

Chapter 2

Examples of Risk Information Concealment Practice

2.1 Industrial Sector

2.1.1 Vajont Dam Disaster (Italy, 1963)

The Vajont hydropower station dam and reservoir was located at the foot of Mt. Toc in the Dolomite region of the Italian Alps. In October 1963, a large landslide of 260 million m³ of rock (equivalent of cube with a 650 m side) filled the reservoir of the dam, initiating a 150–250 m high wave, which overtopped the dam and wiped out several villages in the nearby Piave valley, resulting in the death of at least 1921 people.¹



¹F. Guzzetti, G. Lollino, Book Review of "The Story of Vaiont Told by the Geologist Who Discovered the Landslide", *Natural Hazards and Earth System Sciences*, 11, 2011, pp. 485–486.

2.1.1.1 Risk Concealment Before the Disaster

Vajont dam was an important industrial project for post-war Italy. A general plan was proposed for the erection of seven dams in Piave valley, but from the beginning of the Vajont dam development, the project met with fierce resistance from local communities protesting against the forced sale of land to Società Adriatica di Elettricità (SADE) to construct the highest arch dam in the world. SADE, a private electricity company in North-Eastern Italy, had support from Democrazia Cristiana (the Italian Christian democratic political party, which promoted pro-American and pro-capitalist ideology and was in power at the time). Opposition from locals in villages around the Vajont reservoir was suppressed by the police. After this, the Italian Communist Party, the main opponent of Democrazia Cristiana, stayed on the side of local residents and supported their struggle against SADE and the government during the construction of the dam.²

Engineers and geologists focused on the permeability of the Vajont dam foundation, but did not study carefully the geology and the stability of the slopes surrounding the upstream reservoir of the dam, which consisted of soft materials like sand, limestone and clay.³ The geological instability of the surrounding mountains was well known among local residents⁴: Mt. Toc had many nicknames like “crazy”, “rotten”, “loose” or “walking mountain” among local people due to its propensity for huge unexpected landslides.^{5,6} The construction of the dam was launched in January 1957 with the goal of completing it by 1959 (construction started without government approval, nor serious geological research of the surrounding mountains). Moreover, to meet the need of Italian industry for electricity and maximize the profitability of the project, SADE proposed to increase the height of the dam up to 722.5 m, and triple the volume of the reservoir. In June 1957, government approval was obtained for construction without a geological study of the consequences of expanding the reservoir.

In March 1959 in the nearby Pontesei dam reservoir (owned by SADE), a landslide of 10 million m³ of rock occurred (equivalent of cube with a 220 m side), resulting in the death of one worker, killed by a 20-m wave which overtopped the dam and destroyed a nearby bridge. Moreover, clefts were discovered during mountain road constructions around the Vajont reservoir. Protests from local residents against SADE broke out again. In May 1959, *l'Unità* (the official newspaper of the Italian Communist Party) conjectured that the Pontesei dam accident could

²Rose Marco Delle, Decision-making errors and socio-political disputes over the Vajont dam disaster, *Disaster Advances*, Vol. 5(3), 2012, pp. 144–152.

³Mountain Tsunami, documentary of “Seconds from Disaster” serious, National Geographic Channel, 2012.

⁴*Ibid.*

⁵Sara Pavan, The Vajont Dam, 1998, <http://www.vajont.info/eNGLISH/saraPavan.html>.

⁶Mountain Tsunami, documentary of “Seconds from Disaster” serious, National Geographic Channel, 2012.

recur in the Vajont region: “*when there is water in the reservoir, the mountain will fall down and cause a tragedy*”.⁷ (Later SADE filed a lawsuit against the journalist for “*disclosure of false, exaggerated and biased information aimed at disturbing public order*”⁸ and “*defamation and spreading false information*”⁹). After the Pontesei dam accident, SADE ordered German and Italian geologists to investigate the geology of mountains around the dam. After several months, they confirmed a potential instability in the southern slope of the reservoir: the possible volume of a landslide could exceed 200 million m³ if the reservoir was filled completely due to undercutting of the foundation by an ancient landslide. They passed on information about a possible rockslide to the architect and the chief engineer of the Vajont system, who asked them to moderate some of the report conclusions and suggested testing these hypotheses with another round of studies.¹⁰ These more detailed studies stated that the evidence of an ancient landslide was absent, the slope was potentially immovable and only a small landslide could occur.¹¹ Apparently, any geological survey demonstrating the dangers of further exploitation of the Vajont system was unacceptable for the engineering team, SADE and the government, which was promoting the Vajont arch dam as the highest in the world and as a historic masterpiece of Italian engineering. Frankly admitting that there were errors in the design could lead to question how safely the government was expanding Italian industry. It could also attract attention to its control over private companies. This could change the political landscape, with the Communists using any blunder for political capital.¹² It would also cause losses for SADE and bring their shares down in the market. Nobody among the managerial team wanted to take responsibility for this honest but painful recognition of the dangers.

In February 1960, SADE started filling the reservoir. In the process, small landslides were noticed. On November 4, 1960, when the water level reached 636 m above sea level after weeks of heavy rains, a 0.7 million m³ landslide occurred creating a 2-m wave. SADE geologists revealed a direct correlation between the water level in the reservoir and movement in the southern slope of the lake. They proposed to bring down the level of the reservoir to reduce the observed increasing shift of the southern slope. When the level dropped to 600 m, the movement of land mass went down from 3 cm to 1 mm per day. During 1961, the construction

⁷Rose Marco Delle, Decision-making errors and socio-political disputes over the Vajont dam disaster, *Disaster Advances*, Vol. 5(3), 2012, pp. 144–152.

⁸Marco Paolini, Vajont timeline (from 1928 to 1960), 1998, <http://www.vajont.info/engTimeline1.html>.

⁹French Ministry for Sustainable Development, Release of 50 million m³ of water at the Vajont Dam October 9, 1963. Erto e Casso (PN) Italy, No. 23607, 2010.

¹⁰*Ibid.*

¹¹Mountain Tsunami, documentary of “Seconds from Disaster” serious, National Geographic Channel, 2012.

¹²Rose Marco Delle, Decision-making errors and socio-political disputes over the Vajont dam disaster, *Disaster Advances*, Vol. 5(3), 2012, pp. 144–152.

of a bypass tunnel kept the level of the reservoir down to around 600 m, and there were no serious landslides (even during the cold winter of 1961–1962). In 1961, SADE sponsored a hydraulic study of worst-case scenarios using a simulation model of the reservoir and the dam (1/200 of real size) at Padua University. In July 1962, the results of this research showed that the maximum likely wave from a landslide up to a volume of 40 million m³ would not exceed 25 m, if the minimum sliding duration was 1.5 min¹³; in reality, the volume of the final rockslide was 260 million m³, the slide lasted only 45 s and the height of the wave generated was 150–250 m. The geologists assumed that keeping the maximum water level of the reservoir below 700 m would prevent a possible landslide wave from overtopping the dam crest. There is no documented evidence that the results of the hydraulic study and the possibility of a 25-m wave were transmitted to the government, local authorities, residents or onsite staff at the dam and hydropower station. Supporting such interpretation is the fact that, right before the disaster, SADE personnel and their families had not left the nearby city of Longarone, which was perceived by local residents as a sign that there was no serious threat. After the disaster, it was revealed that the inspectors of the dam and the commissions responsible for regulation of hydropower industry never received any final reports—in particular they never received the studies by geologists who had identified the fault. Nor did they see any of the results from the model tests or their ensuing recommendations, which emphasized the importance of the water level of the retention dam.¹⁴ Moreover, some sources claim that the vice-president of SADE decided not to communicate about the seismic activity registered by the seismographic station at the dam, and even deleted some records about serious tremors in his reports to government officials.¹⁵

In 1960, political debates began about the possible advantages for Italy of the nationalization of 1270 electricity companies and the creation of uniform standards for the use of electrical infrastructure. Nationalization could reduce the selling price of electricity for industrial and retail customers. Intensive discussions about nationalization occurred during 1960–1962. To increase their profits before nationalization, senior managers of SADE decided to fill the reservoir up to 700 m by the end of 1962; the velocity of ground movement increased as a response from 1 mm to 1.5 cm per day.¹⁶ Finally in December 1962, ENEL (the Italian National Agency for Electric Energy) was established and united all private players,

¹³Ibid.

