FUKUSHIMA NUCLEAR CATASTROPHE 3.11: SYSTEM PATHOLOGY OF SOCIAL ORGANIZATIONS

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ABSTRACT

The magnitude 9.0 earthquake and tsunami that struck northeast Japan on March 11, 2011, were unavoidable natural disasters, but we consider the subsequent breakdown of the Fukushima nuclear power plants to be a catastrophe created by avoidable human errors – an organizational disaster. We review the mistakes that have led up to the present nuclear crisis, and recommend several steps to avoid similar crises in the future. These include issues of (i) Fukushima nuclear catastrophe as system pathology of social organizations (ii) the Fukushima nuclear station's non-rational location in a quake-prone area, (iii) the ageing nuclear reactor system – business ethics, (iv) systemic fatigue in organizational management – social responsibility, (v) irrational governance in nuclear policy with regard to the longevity of nuclear reactors, (vi) dynamics of system pathology – socio-biological system hazard, physical ageing, social management.

Keywords: organizational cybernetics, business ethics, social responsibility, system pathology, governance

I. Introduction – Fukushima Nuclear Catastrophe as System Pathology of Social Organizations

The earthquake and tsunami that struck northeast Japan on March 11 of this year were natural disasters of unprecedented scale. More than 24,000 people lost their lives; about 100,000 people have evacuated the area; more than 250 billion dollars of damage was done; and it is expected that rebuilding the homes, businesses and infrastructure of a large section of Japan will take more than 30 years. While most of the time, energy and money should now be devoted to reconstruction, there are fundamental questions with regard to the failure of the nuclear power plants that demand to be answered. The starting point of our research is the question: Was the yet-unresolved Fukushima nuclear power plant accident an unfortunate natural disaster or an avoidable organizational disaster? For the reasons explained below, we conclude that it was a man-made ***catastrophe*** (Thom & Zeeman, 1977). The origins of the Fukushima nuclear catastrophe lie in system pathology.

II. The Fukushima Nuclear Station's Non-rational Location in a Quake-Prone Area

The primary and fatal errors that led to the Fukushima disaster were made already in the late 1960s and early 1970s when the construction of multiple nuclear power plants on the northeast shoreline of Japan was approved. It is of course well-known that

earthquake tremors are frequently felt in nearly all corners of Japan, but the historical record is unambiguous in indicating that the Tohoku Region has experienced the most frequent and most severe earthquakes in Japan (Figure 1), and is a region where catastrophic tsunamis have wiped out coastal towns and villages within recorded history. Magnitude 7~8 earthquakes have frequently occurred in the Tohoku region and the largest earthquake in Japan occurred in the same region about 1000 years ago, the so-called Jogan earthquake. It is consequently beyond understanding that specifically the shoreline of the Tohoku area would be chosen as the location for nuclear facilities.

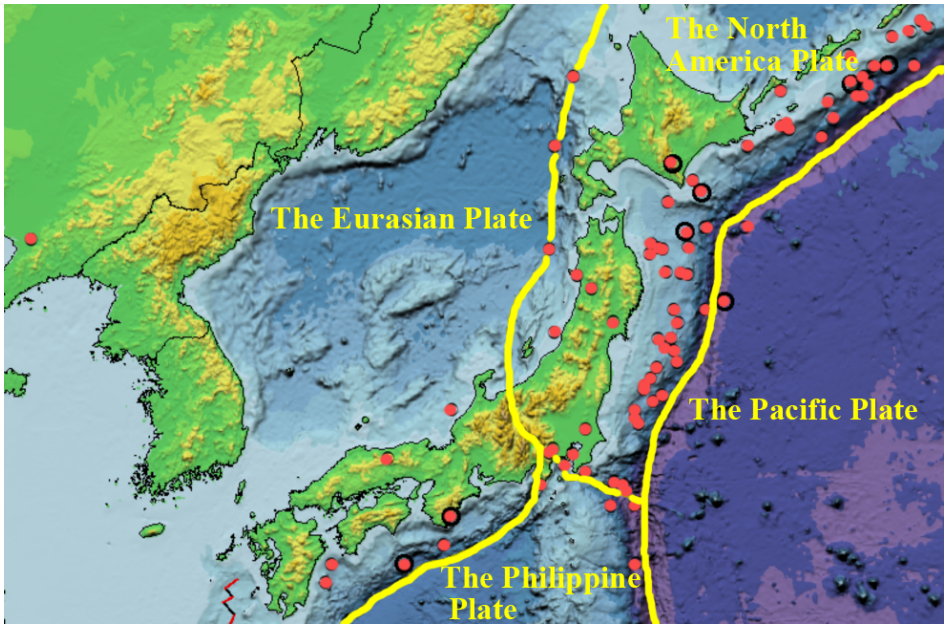

Figure 1: Magnitude 6.0 or greater earthquakes at depths of less than 35 kilometers in Japan over the past 4 decades (http://nhb-arcims.si.edu/ThisDynamicPlanet/index.html). The vast majority are found to have occurred along the fault line off the Tohoku shoreline. Japan is the only area in the world where four plates within several hundred kilometers.

