washington Post, October 3, 1999) Judging from the fact that the plant was promptly licensed, STA and NSC must have taken such groundless assertions by JCO at face value. Even granting that the company's foolishness to mix uranium together in quantities sufficient for fission reaction was unthinkable from the point of view of regulators, their initial decision to license the plant short of fool-proof (fail-safe) security measures remains an inexcusable error.

Furthermore, STA is to be severely blamed for having failed to implement valid checkups of the plant to ensure compliance with safety rules. The STA inspectors did provide checkups of the plant nearly once a year in the period of 1984~1992, however, they failed to carry out detailed inspection of the uranium re-conversion facilities except in the 1987 inspection. Mysteriously enough, there were absolutely no inspections since late autumn of 1992. (Asahi Shinbun, October 9, 1999)

This fact is all the more mysterious when we take into consideration that a level 3 nuclear accident accompanying fire and explosion occurred on March 11, 1997 at a nuclear facility operated by the Power Reactor and Nuclear Fuel Development Corporation (PNC). PNC is one of the governmental nuclear institutions under the direct control of STA. The PNC-operated nuclear facility where the accident occurred is sited in the same village as the JCO Tokai plant. The STA, based on the “thorough” investigation of the accident, introduced a number of institutional and managerial reforms in 1998. The idea of stationing staff of the safety regulatory authorities at PNC was thus coined. Staff was expected to be monitoring the compliance with the national safety rules on the part of nearby nuclear facilities as well as PNC. Did they then inspect the JCO Tokai plant? Yes, they did twice prior to the criticality accident. They did not, however, set foot in the uranium re-conversion plant and check the uranium processing procedures there. Why? The uranium conversion operations at the plant had coincidentally been suspended on either occasion. (Asahi Shinbun, October 9, 1999)

2. Intensified public sentiment against nuclear sector

The great majority of Japanese people, being citizens of the only atom-bombed nation in the world, have long felt extremely nervous about nuclear energy. The Government has spent an enormous amount of money (roughly 37~38 billion yen in total by 1998) for public relations activities to wipe away citizens' fear of nuclear energy (nuclear allergy), stressing the crucial importance of nuclear energy for the nation's economic development. [Sakurai, 1999] Furthermore, the Japanese government has been ingenious enough to eschew, under a nuclear umbrella of the USA, the research and development of domestic nuclear weapons. The nuclear power industry has also been spreading a lot of propaganda, emphasizing the safety of nuclear power generation and the clean (environment-friendly) nature of nuclear energy.

Partly due to such public relations efforts, the Japanese people had become
fairly permissive of nuclear power generation by the end of 1960's. Even the 1979 Three Mile Island and the 1986 Chernobyl did not cause much unrest among the Japanese. The majority was still able to hope that disastrous nuclear accidents would not occur in Japan, which had a reputation for quality high-tech manufacturing and a meticulous workforce. This permissive public opinion presents a sharp contrast to the radically hostile attitude to the use of nuclear technology for military purposes, which has remained unchanged ever since the nightmares of Hiroshima and Nagasaki.

The year 1995 proved to be a turning point in Japanese nuclear history. On December 8 of 1995, a sodium leak and fire accident occurred at the fast breeder reactor Monju operated by the PNC Tsuruga plant. Though this accident was far from a minor one, what terrified the Japanese people much more than the accident itself was the fact that a nuclear institution under the direct control of government had tried to fabricate and alter critical information and data. It is no wonder a large number of the Japanese, that had already become skeptical about the Government's ability in risk management after the Hanshin-Awaji earthquake and a series of ominous crimes by a quasi-religious cult in early 1995, have come to believe that there must be a fatal flaw in nuclear regulatory system as a whole.

To make matters worse, a nuclear-related accident of level 3 occurred on March 11, 1997 at the Tokai Bituminization Facility operated by PNC. Information fabrication and alteration by PNC were again made public. Another accident followed in July 1999, this time at the Tsuruga nuclear power plant operated by the Japan Atomic Power Co., Ltd. Cooling water leaked from a pipe in the building that housed the reactor. It took the company 14 hours to shut down operations after the leak was discovered. Radiation caused by the leak is reported to have been 11,500 times the safety limit, which indicates that the accident did have the potential to result in catastrophic disaster.