¹⁴French Ministry for Sustainable Development, Release of 50 million m³ of water at the Vajont Dam October 9, 1963. Erto e Casso (PN) Italy, No. 23607, 2010.

¹⁵Marco Paolini's monologue performance, <https://www.youtube.com/watch?v=ULm8T8ySs1A>, https://www.youtube.com/watch?v=MQjBgS2_5yU, <http://www.vajont.info/eNGLISH/athensMIover.html>, 1998.

¹⁶French Ministry for Sustainable Development, Release of 50 million m³ of water at the Vajont Dam October 9, 1963. Erto e Casso (PN) Italy, No. 23607, 2010.

including SADE and all its assets, by July 1963.¹⁷ Managers of the private SADE could become managers of the state ENEL after this acquisition. Immediately after nationalization was declared, the level of the reservoir began to go down, and by the spring of 1963, it reached a low of 650 m; ground movement returned to 1–2 mm per day and seismic activity ceased.¹⁸ Nobody within the managerial team of ENEL/SADE wanted to reveal the shortcomings of the Vajont system during the process of transfer of assets. Therefore, in order to demonstrate the quality of the dam to government officials and to present the Vajont system as a fully-functioning project, the reservoir was filled to the limit of 715 m by autumn 1963; by this time, the total cumulative ground movement surpassed 3 m.¹⁹ ENEL/SADE top managers were still confident that they could manage the ground movement by reducing the reservoir level. But from September 1963, in spite of permanent water drainage, the ground movement velocity reached 20 cm per day^{20,21} and residents of villages located above the reservoir were registering cracks in their houses. Within the ENEL/SADE managerial team, the opinion prevailed that, if the reservoir had a water level of 700 m, the possible wave from any size of landslide would not be dangerous for the dam and nearby villages. Because of this, SADE management did not discuss the results of the hydraulic study of 1961–1962 with external and independent geologists, and ignored the necessity to continue investigations of the dynamics of the southern slope of Mt. Toc. They misjudged the possible volume and speed of potential landslides, and the resulting wave height. This underestimation led to a situation where only a few small villages above the reservoir were evacuated. Neither the residents of villages located below the dam nor staff at the Vajont system were informed by ENEL/SADE executives about the possible threats.

On October 9, 1963 at 10:29 pm, dozens of ENEL/SADE workers were on the crest of the dam. They—and thousands of residents of nearby villages—were completely unprepared for the large landslide or for the wall of water, hundreds of meters high, which killed them. Meanwhile, the decision makers in the ENEL/SADE managerial team were at a distance from what they knew to be a dangerous area.

After the accident, an investigation commission stated that the main cause of the disaster was *“bureaucratic inefficiency, muddled withholding of alarming*

¹⁷ENEL, History of establishment and growth of ENEL (1962–1977), http://www.enel.com/en-GB/group/about_us/history/1962_1977.

¹⁸French Ministry for Sustainable Development, Release of 50 million m³ of water at the Vajont Dam October 9, 1963. Erto e Casso (PN) Italy, No. 23607, 2010.

¹⁹Mountain Tsunami, documentary of “Seconds from Disaster” serious, National Geographic Channel, 2012.

²⁰Rinaldo Genevois, Monica Ghirotti, The 1963 Vaiont Landslide, *Giornale di Geologia Applicata* 1, 2005, pp. 41–52.

²¹D. Sornette, A. Helmstetter, J.V. Andersen, S. Gluzman, J.-R. Grasso and V.F. Pisarenko, Towards Landslide Predictions: Two Case Studies. *Physica A* 338, 2004, pp. 605–632.

*information, and buck-passing among top-officials*²²—not an unforeseen natural event, an act of God, as Democrazia Cristiana and ENEL tried to present it. Four years later, the court found 11 executives of ENEL/SADE and government officials guilty.

Unfortunately, thirty years after the Vajont dam disaster, a quite similar cover up of local geological instability and faulty design at Val Di Stava led to the collapse of another Italian dam in 1985, which resulted in 268 deaths.²³

Vajont Dam Disaster: Why Risks Were Concealed

- **Cozy relations between SADE executives and Italian government officials**, which allowed the operator of the dam to construct and exploit it in blatant violations of the existing legislation.
- **The political struggle** between Democrazia Cristiana and the Italian Communist Party: if SADE and Democrazia Cristiana had disclosed defects in the design of the dam and the reservoir, or had revealed the illegal practice used in obtaining the construction permits, a serious political crisis would have erupted in Italy.
- **The short-term profitability** of a private enterprise took priority over the long-term resilience of the Italian electric power industry.
- Geologists and managers at SADE were **unwilling to admit mistakes** in the inadequate preliminary study of the geology and of the stability of slopes surrounding the upstream reservoir of the Vajont dam. They were reluctant to incur the massive losses that would follow from the release of information that would lead to much higher construction costs. The goal was to **save the dam project and avoid the collapse of SADE's shares** in the market.
- False **reassurance/self-suggestion/self-deception** among decision makers about the maximum possible volume and speed of the landslide.
- SADE geologists and managers were **afraid of being accused of incompetence**. They were also keen not to lose public confidence in the ability of Italian private business to implement complex industrial projects.

²²Norbert J. Delatte, *Beyond Failure: Forensic Case Studies for Civil Engineers*, ASCE Press, 2009, pp. 234–248.

²³Flood at Stava Dam, documentary of “Seconds from Disaster” series, National Geographic Channel, 2004.

2.1.2 Three Mile Island Nuclear Accident (USA, 1979)

The Three Mile Island Nuclear Power Plant (NPP) is located 15 km from Harrisburg, Pennsylvania, 140 km from Washington, DC and 240 km from New York. The plant has two pressurized water reactors (PWRs) with a generating capacity of 1700 megawatts (MW). When the largest civil nuclear accident the world had ever seen occurred there at the end of March 1979, Unit 2 (TMI-2) had only been in commercial service for about three months and was operating at 97 % capacity. Unit 1 was shut down for refueling. The reactor core of TMI-2 contained around 100 tons of uranium fuel.²⁴

2.1.2.1 Brief Technical Summary of the Accident

At 4:00 a.m. on March 28, 1979, during regular servicing of the feedwater system on Unit 2, the polisher machines—which remove dissolved minerals from the system—were being repaired when a leakage of water occurred into the air-controlled system that opens and closes the polisher valves. Several hours later, this problem triggered a stoppage of the feedwater pumps, which were responsible for sending heated water from the reactor core to the steam generators of Unit 2.²⁵ This in turn provoked the automatic shut down of steam generators, and thus of the entire TMI-2 reactor. “Scramming” (emergency shutdown) of the reactor stopped nuclear fission completely; nevertheless, decaying radioactive materials left from the fission process continued to heat the reactor’s coolant water. Immediately after shutdown, the decay heat power generation was about 160 MW—around 20 % of the 850 MW generating capacity of TMI-2. One hour after the reactor shutdown, decay heat power generation was approximately 33 MW (4 %). Ten hours after shutdown, it was about 15 MW (2 %). Over time, the decay heat power generation decreased more slowly.²⁶ In spite of the fact that this post-shutdown decay released far less energy than that released during fission, operators of the plant had to continue cooling the reactor for several days to reach a total cold shutdown.²⁷

Because the feedwater pumps had tripped, heat was not anymore being removed from the reactor. This led to rising pressure within the system, so a relief valve at the top of the pressurizer tank—the so-called pilot-operated relief valve (PORV)—was automatically opened in order to reduce pressure by draining the steam and water from the reactor core into a tank on the floor of Unit 2. The valve

²⁴Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, Oct. 1979, p. 83.