The relative proximity of the Tohoku region to the industry-dense, power-hungry regions of metropolitan Tokyo was of course a prime factor in the selection of sites for power plants. The low cost of rural land, the likely economic benefits of building large facilities in the Tohoku region and the absence of an effective, populist opposition to the construction of nuclear power stations were also relevant factors. But, what the power companies and politicians could not provide on their own was a convincing argument concerning the safety of the facilities. For that reason, they needed to solicit the advice of geologists and nuclear physicists for objective, disinterested, scholarly approval of the construction plans.

In fact, there was an abundance of academics willing to approve the plans of the power companies for paltry sums. Some of the scholarly advisors have belatedly come forth with their apologies and "*mea culpa*" rationalizations, but the bottom-line is that they were rewarded for agreeing with the power companies that inordinate safety risks were not being taken in constructing those nuclear facilities – facilities essentially at sea-

level in one of the most earthquake-prone and tsunami-prone regions in the world. One such advisor has recently confessed that his advisory fee over a period of years was 936,000 yen ($11,700 in US dollars) per month, regardless of the frequency of the actual meeting of the advisory committees (Aera, May, 2011). It is difficult to decide which is the greater crime: the continued operation of trouble-prone, ageing nuclear reactors by the power companies (Section III), the absence of independent government oversight of the power plants (Section IV) or the willingness of academic yes-men and lackeys to approve the construction and continued operation of power plants well beyond their period of trouble-free operation.

III. The Ageing Nuclear Reactor System – Business Ethics

The Fukushima Daiichi Nuclear Power Station includes 6 nuclear reactors, all of which are more than 30 years old (Table 1) and all of which were initially scheduled to be decommissioned at 30-40 years.

Table 1. Ageing of Nuclear Reactors in Japan (Source: Masai, 2009).

Nuclear Power Plant Name	Period of Operation	Latest Permission
Tsuruga (West) reactor 1	**41 years** and 2 months	○
Mihama (East) reactor 1	**40 years** and 6 month	○
Fukushima Daiichi (East) reactor 1	**40 years** and 2 months	○
Mihama (West) reactor 2	**38 years** and 10 months	○
Shimane (West) reactor 1	**36 years** and 2 months	○
Fukushima Daiichi (East) reactor 2	**36 years** and 10 months	○
Takahama (West) reactor 1	**36 years** and 6 month	○
Genkai (West) reactor 1	**35 years** and 7 months	○
Takahama (West) reactor 2	**35 years** and 6 month	○
Fukushima Daiichi (East) reactor 3	**35 years** and 2 months	○
Mihama (West) reactor 3	**34 years** and 5 months	○
Igata (West) reactor 1	**33 years** and 8 months	○
Fukushima Daiichi (East) reactor 5	**33 years** and 1 month	○
Fukushima Daiichi (East) reactor 4	**32 years** and 7 months	○
Fukushima Daiichi (East) reactor 6	**31 years** and 7 months	○

To begin with, the life of the nuclear reactor is not legally provided. Even if a nuclear reactor is found to be ageing, power companies can operate them semi-permanently, provided that it passes the maintenance inspection every decade. Specifically with regard to the Fukushima Daiichi power plant's reactor No.1, the Nuclear Industry Safety Agency permitted its operation for more than 40 years on February 7, 2011 (NISA, 2011, p.2). These nuclear reactors were not decommissioned in spite of 120 disclosed troubles and a still-uncertain number of undisclosed troubles (Masai, 2010, p.93).

Figure 2 shows the reported hazards from exposure to radiation, such as "cracks in the nuclear reactor" and "loosening of bolts."(Nihon Kogyo Shinbun, 2003, p.14). The troubles were systematic, and the frequent inappropriate handling of the troubles and the complete absence of efforts to revamp the power plants from the ground up represent a lack of concern from the perspective of safety management. This has been the nature of the business ethics – or, rather, the lack of business ethics – exhibited by the Tokyo

Electric Power Company over many decades. It is evident that Tokyo Electric Power Company's management places more importance on economical ***growth*** (Bertalanffy, 1976, pp.47-48) than on social welfare.