With each accident and scandal, the Japanese government set up investigation committees, put up improvement measures, and fined responsible parties. Furthermore, the government dismantled the notorious PNC on October 1, 1998, to be replaced by the Japan Nuclear Cycle Development Institute (JNC). It was when such improvement efforts were supposed to have been in process that the criticality accident occurred at the JCO Tokai plant. As the government had assured time and again that, with the introduction and implementation of improvement measures based on the thorough ex-post analysis of accidents, another major nuclear accident would never take place in Japan, the accident was all the more shocking for the Japanese. The future prospect for the Japanese nuclear sector, which had been already much deteriorated by then, has now become desperate.

On August 4, 1996 Japan's first referendum on the construction of a nuclear power plant was held in Maki Town of Niigata prefecture, in which well over 60% of voters voted against the construction. With this voting result in hand, the mayor of Maki Town decided not to sell the town land to Tohoku Electric Power Company. Although local governments are not institutionally in a position either to permit or cancel the construction of nuclear-related facilities with all the rights resting with
the central government, this decision by the mayor proved to be a fatal blow to the company. The company was forced to indefinitely freeze its initial construction plan. In addition, this epoch-making referendum has much encouraged anti-nuclear rallies.

Unlike the USA, USSR, Germany, Sweden, and France, Japan was still able to continue expanding the nuclear sector in the 1980's, even into the early 1990's. As many as 16 commercial power reactors of the current total of 51 started operation in the 1980's, and 15 in the 1990's. Amazingly enough, Japan had successfully added an average of two reactors per year up until the early 1990's. However, since two reactors went into operation in June 1997, no electric company has been successful in starting operation of a new nuclear power reactor. This is mainly because of a more intensified public sentiment against nuclear power reactors. The substantial decline of demand for electricity due to economic recession has also proved to be an adverse wind for electric companies.

3. The nuclear regulatory system in Japan

Japanese nuclear policy was implemented, up until January 2001, through two separate government offices, MITI (Ministry of International Trade and Industry) and STA. The introduction, improvement, and utilization of commercial nuclear power reactors, the import of uranium, the outsourcing of uranium enrichment and spent fuel reprocessing, was under the jurisdiction of MITI. The STA, on the other hand, mainly took charge of the research and development of nuclear technologies still in experimental stages. The notorious PNC was under the control of STA together with another government-funded corporation, the Japan Atomic Energy Research Institute, and three national research institutes. PNC was the key institution under STA. PNC was assigned four missions: research and development of (1) advanced thermal reactors, (2) fast breeder reactors, (3) uranium enrichment, (4) nuclear fuel reprocessing.

It is the Long-term Program on Nuclear Energy that constitutes the core of Government nuclear policy, and the Atomic Energy Commission (AEC) is in the position to draw them up. Since AEC announced the first Program in September 1956, it has regularly made revisions to the previous one. Despite the fact that AEC had such a vital policy-making role to play, it was not equipped with its own secretariat. The Secretary of STA automatically assumed the office of chairperson of the Commission, STA providing secretarial work for the Commission. The AEC was, as it were, a bird without wings. It is partly for this reason that AEC rarely, if ever, directed or redirected the government nuclear policy of its own accord. Its function basically remained to confirm and authorize the consensus already reached among major policy actors with vested interests in the expansion of the nuclear sector.

The administrative apparatus in charge of monitoring nuclear-related facilities to ensure citizens' safety is the Nuclear Safety Commission (NSC), which was established on October 4, 1978. NSC is modeled after the Nuclear Regulatory Commission (NRC) in the US. Unlike NRC, which is an independent administrative commission with strong authority, however, NSC has been little
more than a sheer advisory body, all rights to permit (or cancel) nuclear facilities resting with STA or MITI. Furthermore, while NRC commands its own staff of more than 3000, NSC has been without either its own secretariat or staff. NSC depends on STA for secretarial work. Given this fact, it is quite natural that NSC has tended to be rather hesitant about advising new safety measures the enforcement of which is, though highly desirable in terms of nuclear safety, likely to jeopardize the long-standing government policy to expand nuclear sector.