²⁵Ibid, p. 43.

²⁶Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, Jan. 1980, Vol. II-Part 1, p. 577.

²⁷Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, Oct. 1979, p. 83.

should have closed when the pressure fell to proper levels, but it remained stuck open. Instruments in the control room of TMI-2, however, indicated to the plant operators that the valve was closed.²⁸ The design of the reactor and the control room design included instruments that could not show how much water was covering the core.²⁹ As a result, the plant staff was unaware that cooling water was pouring out of the stuck-open valve and assumed that, as long as the pressurized water level was high, the core was properly covered with water.^{30,31} The PORV was open for 2 h and 19 min until operators found the leakage of coolant from the reactor and closed the valve. Furthermore, during the first few minutes after the accident, the automatic emergency cooling system was turned off, reducing the emergency cooling water flow into the reactor to 10 times less than the designed level. The combination of these factors led to overheating and severe damage of the nuclear fuel due to the shortage of coolant within the reactor.³² Later investigations found that about half of the core melted during the early stages of the accident.³³ The US President's Commission on the Accident at Three Mile Island stated: *"We estimate that there were failures in the cladding around 90 percent of the fuel rods. Fuel temperatures may have exceeded 4000 °F in the upper 30 to 40 percent of the core (approximately 30 to 40 tons of fuel). Temperatures in parts of the damaged fuel that were not effectively cooled by steam may have reached the melting point of the uranium oxide fuel, about 5,200 °F"*.³⁴ This deterioration of the nuclear fuel induced a powerful upsurge of radioactivity within the containment building of TMI-2, and caused a dangerous hydrogen gas bubble to form within the reactor vessel produced by the reaction between the zirconium alloy of the melting fuel rod cladding and the steam. If this hydrogen gas had reacted with oxygen, it could have ignited a blow out, damaging the reactor vessel and leading to severe radioactive contamination. Fortunately, the hydrogen bubble was eliminated in the first few days after the accident.

²⁸Backgrounder on the Three Mile Island Accident, United States Nuclear Regulatory Commission, Feb. 11, 2013.

²⁹Ibid.

³⁰Ibid.

³¹Ibid.

³²Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, Jan. 1980, Vol. I, pp. 3–4.

³³Backgrounder on the Three Mile Island Accident, United States Nuclear Regulatory Commission, Feb. 11, 2013.

³⁴Report of the President's Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, Oct. 1979, pp. 30–31.



The accident happened because of a combination of factors. Firstly, plant operators were ignorant of the risks of water leakage into the polisher valve control system and of the PORVs getting stuck open—even though these incidents had occurred many times before the TMI accident at other American NPPs—because information about both problems had been concealed by suppliers of the nuclear steam system and by other NPP operators. Secondly, nobody was really facing up to the challenge posed by the interaction between human and machine in running a nuclear power plant: appeals from the plant's staff about poor control room design, and the imperfection of instrumentation, were being ignored; training was inadequate and operating procedures poor; and neither operators nor management had sufficient specialist knowledge about pressurized water reactors, or skill in diagnosing problems.³⁵ A tremendous amount of nationwide public outrage—and panic within the local community—was induced by unconscious misleading statements by the operators and management of TMI-2, and by executives of Metropolitan Edison (Met Ed), the involved utility company. Incorrect statements by representatives of the federal Nuclear Regulatory Commission (NRC) were influenced by a mistaken evaluation of conditions at the reactor during the first days after the accident, when operators did not realize that coolant was being lost and the plant was experiencing a meltdown.

Fortunately, there was a containment building sited directly above the reactor, the steam generators and the pressurizer of TMI-2. Thus, in spite of the severe core meltdown, the major part of the radioactive material remained within the unit's containment vessel, with minimal threat to the environment.³⁶ The total release of radioactivity to the environment has been established as just 13 to 17 curies of iodine, while 10.6 million curies of iodine were retained in water tanks in

³⁵Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, Jan. 1980, Vol. I, p. 102.

³⁶Report of the President's Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, Oct. 1979, p. 12.

the containment building and 4 million curies were in the auxiliary building tanks.³⁷ The total cost of the 14-year cleanup operation on the TMI-2 site was evaluated at US\$1 billion in 1993 US\$.³⁸ In spite of the contamination of the TMI-2 site, the nearby TMI-1 has worked properly for decades since the accident—in fact in 2009, the NRC approved an extension of the TMI-1 operating license for a further 20 years.³⁹

The event, which was rated as a Level 5 accident out of a maximum Level 7 according to the International Nuclear and Radiological Event Scale, led to wider consequences. Nearly 150,000 people were evacuated from their homes during the accident,⁴⁰ which turn out to be unnecessary. The Federal Emergency Management Agency (FEMA) was established on April 1, 1979 to coordinate evacuation efforts during any such accident that could occur in the future. After the accident, strong public resistance to civil nuclear energy, which was manifested very clearly on May 6, 1979 when 65,000 antinuclear demonstrators gathered in Washington, led to the suspension of the construction of new nuclear power stations within the United States.

At the beginning of 1980, the US President's Commission on the Accident at Three Mile Island and the Nuclear Regulatory Commission both published detailed reports, open for public evaluation, about the TMI-2 accident. However, executives of the Soviet and Japanese civil nuclear industries obviously did not pay serious attention to the findings of these commissions regarding organizational imperfections before and after the accident, as would be revealed later in their corresponding disasters from the fact that they did not implement many of the commissions' recommendations in their own industries. Unfortunately, many of the organizational mistakes, and the pervasive climate of poor communication about risks that occurred during TMI-2, were repeated before and during the 1986 Chernobyl and 2011 Fukushima disasters.

2.1.2.2 Risk Concealment Before the Disaster

Rapid Growth of the American Civil Nuclear Industry at the Expense of Safety Considerations

The American civil nuclear industry originated from the Manhattan Project, a US military nuclear program launched in 1942. In 1946, the first civil reactor was

³⁷Report of the President's Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 31.

³⁸14-Year Cleanup at Three Mile Island Concludes The New York Times, August 15, 1993.

³⁹NRC Issues Final Safety Evaluation Report For Three Mile Island Nuclear Plant License Renewal Application, U.S. Nuclear Regulatory Commission Press Release-09-119, June 30, 2009.

⁴⁰Robert A. Stallings, Evacuation behavior at Three Mile Island, International Journal of Mass Emergencies and Disasters, № 2, 1984, p. 12.

constructed at Oak Ridge National Laboratory. By 1955, the first nuclear submarine, based on a pressurized-water reactor design, had taken to the water.⁴¹ In parallel with military nuclear development, the Eisenhower administration tested five different types of reactors in order to choose the most effective designs for a national civil nuclear program based on tenders from private companies to “*design, construct and operate ... atomic power plants with [their] own capital*”.⁴² Following these tests, the Navy’s pressurized-water reactor (PWR) design and the boiling-water reactor (BWR) design were selected—nowadays, 69 of the 104 reactors operating in the United States are PWR and 35 are BWR.⁴³ The 1960s and 1970s were boom years for the industry: 91 reactors were ordered in 1969 and 160 by the end of 1972.⁴⁴ While reactor projects were small in terms of capacity, safety concerns were not adequately emphasized. But when high-capacity reactors were projected in densely populated areas in order to minimize transmission costs and power losses, the U.S. Atomic Energy Commission (AEC) had to pay attention to quality assurance programs, to the redundancy of certain critical equipment, to the addition of an emergency core cooling system and to improvements in containment design.⁴⁵ At the same time, the industry was reluctant to implement additional safety measures because of the desire to reduce production costs in comparison with other fuels.⁴⁶ According to TMI-2’s NRC report “[t]he industry wanted a ‘streamlined’ licensing process to reduce the lengthening lag time between application for permits and licensing, and actual issuance. ... In the promotional atmosphere of the AEC, such arguments had appeal”.⁴⁷ After the 1973 oil crisis, the energy independence of the United States and the development of domestic energy sources assumed greater importance, and the government gave additional support to the civil nuclear industry by promoting “Project Independence”, an ambitious plan to build 1000 nuclear reactors by 2000.^{48,49} In 1974, the AEC was split into the Energy Research and Development Administration (the promotional side) and the Nuclear Regulatory Commission

⁴¹Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 179.