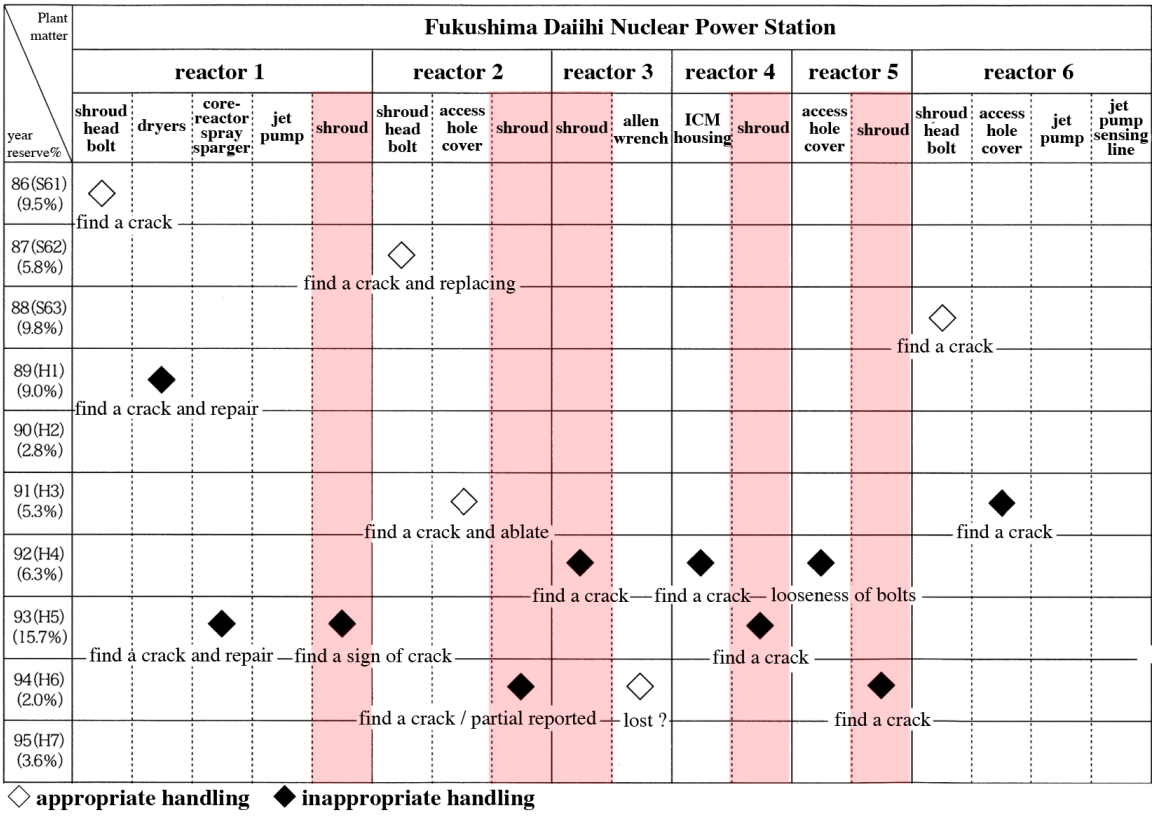

Figure 2: The number of appropriate and inappropriate responses to technical problems at the Fukushima Daiichi Nuclear Power Station. The pink regions indicate the repeated "inappropriate handling" of serious problems, specifically, the concealment of cracks in the shroud (source: Nihon Kogyo Shinbun, 2003, p.14).

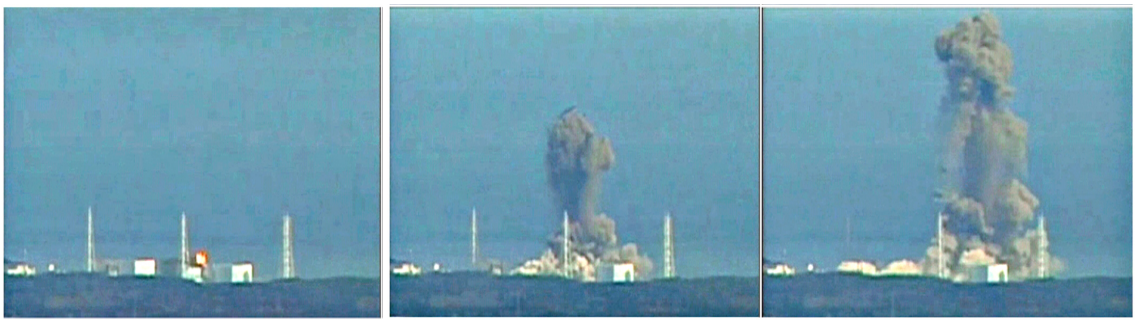

Figure 3: The explosion at Fukushima reactor #3 on March 14, 2011 (source: NTV, 2011).

The Fukushima nuclear power station has continued to operate in spite of signs of ageing and, indeed, until the recent disaster, three new reactors had been scheduled to be built in the same location without first decommissioning the old reactors. The damage of

this accident has not been confined solely to the local populace's exposure to radiation; there has also been significant damage to international relations. Various foreign countries have expressed misgivings about the spread of radioactive substances within Japan and their possible spread overseas. Two months following the natural disaster, the damage has continued to enlarge both economically and socially to the entire country. Moreover, the international community has clearly lost confidence in Japan's ability to respond effectively to domestic problems.