In the 1993 general election, the Liberal Democratic Party (LDP), which had been in power for almost half a century except for a very brief period soon after the end of World War II, suffered a historical defeat. It gave birth to the anti-LDP coalition government headed by the Prime Minister Hosokawa. He appointed Mr. Eda, a well-known Diet member from the Social Democratic Party, to the post of Secretary of STA. As the chairperson of AEC, he took initiative in trying to boost further information disclosure and democratization of the policy-making process in nuclear-related issues. Among the measures he instituted was a public hearing on the future direction of nuclear policy, which took place in March 1994. AEC members, for the first time in Japanese nuclear history, invited and heard from a couple of radical critics of nuclear power generation. In this sense, the hearing was an epoch-making event in spite of the fact that the great majority of invited speakers were, more or less, sympathetic with the current government policy.

The 1995 accident at the fast-breeder reactor Monju accelerated this new current. On January 23, 1996 governors of three prefectures (Niigata, Fukushima, and Fukui) that had hitherto accepted in aggregate over 60% of all the nuclear reactors in Japan issued a joint proposal to the Japanese government. In this proposal, they stressed, first, the need for a more cautious approach on the part of Government to such controversial issues as plu-thermal plans and nuclear fuel cycle projects. Second, they proposed that the government provide more opportunities (public forums) to openly discuss nuclear-related issues. Third, they urged for a prompt review of the Long-term Program of Nuclear Energy. In response to this proposal, Prime Minister Hashimoto, who had by then successfully formed the LDP-led coalition government, directed MITI and STA to devise improvement measures for nuclear governance. One of the ideas coined by MITI and STA was to hold the Round-table Talk on Nuclear Policy.

The goals of the Talk were, like the public hearing in 1994, to further open debate and hopefully reach consensus concerning the future direction of nuclear policies. A series of talks, eleven in total, took place from March through September 1996. Six moderators and a total of 127 speakers were carefully selected, nominally by AEC but substantially by STA. Each time a few speakers critical of the government nuclear policy were invited, while the great majority proved to be always pro-government people. The historical significance of these talks is in that the principle of publicity was upheld to a considerable degree. Proceedings of each talk and their minute records are open to the public, even accessible through internet. Videotapes are also available. The talks, however, were closed without any remarkable achievements, only to make public once again the existence of intense confrontation over a number of key issues.
The second series of round-table talks began in September 1998, and since then such talks have been institutionalized as a vital part of policy-making process. There is no evidence, however, that they have had any effect on Government nuclear policy. The Japanese government has confirmed time and again, even after the criticality accident, that the core of nuclear policy is, as before, in the development of fast breeder reactors, implementation of plu-thermal plans, and promotion of nuclear fuel cycle projects.

On December 3, 1997 the Administrative Reform Committee headed by the Prime Minister Hashimoto announced the basic principle for administrative reform. The new system started in January 2001. By far the most dramatic reform in the context of nuclear issues was the dismantling of STA. The newly established Cabinet’s Office is now in charge of AEC and NSC. The giant Department of Economics and Industry has gained control of most of the regulatory authority over the development and utilization of nuclear energy. The responsibility for the implementation of nuclear policy in general, on the other hand, now rests with the Department of Education, Science, and Technology, with the exception of the development and utilization of nuclear energy.

It is not yet clear, however, if and to what extent the authority of AEC and NSC has been strengthened vis-à-vis other governmental bodies. In addition, the much-criticized characteristic of the Japanese administrative system, namely that one and the same department or agency simultaneously promotes and regulates a specific policy area, has little changed. Long-term program on nuclear energy has undergone almost no change, either.