⁴²Ibid, p. 180.

⁴³US Nuclear Operating Plant Basic Information, Nuclear Energy Institute, March 2013.

⁴⁴Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 182.

⁴⁵Ibid, p. 182.

⁴⁶Ibid, p. 183.

⁴⁷Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 182.

⁴⁸Richard Nixon, Address to the Nation About Policies To Deal With the Energy Shortages, November 7, 1973.

⁴⁹Leslie Kaufman, Japan Crisis Could Rekindle U.S. Antinuclear Movement, The New York Times, March 18, 2011.

(the regulatory role); but in spite of this separation of interests, a NRC commissioner stated right after the TMI-2 accident that *“I still think it [the NRC] is fundamentally geared to trying to nurture a growing industry”*.⁵⁰ The US President’s Commission report concluded that, because of the need to ensure national energy independence, *“the NRC is so preoccupied with the licensing of plants that it has not given primary consideration to overall safety issues. ... NRC has a history of leaving generic safety problems unresolved for periods of many years”*.⁵¹ The commission primarily focused on nuclear reactor designs, licensing of new plants and equipment malfunction on existing plants, but paid less attention to systematic safety concerns—the day to day running of plants, serious operator errors, critical areas of operator training, engineering with concern for human factors, utility management, the technical qualifications of staff and the protection of public health and safety.^{52,53} The President’s Commission report stated: *“Two of the most important activities of NRC are its licensing function and its inspection and enforcement activities. We found serious inadequacies in both. In the licensing process, applications are only required to analyze ‘single-failure’ accidents. They are not required to analyze what happens when two systems fail independently of each other, such as the event that took place at TMI. ... The accident at TMI-2 was a multiple-failure accident. ...insufficient attention has been paid [by the NRC] to the ongoing process of assuring nuclear safety. ... NRC is vulnerable to the charge that it is heavily equipment-oriented, rather than people-oriented. ... [I]nspectors who investigate accidents concentrate on what went wrong with the equipment and not on what operators may have done incorrectly, in the lack of attention to the quality of procedures provided for operators, and in an almost total lack of attention to the interaction between human beings and machines”*.⁵⁴

Lack of Communication About Minor Incidents Within the American Civil Nuclear Industry

The industry had the very serious problem that decision makers had a fragmented perception of the risks, because information about operating experience, including dangerous incidents, was not routinely and reliably exchanged between the NRC, utility companies that operated plants, NPP designers, manufacturers of reactor systems, and contractors and suppliers of critical components. The President’s

⁵⁰Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 51.

⁵¹Ibid.

⁵²Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 89.

⁵³Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 20.

⁵⁴Ibid, pp. 20, 21, 52.

Commission outlined this problem: *“The NRC accumulates vast amounts of information on the operating experience of plants. However, prior to the accident, there was no systematic method of evaluating these experiences, and no systematic attempt to look for patterns that could serve as a warning of a basic problem... The major offices within the NRC operate independently with little evidence of exchange of information or experience. For example, the fact that operators could be confused due to reliance on pressurizer level had been raised at various levels within the NRC organization. Yet, the matter ‘fell between the cracks’ and never worked its way out of the system prior to the TMI-2 accident”*.⁵⁵

Moreover, the President’s Commission found out that the mistaken shutdown of the emergency cooling system was not unique to this incident, but a problem well known to representatives of the nuclear steam system suppliers. It had occurred at PWR plants on several occasions, but nobody had transmitted this information to other plants: *“The same problem of water leaking into the polisher valve control system had occurred at least twice before at TMI-2... During the 18-month period before the accident, no effective steps were taken to correct these problems... Had Met Ed [the operator of the TMI] corrected the earlier polisher problem, the March 28 sequence of events may never have begun. ... A senior engineer of the Babcock & Wilcox Company noted in an earlier accident [on Davis-Besse NPP in 1977], bearing strong similarities to the one at Three Mile Island, that operators had mistakenly turned off the emergency cooling system. He pointed out that we were lucky that the circumstances under which this error was committed did not lead to a serious accident and warned that under other circumstances (like those that would later exist at Three Mile Island), a very serious accident could result. He urged, in the strongest terms, that clear instructions be passed on to the operators. This memorandum was written 13 months before the accident at Three Mile Island, but no new instructions resulted from it... Nine times before the TMI accident, open pressurizer relief valves (PORVs) stuck open at B&W plants. B&W did not inform its customers of these failures, nor did it highlight them in its own training program so that operators would be aware that such a failure causes a small-break LOCA [loss of coolant accident]”*.⁵⁶

In addition, the excessive complexity of control room design, which made it difficult for operators to quickly grasp the condition of a nuclear plant and so make decisions adequately, had been recognized at the design phase but ignored until the TMI case: *“Burns and Roe, the TMI-2 architect-engineer, had never systematically evaluated the control room design in the context of a serious accident to see how well it would serve in emergency conditions. Over 100 alarms went off in the early stages of the accident with no way of suppressing the unimportant ones and identifying the important ones. The danger of having too many alarms was recognized by Burns and Roe during the design stage, but the problem was never resolved... The TMI-2 control room operator complained to his superiors*

⁵⁵Ibid, pp. 21, 52.

⁵⁶Ibid, pp. 10, 43, 93.

*about problems with the control room. No corrective action was taken by the utility...".*⁵⁷

There was a huge problem of risk information transmission between the different players during the development of the nuclear industry, and an inadequate response even to identified risks: *"In a number of important cases, [the companies] failed to acquire enough information about safety problems, failed to analyze adequately what information they did acquire, or failed to act on that information. Thus, there was a serious lack of communication about several critical safety matters within and among the companies involved in the building and operation of the TMI-2 plant. ... [C]ompanies ... have little communication with those responsible for operator training and, therefore, the content of the instructional program does not lead to sufficient understanding of reactor systems... A similar problem existed in the NRC... The information and direction issued by NRC to licensees based on operating experience was, at times, fragmented and misleading... [I]mportant safety issues are frequently raised and may be studied to some degree of depth, but are not carried through to resolution; and the lessons learned from these studies do not reach those individuals and agencies that most need to know about them".*⁵⁸

Once the plants were operational, it was common practice to focus on eliminating any potential large incidents, whereas fixing minor errors and flaws was generally seen by nuclear executives as less important: *"It was natural for the regulators and the industry to ask: 'What is the worst kind of equipment failure that can occur?' A preoccupation developed with such large-break accidents as did the attitude that, if they could be controlled, we need not worry about the analysis of 'less important' accidents... This was true in the B&W incident described above, it was true about various warnings within NRC that inappropriate operator actions could result in the case of certain small-break accidents... TMI illustrated a situation where NRC emphasis on large breaks did not cover the effects observed in a smaller accident",*⁵⁹ which can be attributed to the concept of "deterministic design", which does not incorporate the complexity of the possible cascades that can develop along the multiple branches of the tree of scenarios.

The NRC's post-accident investigation confirmed the findings of the President's Commission: *"[Similar incidents to the TMI-2 accident] occurred in 1974 at a Westinghouse reactor in Beznau, Switzerland, and in 1977 at Toledo Edison's Davis Besse plant in Ohio, a Babcock & Wilcox reactor similar in design to the one at Three Mile Island. Both involved the same failed open pressurizer relief valve (PORV), and the same misleading indications to operators that the reactor coolant system was full of water. In both cases, operators diagnosed and solved the problem in a matter of minutes before serious damage could be done. The NRC never learned about the incident at the Beznau reactor until after the TMI-2 accident, because Westinghouse was not required to report to the NRC such*

⁵⁷Ibid, pp. 29–30.