IV. Systemic Fatigue in Organizational Management – Social Responsibility

'Shell melt-through' generally means 'melt down'. This occurred already about 1 hour 40 minutes following the earthquake due to a loss of back-up electric generation for the cooling operation. The possibility of this danger had already reported by the Japan Nuclear Energy Safety Organization in October, 2010 (JNES, 2010, p.(4)-7). Although the nuclear policy explicitly states that "even if the probability is low, it is necessary to take steps to remedy possible dangers," measures were not taken. According to the report of Nuclear Industrial Safety Agency (NISA, 2010, p. 1), serious violations of nuclear waste management in nuclear reactors No.1, No.3 and No.5 reactor of the Fukushima Daiichi Nuclear Power Station were pointed out. Moreover, one level 2 violation was pointed out with regard to nuclear waste management, but the troubles were concealed and records falsified by both the Tokyo Electric Power Company and General Electric.

Figure 4: Concealment of troubles and falsification in the records by TEPCO and GE. The red line indicates the period at which multiple incidents and troubles began – generally suggesting that the trouble-free period is somewhat less than 20 years.
So furce: Civil Nuclear Information Center (2002),

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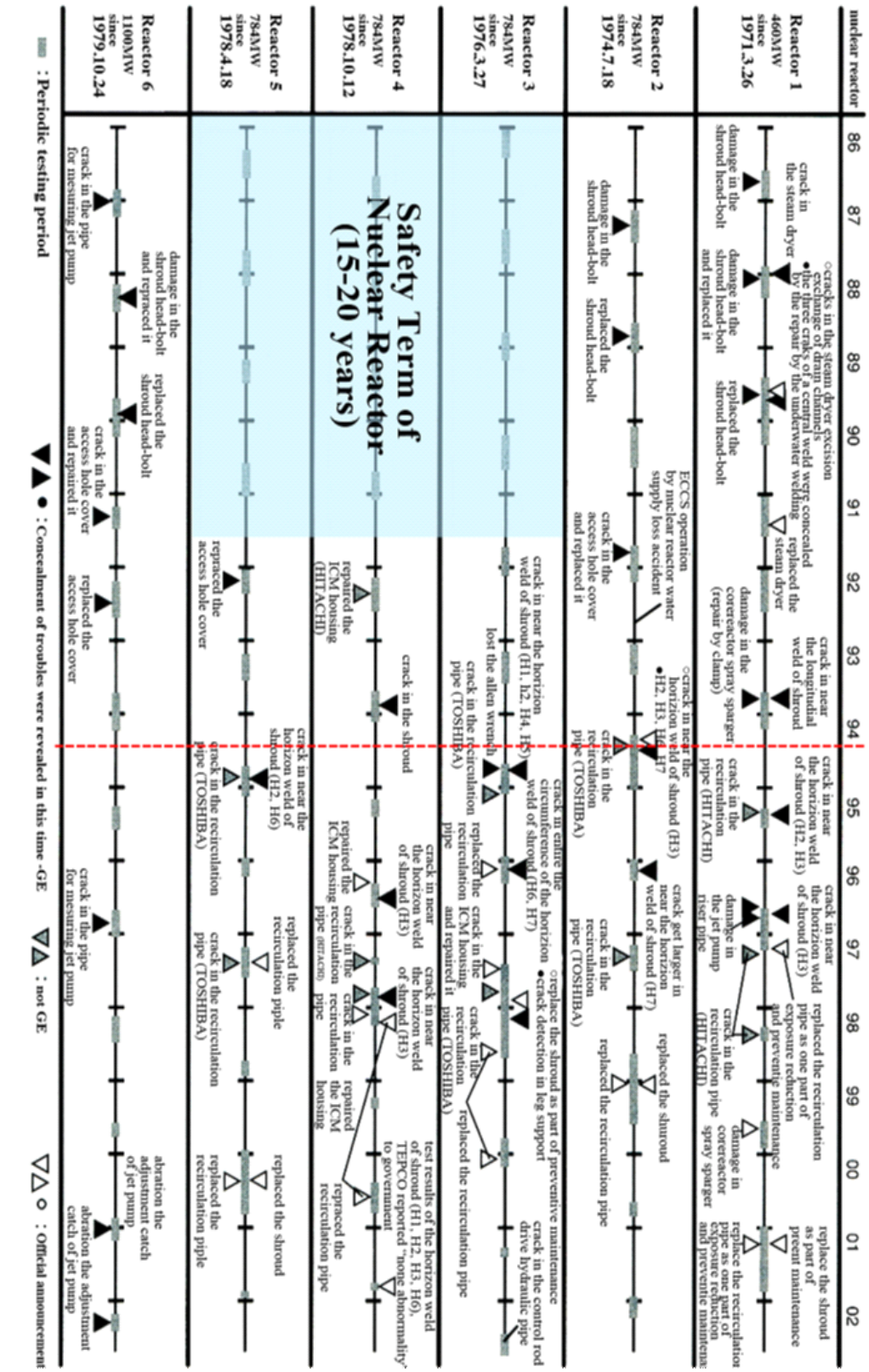