4. Is trial and error an appropriate guide for nuclear governance?

The Round-table Talks have hitherto failed to lead to any substantial consensus regarding the future direction of nuclear policy. The records of Talks clearly show that there have been few constructive debates or fruitful dialogues either between AEC members and invited speakers or among invited speakers themselves. The reason for these failures undoubtedly lies in the existence of fierce confrontation among participants over crucial policy issues and philosophical beliefs underlying them.

Participants can be classified, according to the philosophical beliefs upon which they, whether intentionally or implicitly, base their policy claims, roughly into two groups: the nuclear progressive and the nuclear conservative. The former emphasize the arguably enormous benefits expected to follow from the utilization of nuclear power. They believe in the scientific and technological feasibility of minimizing the health and environmental risks of nuclear accidents and radiation-contaminated wastes. The latter, on the other hand, recommend a more conservative approach to the intractable uncertainties and catastrophic risks inherent in the utilization of nuclear power.

The core of the nuclear progressives’ philosophy is in their firm belief that anything technologically possible is good as long as its utilization contributes to further one or several desirable policy goals, be they economic development or environmental preservation. Both nuclear fuel cycle and plutonium utilization are
possible today, at least in narrow technological terms. They would probably bring about no small benefits of various kinds as well. Important to note, however, is that everything good in one or several respects is normally also accompanied by undesirable consequences in other respects. For instance, the construction of a motorway, which itself might be good in that it enables rapid transportation and consequently boosts economic development, often results in air pollution and damage to an ecosystem.

Once a fatal accident occurs at a plutonium-utilizing nuclear reactor, no matter how low its probability, it will unavoidably have deep and prolonged effects not only on the life, health, and welfare of a tremendous number of people including future generations but also on the ecosystem as a whole. In addition, radiation-contaminated wastes produced in the process of nuclear power generation and fuel reprocessing will continue to pose serious hazards for an almost indefinite time, unless nuclear scientists make a revolutionary breakthrough in waste-disposal methods, which is unlikely at least in near future. The half-life of plutonium-239 is 24,000 years, that of neptunium-237 is 2,130,000 years, and that of iodine-129 is 16 million years. The operation of nuclear reactors, even of normal light water reactors using only uranium for fuel, ends in pushing off on future generations the heavy burden of always having to take the utmost of care in preventing isotope leaks from storage facilities, thus making them substantially worse off. Everything considered, it is not clear at all if nuclear power generation in general, let alone by plutonium-utilizing reactors, in the long run, is really good for society as a whole.

For the nuclear progressive, repeated accidents, even those of the Chernobyl level, are not a decisive reason for discontinuing nuclear power generation, but rather a good opportunity for learning. Nuclear experts and regulators are able to learn how to better deal with nuclear risk, namely how to lower the probability of catastrophic accidents, only through the detailed ex-post analysis of such accidents. What is of crucial import is, according to their conviction, how to use risk to get more of the good and less of the bad, not how to avoid risk: more harm than good is done by efforts to avoid risk. Trial and error is thus their basic strategy for managing nuclear risks.

There is nothing intrinsically wrong in the trial and error approach to risk per se. True, without trials there can be no errors; but without these errors, there is also less learning. Wildavsky is probably right in claiming that:

> Trial-and-error risk taking is the preferable strategy for securing safety. Encouraging trial and error promotes resilience—learning from adversity how to do better—while avoiding restrictions that encourage the continuation of existing hazards. Increasing the pool of general resources, such as wealth and knowledge, secures safety for more people than using up resources in a vain effort to protect against unperceivable, hypothetical dangers. [Wildavsky, 1988: 2]

In contrast, the trial without error (no trial without prior guarantees against
error) approach to risk, which allows no change unless there is solid proof that the proposed substance or action will do no harm, may not be an advisable one in most cases.