⁵⁸Ibid, pp. 11, 23, 43, 55.

⁵⁹Ibid, pp. 9, 11, 30.

occurrences at foreign reactors. Westinghouse concluded that the actions by the Swiss operators proved the validity of an earlier Westinghouse study showing that, in this kind of incident, operators would have enough time to react to a stuck-open valve and correct the situation. A brief account of this earlier study had, in fact, previously been submitted to the NRC. But neither the Beznau incident nor the earlier study had prompted Westinghouse to notify its customers or the NRC that operators might well be misled by their instruments if a valve stuck open. The Davis Besse accident was intensively analyzed by Toledo Edison, by Babcock & Wilcox, and by the NRC. Each of these studies identified what should have been perceived to be a significant safety issue. But because no effective system for evaluating operating experience was in effect, none of the results of these studies were ever communicated to [Met Ed] or its operators at the TMI-2 plant. ... Toledo Edison, at the insistence of an NRC inspector and his supervisor from the agency's regional office, which is a part of NRC's Office of Inspection and Enforcement (IE), eventually adopted new operator precautions. But they were not communicated to B&W or to other utilities, and IE's regional office did not flag the issue to NRC headquarters".⁶⁰

The American nuclear regulator admitted that its inspectors had not given TMI plant managers their conclusions from the experience of erroneous shutdowns of the cooling system at several other NPPs, over a number of years before the TMI accident. In later case studies, we will see exactly the same behavior by regulators of The Soviet Ministries of Medium Machine Building, and Energy and Electrification, during the 1970s and 1980s. The staff at both Chernobyl NPP and the Sayano-Shushenskaya hydropower station operated complex and dangerous technology without understanding the technical shortcomings of the equipment, or the need to implement special safe operation regimes—even though these had been revealed years if not decades earlier at other plants. In all these cases, the regulators concerned knew the risks, but for different reasons did not pass this knowledge on to operators—and disasters occurred as a result. The TMI investigation report included this example: *"In January 1978, a NRC reviewer in NRR prepared a memo based on ... the Davis Besse incident, which noted that, in certain circumstances, operators could be misled by their instruments to turn off the emergency core cooling system. But the reviewer's memo was not circulated outside NRR and the issue was not identified as a possible generic safety problem for operating plants; it was simply filed away... In sum, the agency's fragmented bureaucracy, its preoccupation with hardware and design questions, and the lack of any clear-cut responsibility for identifying significant operating problems and warning operators about them combined to prevent the real message of Davis Besse from getting to Three Mile Island... The structure of the nuclear industry has not been conducive to the effective sharing and integration of operating data. The utilities that operate the plants have never mobilized an industry-wide effort*

⁶⁰Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, pp. 94–95.

*to concentrate on safety-related operational problems. As for the four principal U.S. manufacturers of reactors (“vendors”) – General Electric, Westinghouse, Combustion Engineering, and B&W – we found a great deal of variation in the extent to which they monitor at their own expense operating problems in the plants they have built, after those plants are tested and turned over to the utilities that have purchased them. And the relationship between the vendor and its utility customer after operation of a plant begins is largely determined by the individual utility’s choice of how much technical assistance it is willing to buy from the vendor on an ongoing, contract basis. Moreover, there is no requirement that utilities report failure data to the vendors... [A]lthough NRC requirements result in a great deal of material on reactor operations being generated and sent to the NRC by the utilities, this information has not been systematically reviewed to extract potentially important safety problems or trends... The situation is made more complex because the reporting requirements differ from plant to plant: incidents reportable at some plants do not have to be reported at others. As a result, the NRC is flooded with a mass of undifferentiated data on reactor operations... NRC publishes a computerized listing of [Licensee Event Reports], each described in a few sentences at most, and a periodical called ‘Current Events-Power Reactors’ containing more detailed descriptions of major problems... The lessons learned from malfunctions and mistakes at nuclear plants both here and abroad were never effectively shared within the industry... Coordination among these parties and between them and the NRC, as well as within the NRC, is inadequate”.*⁶¹ This report was openly published in 1980—but remarkably, Soviet energy industry regulators did not learn the lessons of TMI: no system was established to continuously transmit detailed information about incidents occurring at Soviet nuclear and hydropower plants, so operators remained unaware of the risks. Decades later this lack of communication led to disasters.

In short, all the key organizations accountable for the safe operation and regulation of TMI-2 played their part in the accident, but none of them understood the whole picture of the risks involved in running a pressurized-water reactor: no one fully grasped what could develop during a multi-failure hardware malfunction, under the control of staff who had not been trained for such failures.

2.1.2.3 Challenges of Adequate Risk Transmission After the Disaster

Misreading of Instruments Led to Mistakes by the Operators at TMI-2

There were more than 750 alarms in the control room at TMI-2, and when multi-factor malfunction occurred in the early morning of March 28, 1979, more

⁶¹Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, pp. 3, 33, 89, 94, 95, 96, 97.

than 100 of these alarms immediately went off.⁶² Operators there recalled that the console was “*lit up like a Christmas tree*”.⁶³ The control room’s alarm printer was overloaded: it could type one line every 4 s, but several alarms per second were occurring during the first few minutes.⁶⁴ Moreover, there was no system to prioritize alarms, so operators could not trace back the sequence of emergency events in time to make decisions adequately. In addition, the control room and instrumentation were designed for normal, not conditions when an accident occurs.⁶⁵ The control room was far too large and there was no orderly grouping of instruments by function—in particular, emergency controls and instruments were not sited in a common location.⁶⁶ For the four TMI-2 operators, it was difficult to run the plant based on information from instruments that were not designed to show, for example, how much water covered the core, or which quickly went off scale, as was the case with the radiation-monitoring equipment.⁶⁷ The infamous PORV alarms were on a panel remote from the central console and facing away from the operators, and the indicator light on the control panel for the PORV was wired to show only what the valve had been “instructed” by the electrical system to do, not the valve’s actual position.^{68,69} This combination of circumstances misled the operators, who did not realize that the PORV had been open for 2 h and 19 min and that the plant had lost a critical amount of coolant. A year before the accident, a TMI-2 operator had informed Met Ed management about the problem: “*The alarm system in the control room is so poorly designed that it contributes little in the analysis of a casualty. The other operators and myself have several suggestions on how to improve our alarm system—perhaps we can discuss them sometime, preferably before the system as it is causes severe problems*”.⁷⁰ The company made several improvements on TMI-1, but nothing had been done on TMI-2 at the time of the accident. Also the operators of the plant—despite having a rigorous background of working on nuclear submarines for the US Navy—had never been trained to understand all the plant parameters, and lacked theoretical knowledge of the operating principles

⁶²Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume II-Part 2, p. 577.

⁶³Gregory Rolina, *Human and Organizational Factors in Nuclear Safety: The French Approach to Safety Assessments*, CRC Press, 2013, p. 42 and Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume II-Part 2, p. 593.

⁶⁴Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume II-Part 2, p. 318.

⁶⁵Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 128.

⁶⁶*Ibid*, p. 123.

⁶⁷*Ibid*, p. 128.

⁶⁸*Ibid* p. 123.

⁶⁹*Ibid*, p. 126.