In figure 4, the filled-in black triangles show the concealed events prior to 2002. Tokyo Electric Power Company did not announce these events in spite of the fact that troubles were experienced at all of their reactors. For example, they found cracks in the 'shroud' which is the cylindrical stainless equipment that surrounds the reactor core, but did not report the actual number of cracks. In addition, from the number of occurrences of trouble, it is evident that nuclear reactors No. 3, No. 4, and No. 5 operate with more stability than No. 1 or No. 2. As of 1986, 15 years had elapsed since reactor No. 1 began operations. In Reactor No. 3, the first trouble occurred 20 years from the beginning of operations. No. 4 and No. 5 experienced troubles after 14 years. In light of these experienced with Reactors 1-5, it can be said that the nuclear reactor's stable operating period is about 15-20 years. Unfortunately, if the life of a nuclear power plant is limited to just 20 years, the total cost of nuclear power generation is high, because maintenance and decommission will entail a huge expenditure. For this reason, many Japanese Electric Power Companies are in ***un-competitive*** situations, and, as a result, the companies are necessarily motivated not to make timely decisions about decommissioning even when circumstances indicate the reality of technical problems.

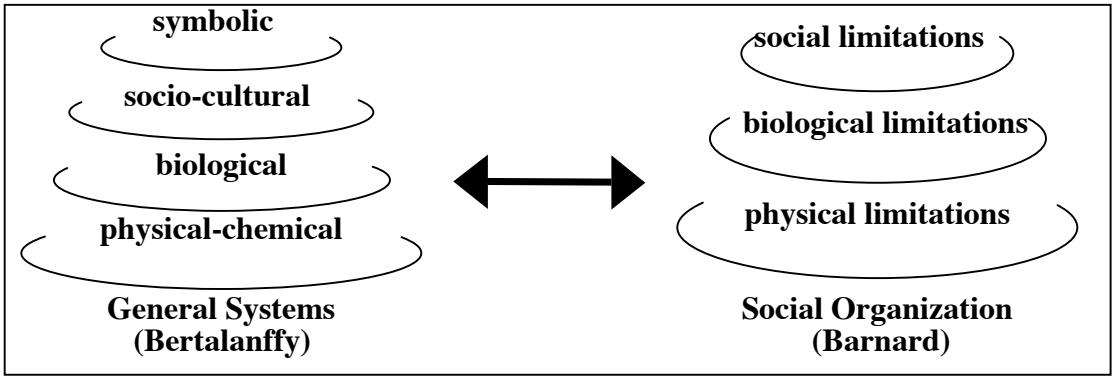

Figure 5: The multiple levels of factors that must be considered in a system's approach to the governance of nuclear power stations.

The supervisory authorities of nuclear power generation in Japan are a double administrative structure. One is a Cabinet Office (Japan Atomic Energy Commission and Nuclear Safety Commission of Japan) and the other is the Ministry of Economy, Trade and Industry (Nuclear Industrial Safety Agency). The reality of multiple supervisory committees makes it unclear where responsibilities lie. Moreover, the practice of former government officials finding employment in the private sector is a widespread problem. Five persons who acted as supervisory authorities later became directors of the Tokyo Electric Power Company (The Mainichi Daily News, April 15, 2011). Clearly, the social function of overseeing the safety of the nuclear power industry has declined and there is a strong possibility that the friendly relations between the supervisory authorities and industry have had deleterious effects on their watchdog role. These are problems of social responsibility and the dangers of failing to maintain a distinction between public and private sector functions.

V. Irrational Governance in Nuclear Policy with regard to the Longevity of Nuclear Reactors

As shown in Figure 6, the Fukushima nuclear power plants were set up in an area of highest earthquake probability in Japan. Furthermore, over the course of 40 years, there were fully 120 disclosed problems at these power plants, and a still-uncertain number of undisclosed problems.