Even granting the superiority of trial and error over no trial without prior guarantees against error as the general approach to managing risks, there still remains a question if the former is always an advisable approach. Are there not any exceptional cases in which its general validity must be laid aside? The following rather lengthy argument by Goodin is very instructive in this regard:

Trial and error, and learning by doing, are appropriate—either for the epistemic task of discovering what the risks are or for the adaptive task of overcoming them—only under the special conditions. First, we must have good reasons for believing that the errors, if they occur, will be small—otherwise the lessons may prove far too costly. No doubt some nuclear mishaps will be modest. But for the same reasons that small accidents are possible, so too are larger ones; and some of the errors resulting in the failure of nuclear reactor safeguards may be very costly indeed. This makes trial and error inappropriate in that setting. Second, errors must be immediately recognizable and correctable. The impact of radioactive emissions from operating reactors or leaking waste storage sites upon human populations or the natural environment may well be a “sleeper” effect that does not appear in time for us to revise our original policy accordingly. Finally, learning by doing is a flawed strategy because it is often unclear how to describe the salient features of what you have done in the past and hence what “lessons” to draw from the experience. [Goodin, 1982: 189]

Wildavsky does acknowledge that there are cases in which we are better advised not to apply the strategy of trial and error. The crucial question for him is “one of proportion (How much of each strategy?), of relevance (What kinds of dangers deserve the different strategy?), and ultimately, given uncertainty, of bias (When in doubt, which strategy should receive priority?)”. [Wildavsky, 1988: 37] Excellent argument! He does not, however, make clear which strategy to apply to nuclear power generation. He does little more than to lament that the development of nuclear power has been too rapid and too large-scale:

I am not arguing the desirability of nuclear power. Perhaps nuclear power was developed too rapidly or subsidized too heavily, so that the plants were built too big, too costly, too close to population centers, and too exposed to catastrophe. A slower and smaller approach might have encouraged the development of nearly fail-safe designs (total safety is beyond our reach), thereby ruling out the worst. [Wildavsky, 1988: 236]

Detailed computation of benefits and costs accruing from the research and development of nuclear energy remains to be done in order to reach a well-grounded policy proposal. In addition, sophisticated analysis of the nature of
nuclear risks is badly needed. These, however, I would like to reserve for another occasion. Allow me to conclude my speech by calling your attention to two observable facts, which in my opinion are likely to support more the conservative approach to nuclear risks.

First, most people are disproportionately averse to risks of large-scale catastrophes. An expected fatality of one person per year might mean that there is a one-tenth chance of ten people dying (Case A), or it might mean that there is a one-millionth chance of one million dying (Case B). Cases A and B are indifferent in purely statistical terms. It is “irrational” from the statistical point of view not to regard A and B as equally risky. In psychological terms, however, there is reason for the people to have more intense fear of Case B than of Case A. Prudential policy-makers are advised to take this psychological fact seriously. Casual risks like car crashes, typhoons, and workplace accidents are of the Case A type. On the other hand, risks of catastrophes like the worst possible nuclear accidents and the spread of fatal diseases carried by microbes carelessly released in the environment are no doubt of the Case B type.

Second, learning by doing, which is by far the most critical element of the successful trial and error both for individuals and organizations, is no easy task, especially for the latter. Each organization has its own culture, which is often so stubborn as to resist to any change. An innovative mentality will tend to be weaker among members as organizations grow in size. This is more true of government agencies than of giant private firms: the fear of bankruptcy forces the latter into unremitting organizational reforms, thereby reducing the production cost to the lowest possible level.

Top government agents are not always indifferent to transforming organizational culture and providing more reliable regulatory measures. Their concern for organizational reform is, however, usually not as strong and enduring as the survival instinct found in entrepreneurs. Even if they were firmly determined to improve agency performance, they would probably find much difficulty in defeating the inertia among rank-and-file public servants that have long enjoyed, at least in Japan, a privileged employment guarantee and standardized salary schedule. [Adachi, 1999: 226] The history of the Japanese nuclear regulatory administration seems to reaffirm this point. Frankly, we can hardly expect STA and its successor to establish the culture of learning by doing, thereby become an efficient nuclear regulatory body.

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