⁷⁰*Ibid*, p. 124.

of a pressurized water reactor.⁷¹ After the accident, the NRC concluded: “*Not all utilities [in the United States had] either as large an engineering staff or executives with appropriate backgrounds to enable them to direct actual plant operations during emergencies... [Nevertheless,] we have concluded that the utility [Met Ed], in terms of technical capability, is as good as the median nuclear utility*”.⁷² Investigators ruled out any deliberate withholding of information: “*However, based on the evidence, we could not conclude that the causes of this breakdown in information flow went beyond confusion, poor communications, and a failure by those in the control room, including NRC and B&W employees, to comprehend or interpret the available information, a failing shared to some extent by offsite organizations as well. A number of factors other than deliberate attempts to downgrade the seriousness of the situation could have accounted for the failure of the control room crew to communicate critical information. The failure to recognize and act on significant data in our view demonstrates a lack of technical competency by site employees to diagnose and cope with an accident. Moreover, the inability of the utility’s management to comprehend the severity of the accident and communicate it to the NRC and the public was a serious failure of the company’s management. [Nevertheless,] there is no evidence to show willful withholding of information by Met Ed from NRC*”.⁷³

The NRC investigation also outlined the atmosphere among TMI-2 staff at the time of the accident: “*[N]o one appears to be theorizing about the cause of the increased radiation levels in the plant. No one postulates an uncovered core. If anyone is thinking such thoughts, he is keeping them to himself... Intellect tells them they don’t really know what is going on; ego tells them none of the rest of these guys do either; on the evidence, both are right... Understanding what is happening to the core itself will not come until much, much later*”.⁷⁴ Another important factor influencing the misreading of the situation by operators and management at TMI-2 was a prevailing mindset about the impossibility of a meltdown on the plant: “*[The] inability to recognize and comprehend the full significance of the information, and certain psychological factors: the difficulty of accepting a completely unexpected situation, the fear of believing that the situation was as bad as the instruments suggested, and a strong desire to focus on getting the reactor stable again rather than dwelling on the severity of the accident*”.⁷⁵ For example, TMI station manager Gary Miller testified that “*I don’t believe in my mind I really believed the core had been totally uncovered, or*

⁷¹Ibid, pp. 102–103.

⁷²Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume II-Part 3, p. 811.

⁷³Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 70.

⁷⁴Ibid, pp. 22–23.

⁷⁵Ibid, p. 70.

*uncovered to a substantial degree at that time”.*⁷⁶ According to the NRC investigation, during the first hours after the accident, Miller sent “*Lead Instrumentation Control Engineer Ivan Porter down below the control room to take more instrument readings directly off the wires that lead to the incore thermocouples. Porter has his technicians take four or five initial readings. Several are too low to be believable, but at least two are above 2000 °F. The technicians express concern that the core is uncovered ... [T]he technicians are taking dozens of additional readings. Many of them are far too high for comfort... Porter shrugs them off and returns upstairs to brief Miller. He tells Miller of the readings, but says he does not believe the high ones are accurate – after all, the low ones cannot be right... Apparently there was a lack of skepticism or a lack of willingness to believe the worst”.*^{77,78}

Misjudgments of the Status of TMI-2 Resulted in Misleading Information Being Given to External Audiences

These misjudgments of the plant status led the operators and management of TMI-2 to send misleading information to their supervisors at Met Ed and its parent company General Public Utility—who in their turn informed the NRC, the designers of the plant, federal, state and local government representatives and the general public about the unimportance of the accident. For instance, 5 h after the accident, around 20 engineers and managers from Babcock & Wilcox assembled in Lynchburg, Virginia, for a speaker-phone conference with the B&W representative at TMI, but the meeting was “*...under the circumstances, a surprisingly placid gathering, marked by a dearth of information from the plant site. ‘B&W’s most prevalent feeling,’ according to one of the people present, ‘was we’re just in the dark’*”.⁷⁹ Their reaction—and that of other external audiences—would have been very different if TMI-2 staff had been able, during the first hours after the accident, to recognize the possible consequences of the PORV being open for several hours and the reactor core being uncovered (which raised the temperature within the reactor and damaged the fuel rods), evaluate the real cause of the radioactivity and hydrogen bubble, correctly deduce the possibility of a core meltdown and immediately inform their supervisors. This would have enabled prompt federal response measures to be taken—instead of which, about 4 h after the accident,

⁷⁶Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 103.

⁷⁷Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, pp. 30–31.

⁷⁸Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume II-Part 3, p. 827.

⁷⁹Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 21.

Met Ed manager of communications services was telling the media that “[t]here was a problem with a feedwater pump. The plant is shut down. We’re working on it. There’s no danger off-site. No danger to the general public”.⁸⁰

Misinformation About Real Condition of TMI-2 Led to Inadequate Crisis Response

These unwittingly inaccurate reports from TMI just postponed necessary action by external decision makers. It was only on the third day after the start of the accident that the possible meltdown of the reactor and the existence of a hydrogen bubble were officially confessed, in spite of the fact, shown in later investigations, that only 2 h into the accident at least a few of the reactor’s fuel rod claddings had ruptured and zirconium alloy had already reacted with the steam to generate hydrogen. Moreover, there was already severe damage to the reactor core 3–4 h from the start of the accident.^{81,82,83} The NRC concluded: *“In sum, ...the evidence failed to establish that Met Ed management or other personnel willfully withheld information from the NRC. There is no question that plant information conveyed from the control room to offsite organizations throughout the day was incomplete, in some instances delayed, and often colored by individual interpretations of plant status... Lack of understanding also affected the public’s perception of the accident because early reports indicated things were well in hand, but later reports indicated they were not. [Only on the third day after the accident started], when the continuing problems were generally recognized, the utility management and staff began effective action to obtain assistance, plan for contingencies, and direct daily plant operations to eliminate the hazards. The recovery effort was massive, involving hundreds of people and many organizations”*.^{84,85} Thus it was only on the third day that General Public Utility executives began to ask for scientific and operational assistance from other utilities, reactor manufacturers, firms of architects and engineers, and national nuclear laboratories. And it was only on the afternoon of the fourth day that 30 people from 10 organizations of the Industry Advisory

⁸⁰Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 104.

⁸¹Ibid, p. 99.

⁸²Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 21.

⁸³Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume II, pp. 535–537.

⁸⁴Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 69.

⁸⁵Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume II-Part 3, p. 811.

Group arrived at TMI-2 and started to blueprint solutions to the core-cooling problem.⁸⁶

In its turn, the President's commission declared that the NRC was not ready to conduct adequate response measures in such a situation: "[W]e are extremely critical of the role [the NRC] played in the response to the accident... During the most critical phase of the accident, the NRC was working under extreme pressure in an atmosphere of uncertainty. The NRC staff was confronted with problems it had never analyzed before and for which it had no immediate solutions".⁸⁷ According to the NRC investigation: "They have no time to assess the situation themselves"⁸⁸ The inadequate NRC assessment of the plant's status—based on information from the utility and mistakes in estimates of the hydrogen bubble size—led to correspondingly inadequate response measures: "On the first day of the accident, there was an attempt by the utility to minimize its significance, in spite of substantial evidence that it was serious. Later that week, NRC was the source of exaggerated stories. Due to misinformation, and in one case (the hydrogen bubble) through the commission of scientific errors, official sources would make statements about radiation already released... The response to the emergency was dominated by an atmosphere of almost total confusion. There was lack of communication at all levels... The fact that too many individuals and organizations were not aware of the dimensions of serious accidents at nuclear power plants accounts for a great deal of the lack of preparedness and the poor quality of the response... Communications were so poor [more than 48 hours from the accident] that the senior management could not and did not develop a clear understanding of conditions at the site. As a result, an evacuation was recommended to the state by the NRC senior staff on the basis of fragmentary and partially erroneous information. ... The President asked us to investigate whether the public's right to information during the emergency was well served. Our conclusion is again in the negative".⁸⁹

The situation was aggravated by the fact that many decision makers were informed about the accident not by Met Ed managers or emergency agencies, but by media news representatives. An example of this is Paul Doutrich, at the time the mayor of Harrisburg—the state capital of Pennsylvania situated at about 15 km from TMI. He only found out about the accident when a radio station in Boston called him 5 h and 15 min after the beginning of the accident—despite the fact that a general emergency had been declared after 3 h and 24 min because of high

⁸⁶Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, pp. 68, 83.