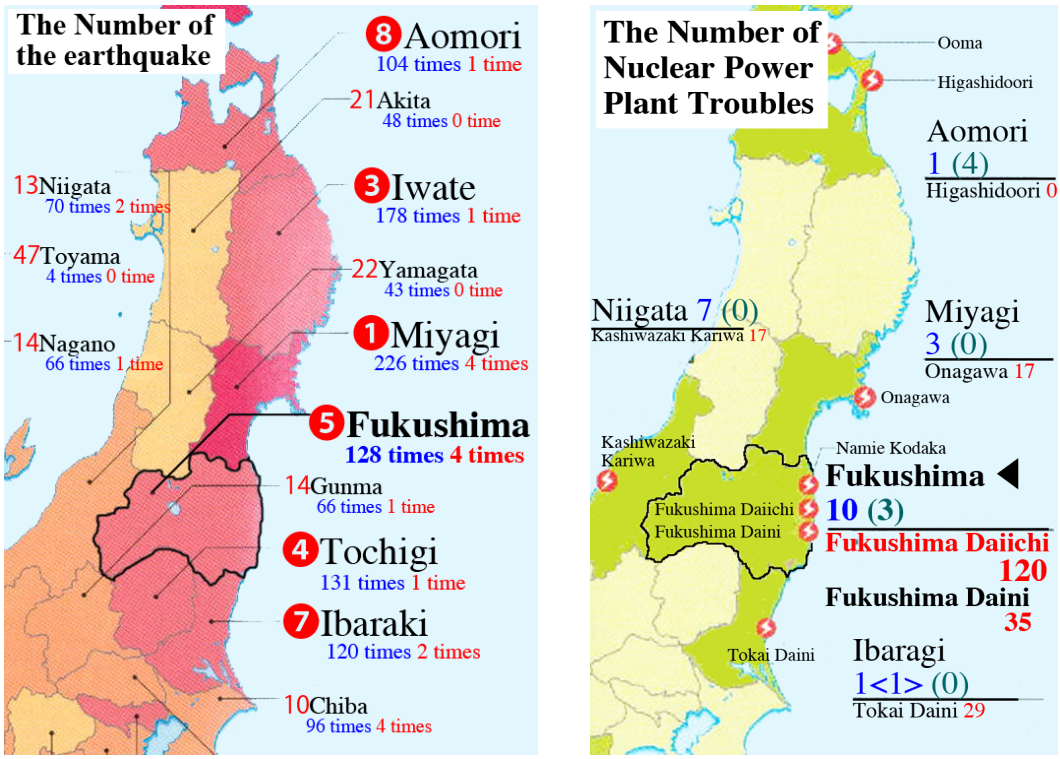

Figure 6: On the left is shown the incidence of felt earthquakes in the Tohoku Region (from 2008.9 to 2009.8). The number of earthquakes of seismic intensity 1~4 is shown in blue; the number of earthquakes of seismic intensity more than 5 is shown in red. On the right is shown the number of nuclear power plant troubles. Red indicates the number of troubles of nuclear reactors; blue indicates the number of the operating nuclear reactors; green indicates the number of scheduled nuclear reactors (source: Masai, 2009).

The organizational problems that have plagued the Fukushima nuclear facilities are of three kinds: the construction and later proliferation of nuclear plants in an area where earthquakes are known to occur, frequent troubles because of the ageing of plants designed to last for a standard of 30 years, and finally troubles due to the attempted concealment of events related to accidents and ageing. Including these, there were also problems in safety management. In short, the functioning of "checks and balances" by administrative supervision has not worked well, and there is a distinct possibility that the Japanese system for nuclear power plant management has inherent organizational problems.

Moreover, insufficient disclosure of information to the residents in the affected area has also become a problem. Although the scale of this earthquake was beyond all expectations, many problems have arisen in response to the natural disaster and the extreme vulnerability of countermeasures to the catastrophe was exposed. We recommend that, in the near future, organizations should shift from policy that gives priority to economic profits to policy where safety management and long-term sustainability within Japanese society becomes paramount. Nuclear power generation holds a ***dominant*** position relative to other means of generating electricity – hydropower, thermal power, wind power, solar power, geothermal power, tidal power – but the dominance is based on the presumption that nuclear reactors have a longevity of at least 40 years. Actually, the cost of constructing nuclear reactors is necessarily high, so that the first 20 years of operation is essentially a period of regaining the initial investment. If, however, the stable lifetime of nuclear reactors is only 20 years, as suggested by the Japanese history of nuclear power generation, then nuclear technology becomes uncompetitive in comparison with other power generation technologies.

Figure 7: The situation in the Tohoku region after the tsunami. (source: Sankei Shinbunsya, *Tatakau Nihon*, 2011, p.6)

The response of the Tokyo Electric Power Company and the government to the nuclear power plant disaster has clearly not been sufficient. The disclosure of ambiguous, contradictory and incomplete information has only added to the fear and suffering of the victims.

Figure 8 shows that the radial distance from a nuclear power plant is an unreliable measure because of local weather patterns. Outside the area of evacuation that the government has established, radiation doses much more than normal have been recorded, for example, in Koriyama and Tenei, etc. Notably, measurements at prefectural schools indicate that five places exceed the provisional standard value that the government

established – 3.8 micro-sieverts – and there are many points where doses of radiation of 2-3 micro-sieverts per hour have been detected. The Government decided on a provisional radiation standard for schoolyards of "20 milli-sieverts per year". That standard was based on the ICRP's recommendation for adults, but can it apply for children, as well? A special advisor to the Cabinet's nuclear engineering specialists noted the danger for danger, and subsequently resigned. Nevertheless, the schools located outside the evacuation zone in Fukushima Prefecture continue to carry out classes as usual. As Bertalanffy (1976) emphasized many years ago, it is necessary to disclose information, not only for the needs of governmental administration, but also for needs of residents in areas affected by natural disasters.