⁸⁷Report of the President's Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, pp. 21, 30.

⁸⁸Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 36.

⁸⁹Report of the President's Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, pp. 17, 18, 21, 39, 40.

radiation levels within the containment building: “*They asked me what we were doing about the nuclear emergency. My response was, ‘What nuclear emergency?’ They said, ‘Well, at Three Mile Island.’ I said, ‘I know nothing about it’*”.⁹⁰ Around the same time, the NRC notified the White House about the event at Three Mile Island. Seven hours after the accident, Robert Reid—mayor of Middletown, a small city located near TMI—called the Met Ed headquarters in Reading, who assured him that there was no escape of radioactive particles; but 20 s later, when he turned on the radio, he heard that radioactive particles had been released. Around the same time, William Scranton, Pennsylvania’s Lieutenant Governor, said in a briefing with press representatives that “*The Metropolitan Edison Company has informed us that there has been an incident at Three Mile Island, Unit-2. Everything is under control. There is and was no danger to public health and safety... There was a small release of radiation to the environment. All safety equipment functioned properly*”.⁹¹ The President’s Commission report described this incident: “*While some company executives were acknowledging radiation readings off the Island, low-level public relations officials at Met Ed’s headquarters continued ... to deny any off-site releases [8 hours after the accident]. It was an error in communications within Met Ed, one of several that would reduce the utility’s credibility with public officials and the press. ‘This was the first contradictory bit of information that we received and it caused some disturbance’... ‘I think they were defensive,’ Scranton told the Commission in his testimony*”.⁹² Another such discrepancy on the third day after the accident showed that top management at Met Ed were still not coordinating the measures they were taking within their own organization: journalists were aware that the radioactivity released during the dumping of wastewater from TMI-2 into the Susquehanna River had been reported at 1200 millirems per hour, but Met Ed’s vice president for power generation was not. During the regular press briefing, the vice president revealed data referring to a radiation level of 300 to 350 millirems per hour. This provoked suspicion that Met Ed was trying to conceal the real radiation reading, but the vice president declared that he had not heard the number 1200 and let drop: “*I don’t know why we need to tell you each and every thing that we do specifically*”.⁹³ Consequently the NRC concluded that: “*The TMI accident was a first of a kind for the nuclear power industry. Neither the utility nor the NRC was prepared to cope with the public’s need for information. As a result, the residents around TMI were unduly confused and alarmed, and the level of anxiety nationwide about the safety of nuclear plants was unnecessarily raised. The information Met Ed and NRC provided to the news media during the course of the TMI accident was often inaccurate, incomplete, overly optimistic, or ultraconservative. Errors in judgment by*

⁹⁰Ibid, p. 104.

⁹¹Ibid, p. 104.

⁹²Ibid, pp. 106–107, 109.

⁹³Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 120.

Met Ed and NRC officials were major contributors to the inadequate public information effort at TMI... At the same time, the NRC failed to coordinate its internal flow of public information, resulting in speculative reports from Washington which conflicted with statements made by NRC to officials in Harrisburg. The NRC made the problem of conflicting reports even worse by refusing to participate in joint press conferences with the utility. The State's public information effort, which relied almost entirely on information from Met Ed and later the NRC, suffered accordingly. While both the public information performance of Met Ed and the NRC can be faulted in many instances, we found no evidence that officials from either the utility or the regulatory agency willfully provided false information to the press or public".⁹⁴ According to a White House representative "many conflicting statements about TMI-2 reported by the news media were increasing public anxiety".⁹⁵

The invisibility of radiation also aggravated the perception of the accident by local residents: *"Never before have people been asked to live with such ambiguity. The TMI accident – an accident we cannot see or taste or smell ... – is an accident that is invisible. I think the fact that it is invisible creates a sense of uncertainty and fright on the part of people that may well go beyond the reality of the accident itself".⁹⁶* In addition, nationwide public nervousness during the accident was likely intensified by the Hollywood blockbuster "The China Syndrome". The movie was introduced at cinemas all over the country 12 days before Three Mile Island. The plot was about an accident at a fictitious nuclear power plant near Los Angeles. In the film, the investigation that followed revealed massive cover-ups during construction of the plant, and deliberate attempts by the plant's management to conceal facts from the public. Remarkably, in one scene of the movie, a physicist is trying to evaluate the possible consequences of a total reactor core meltdown, and says that *"an area the size of Pennsylvania"* would be permanently uninhabitable.⁹⁷ Many of the 400 reporters who had arrived at TMI were under the influence of this movie, and assessed unintentionally misleading statements by Met Ed and the NRC as deliberate risk concealment. The President's Commission also mentioned that *"[a]nother severe problem was that even personnel representing the major national news media often did not have sufficient scientific and engineering background to understand thoroughly what they heard, and did not have available to them people to explain the information. This problem was most serious in the reporting of the various releases of radiation and the explanation of the severity (or lack of severity) of these releases... We therefore conclude that, while the extent of the coverage was justified, a combination of confusion and weakness in*

⁹⁴Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 120.

⁹⁵Report of the President's Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 120.

⁹⁶Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 48.

⁹⁷Ibid, p. 29.

*the sources of information and lack of understanding on the part of the media resulted in the public being poorly served... [N]either the utility nor the NRC nor the media were sufficiently prepared to serve the public well".*⁹⁸

On the fifth day after the accident, when it became clear that the risk of a hydrogen explosion within the reactor vessel had been mitigated, US President Jimmy Carter—formerly a senior officer on a nuclear submarine—visited TMI-2. He tried to convince the public that the reactor was stable, but stated that certain actions may yet have to be taken to bring it to cold shutdown.⁹⁹ And on the seventh day Dick Thornburgh, Governor of Pennsylvania, announced: “*The threat of any immediate catastrophe is over*”.¹⁰⁰

Three Mile Island Nuclear Accident: Why Risks Were Concealed

- The US government and the NRC shared an interest in developing the domestic civil nuclear industry, as part of a larger program to ensure the energy independence of the country after the severe oil crises of 1973 and 1979. This led to a perception among industry executives that **increasing the production of electricity took priority over safety matters**.
- **Wishful thinking/self-deception among decision makers**, who persuaded themselves that minor accidents did not merit close scrutiny; that the probability of a multi-factor malfunction of hardware was marginal; that the influence of human factors on the operation of a reactor during an emergency was minimal; and that the worst-case scenario—meltdown or decapsulation of a reactor vessel—could never happen.
- Government and the nuclear industry had weak control over the complex systems involved, and had only a **fragmentary perception of the whole picture of risks**. Key decision makers were ignorant of other accidents or near-miss cases within the organization or the wider industry, nationally or abroad.
- There was **no system for managing knowledge about risks within the industry** (exchange, accumulation, systematization and transmission).
- There was **no industry-wide risk assessment system for timely evaluation of the condition of nuclear power plants**. Both operators and management at TMI-2 misjudged the status of the plant, causing them to give misleading information to other audiences and delaying the measures that needed to be taken to cool the reactor.

⁹⁸Report of the President’s Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI, October 1979, p. 19.

⁹⁹Three Mile Island: Report to the Commissioners and to the Public, M. Rogovin and G. Frampton, U.S. Nuclear Regulatory Commission, January 1980, Volume I, p. 85.

¹⁰⁰Ibid, p. 76.