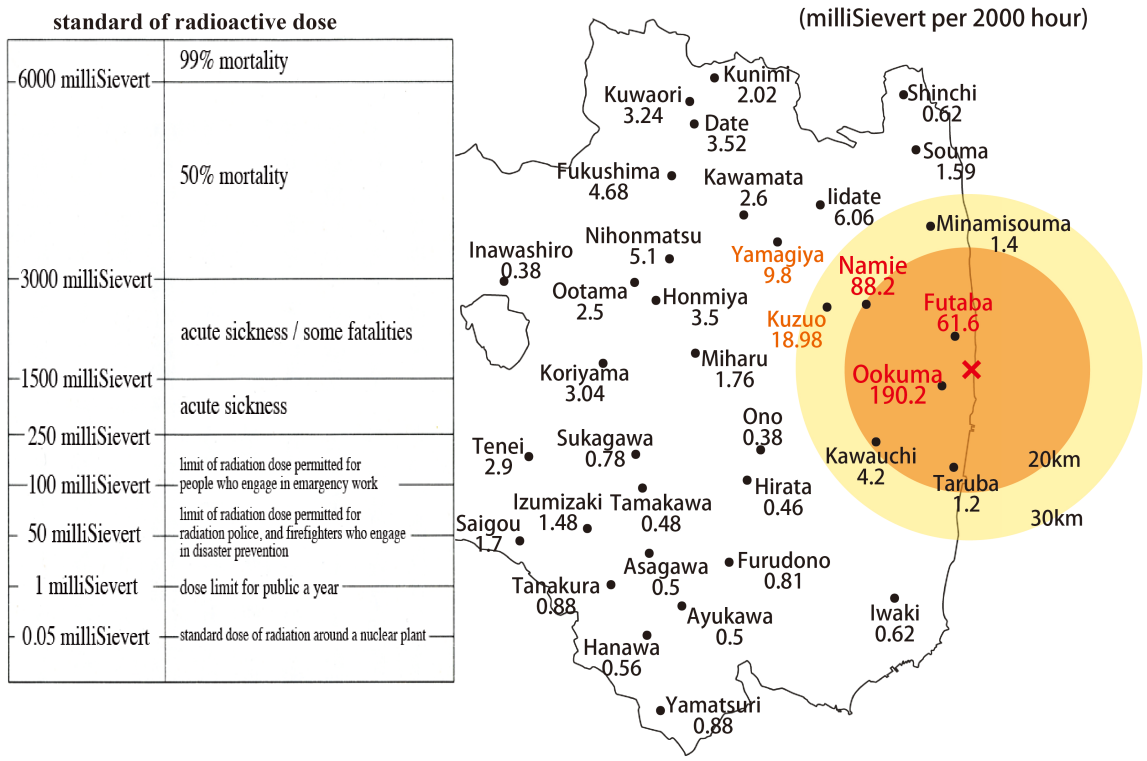

Figure 8: On the left is shown damage due to radiation exposure. On the right is shown the geographical distribution of radiation around the Fukushima reactors per 2000 hours (numbers indicate accumulated Sieverts).

VI. Dynamics of System Pathology – Socio-Biological System Hazard

To summarize, the following are organizational problems could have been avoided. Firstly, the nuclear power plant was constructed in an area where many earthquakes occur **(nuclear power plant location)**. Secondly, there has been a significant number of nuclear power plant troubles due to ageing and, moreover, systematic concealment of those problems **(ageing nuclear power plant)**. Thirdly, there has been a long-term deterioration of organizational systems, like the safety management of Tokyo Electric Power Company and problems of the administrative supervisory role

(organizational errors). At the very least, in the future the Japanese Government and the Tokyo Electric Power Company should disclose accurate information to facilitate local recovery, such that the disclosure of information can be trusted and there is greater faith in social responsibility. This will also help to restrict damage caused by rumours by overseas media. Consideration of the dangers of nuclear power must be made from a global perspective. We recommend not only stopping the Hamaoka nuclear station but also undertaking independent checking of the 54 reactors in Japan. At the recent G-8 summit meeting held in Deauville, France, on May 26, Japanese Prime Minister Naoto Kan requested to the IAEA, that a new safety standard for nuclear plants be established for quake-prone countries. Properly speaking, however, Japan should make devise this standard and suggest it to the world. It is Japan's duty.

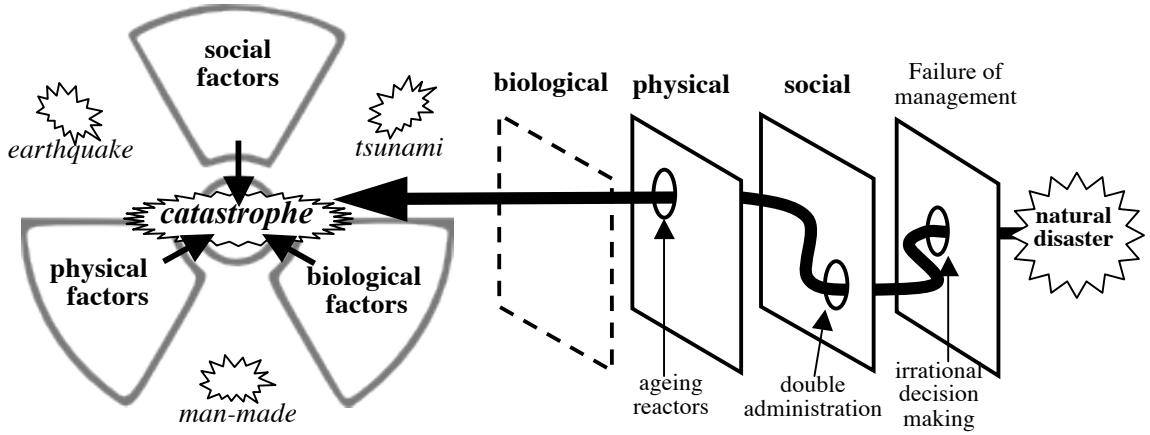

Figure 9: Radioactive hazards (Reason, 1997, pp. 11-13 & Barnard, 1938, pp. 25-41)

Barnard (1938) has emphasized the complex interactions among biological, psychological and organizational factors. In that light, the Fukushima nuclear catastrophe is clearly an example of the pathology of social systems. The deleterious effects of such pathology can perhaps be minimized by working within the conceptual framework of traditional system theory (Wiener, 1961).

VII. Conclusions

The ongoing Fukushima nuclear disaster has its origins in a failure to think in terms of "whole systems". With only the short-term goals of financial gain and social consensus under consideration, unacceptable risks have been taken in the Japanese nuclear power industry, ultimately leading to large-scale problems for the Japanese population.

Subsequent to the current disaster, some individuals within the energy business, government and academic circles have expressed regrets at the inability to predict natural disasters, but that is not where the problem lies. No one can predict natural disasters, but social policy requires full consideration of the factors that are under human control. That type of responsible governance has been notably absent. Most notably, on February 7, 2011, the Nuclear Industry Safety Agency granted permission for the operation of the

Fukushima Daiichi power plant's reactor No.1 for a period of 40 years (NISA, 2011, p. 2). Despite the fact that the word standard for the longevity of nuclear power plants is 30 years, and despite the fact that specifically the Fukushima plants have exhibited many technical problems over the past 20 years, scandalously, the agency ultimately responsible for the governance of nuclear power in Japan issued the following statement a mere one month before the earthquake:

> "With regard to the measures that should be taken against the effects of ageing, we confirm that the evaluation of the soundness of the structures and equipment, ***assuming a tentative useful period of operation of 60 years from first commissioning***, has been undertaken." (NISA, 2011, p. 4) (italics added)

Sixty years! Bureaucrats irresponsibly turned a blind-eye to the numerous technical problems of the Fukushima plants and yielded to the profit motivations of the power industry – aided and abetted by academic yes-men – to approve the operation of power plants for up to 60 years! Subsequent events have revealed the total incompetence behind that approval, and are strongly suggestive that Japanese nuclear policy is essentially ***uncontrolled***.

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REFERENCES

Asahi Shinbunsya (May 15, 2011), *Genpatsu to Nihonjin*, Aera. (The Asahi Shimbun (May 15, 2011), *Nuclear Power and the Japanese Peopl*e, AERA)

Barnard, C. I.(1938), *The Functions of the Executive*, Harvard University Press, pp.25-41.

Bertalanffy, L. von (1976), *General System Theory: Foundations, Development, Applications*, George Braziller, p.47.

Genshiryoku Anzen Hoanin (2010), *Genshiryoku Hatsudensyo no Hoankatsudou Hyouka (Shikou) no kekka ni tuite*. (Nuclear Industry Safety Agency (2010), *Results of preservation activity global assessment (trial) of the nuclear power plant of 2009*)

Genshiryoku Anzen Kiban Kikou (October, 2010), *Jishin level 2 PSA no Kaiseki (BWR)*, (Japan Nuclear Energy Safety Organization (October, 2010), *Analysis of Earthquake Level 2 PSA (BWR)*, p.(4)-7.)

Genshiryoku Hoanin (2011), *Fukushima Daiichi Nuclear Power Plant's Reactor No.1*,

Genshiryoku Shiryou Jouhousitsu (2002), *Iwanami Booklet No.582, Kensyou Touden Genpatsu Trouble Kakushi*, Iwanami Syoten (Civil Nuclear Information Center (2002), *TEPCO Concealed Nuclear Troubles*, Iwanami Publishers, p. 7)

Nihon Kogyo Shinbun (2003), *Kakusareta Genpatsu Data*, Fuji Sankei Group, Nihon Kogyo Shinbun (Japanese Industry Newspaper (2003), *Concealment of Nuclear Power Plant Data*, Fuji Sankei Group)

Reason, J.(1997), *Managing the Risks of Organizational Accidents*, Ashgate Publishing Limited, pp.11-13.

The Mainichi Daily News, April 15, 2011.

Thom, R., & Zeeman, E.C. *Une théorie dynamique de la morphogenèse*, Misuzu Shobo, 1977.

Weiner, N.(1961), *Cybernetics, or control and communication in the animal and the machine* [2nd], The MIT Press, pp.155-160.

Yasuo MASAI (2009), *Imagawakaru Jidaigawakaru Nihontizu 2010 Nenban*, Seibidou, (Yasuo, M. (2009), *Map of Japan 2010 Edition: Following the Era and Now*, Seibidou Syuppan Publishers, p. 93)