2.1.3 Bhopal Pesticide Plant Gas Leak (India, 1984)



During the night between December 2 and 3, 1984, at the pesticide plant in Bhopal, India, more than 40 tons of methyl isocyanide (MIC) and other gases leaked into the atmosphere. MIC is an intermediate in pesticide production processes and has an extremely toxic impact on human health. Over the days following the accident, from 3,000 to 10,000 citizens of Bhopal died, 100,000 were injured with irreversible changes in their health and more than 500,000 were exposed to toxic gases,¹⁰¹ out of a total population of around 850,000 residents. After the disaster, no measures were taken to clean up the site of the plant. Since 1984, contaminated soil and water sources around the plant have continued to affect the environment of Bhopal.¹⁰² Thirty years after the disaster, the death toll amounts to more than 15,000 victims of the lingering effects of MIC poisoning.¹⁰³ In terms of casualty numbers, this makes Bhopal the second largest industrial accident in world history; the largest was the breach of the Banqiao and Shimantan Dams in Central China in 1975 due to Typhoon Nina, when 26,000 people according to official estimates—or 83,000 according to unofficial data—were killed by the destruction of the dams and ensuing floods; 145,000 perished in the following months from disease and famine.^{104,105}

¹⁰¹Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 9.

¹⁰²*Clouds of injustice. Bhopal disaster 20 years on.* Amnesty International Publications. London, 2004.

¹⁰³Rishi Lekhi, 30 years later, disaster haunts Bhopal survivors, Associated Press, Dec 3, 2014.

¹⁰⁴Typhoon Nina–Banqiao dam failure, *Encyclopaedia Britannica*.

¹⁰⁵David Longshore, *Encyclopedia of Hurricanes, Typhoons, and Cyclones*, Infobase Publishing, 2009, p. 124.

2.1.3.1 Risk Concealment Before the Disaster

In 1969, Union Carbide Corporation (UCC), an American company, opened a pesticide plant in Bhopal (Madhya Pradesh state, India). In the early years, the plant produced pesticides extracted from US-imported concentrate. However, the Indian government pushed UCC to organize a full-cycle chemical output at the Bhopal plant. They motivated UCC to hire, train and develop local staff for the management of the plant, and allowed it to own 50.9 % of its Indian branch (Union Carbide India Ltd (UCIL)) while reserving less than 50 % for Indian businesses and local investors. This was an exception granted to UCC to the norm imposed at that time by the Indian government that it should own more than 50 % of the shares of any foreign investment.¹⁰⁶ Such exception made Union Carbide Corporation with headquarters in the United States clearly responsible for all matters concerning the Indian plant. In 1979, UCIL launched production of an insecticide called carbaryl pesticide under the trademark SEVIN, using locally produced methyl isocyanide (MIC). UCC invested reluctantly in MIC production in India because the cost of local production exceeded US costs by a factor of 3 to 4. Due to severe droughts in India in 1977, 1982 and 1984, and the resulting decline in demand for pesticide from local farmers, the Bhopal plant became unprofitable (up to \$4 M losses from 1980 to 1984). By 1982, the plant was working at just 50 % of its capacity, and by 1984 just 20 %.¹⁰⁷

In spite of the fact that more than 20 Indian engineers were flown to the USA in 1978–1979 at the UCC’s West Virginia MIC plant to learn how to run the MIC process safely, there were at least five major chemical leaks—in which one worker died and close to 50 were injured—at the Bhopal plant between 1981 and 1984.¹⁰⁸ Moreover, due to the policy of the Indian government to have 100 % replacement of all positions in industry by Indians, the last American engineer left the Bhopal plant by the end of 1982.¹⁰⁹ From that time, the plant was operated only by Indian citizens and employed around 650 people. In 1982, UCC began to put pressure on the management of UCIL to reduce production costs, that resulted in decrease of morale at the plant: *“There was widespread belief among employees that the management had taken drastic and imprudent measures to cut costs and that attention to details that ensure safe operation was absent”*.^{110,111} UCIL started to extend the time between full safety checks from every 6 months to every 12 months and,

¹⁰⁶Personal communication with Dr. Ingrid Eckerman (February 28, 2015).

¹⁰⁷M.J. Peterson, Case Study: Bhopal Plant Disaster (with appendixes), University of Massachusetts—Amherst, 2009.

¹⁰⁸M.J. Peterson, Case Study: Bhopal Plant Disaster, Appendix A: Chronology, University of Massachusetts—Amherst, 2009.

¹⁰⁹M.J. Peterson, Case Study: Bhopal Plant Disaster (with appendixes), University of Massachusetts—Amherst, 2009.

¹¹⁰*Ibid.*

¹¹¹Nancy G. Leveson, Engineering a Safer World: Systems Thinking Applied to Safety, MIT Press, 2011, pp. 25–27.

instead of replacing rusted pipes by stainless pipes every 6 months, they replaced them by common steel pipes every 2 years.¹¹² UCIL fired the best trained and most experienced (and therefore most highly paid) engineers and hired lower paid staff with little experience of working with dangerous chemicals and equipment (for instance, the chemical engineer, who was responsible for managing the MIC unit “*resigned because he disapproved of falling safety standards*” one year before the disaster and an electrical engineer replaced him¹¹³); and the length of training courses declined from 6 to 2 months.¹¹⁴ Thirty percent of the staff at the Bhopal plant were fired and, for several years, turnover of staff at the plant exceeded 80 %; by December 1984, only a negligible number of employees remained who had been trained in the United States on the original MIC unit.^{115,116} In addition, the managers of UCIL decided to reduce the number of workers in every shift on the MIC unit: only one manager and six workers were required on a given shift in spite of UCC stating that they should keep three supervisors and twelve workers on each shift on the MIC unit.¹¹⁷ Despite these desperate attempts to economize, the SEVIN production plant remained unprofitable, and UCC had plans to sell the plant or disassemble it and ship it to Brazil and Indonesia.¹¹⁸ By the autumn of 1984, plant operators were ordered to produce SEVIN from the remaining stocks of chemicals in anticipation of the possible shutdown of the plant in the near future; the MIC production unit had been halted six weeks prior to the incident. As a result, the plant accumulated a large amount of MIC in its tankers: stocks of this lethal chemical reached 62 tons, of which only 3–4 tons were required daily for production of SEVIN. It was in contravention of common practice in the chemical industry, which is to “*always keep only a strict minimum of dangerous materials on site*”.¹¹⁹ Due to cost cuts on refrigeration, the MIC mixture began to be stored at the plant at temperatures of nearly 20 °C, while technical requirements for the mixture required it to be stored below 5 °C in order to avoid uncontrolled reactions. At the same time, plant managers had updated the settings of temperature

¹¹²Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 32.

¹¹³Nancy G. Leveson, *Engineering a Safer World: Systems Thinking Applied to Safety*, MIT Press, 2011, pp. 25–27.

¹¹⁴Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 30.

¹¹⁵M.J. Peterson, *Case Study: Bhopal Plant Disaster (with appendixes)*, University of Massachusetts—Amherst, 2009.

¹¹⁶Bridget Hanna, Ward Morehouse, Satinath Sarangi, *The Bhopal reader: remembering twenty years of the world's worst industrial disaster*, The Apex Press, New York, The Other India Press, Mapusa, Goa, 2005, p. 41.

¹¹⁷Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 31.

¹¹⁸*Ibid.*, p. 25.

¹¹⁹*Ibid.*, p. 25.

alarm activation, so that operators did not receive early warnings of the temperature rise in the MIC tanks.¹²⁰ To make matters worse, on 31 October 1984, Indira Gandhi, the 3rd Prime Minister of India, was assassinated by two of her Sikh bodyguards—and during the massive social riots that followed, the plant could not safely produce SEVIN from its tremendous stocks of MIC. In November 1984, the Indian government announced nearly two weeks of national mourning and brought in a curfew to stop communal and religious violence in the country. Consequently, workers on the second and third shifts at the Bhopal plant had trouble fulfilling their duties and production of SEVIN from existing MIC stocks was slow.¹²¹

For many years, Bhopal was considered an attractive place to get a job, and many poor people from the countryside moved to the city and seized empty land to build slums. The population of Bhopal increased from 300,000 at the end of the 1960s to 900,000 in the mid 1980s.¹²² Local authorities were reluctant to fight illegal land grabbing and construction and, as a result, shantytowns built up around the plant. During an inspection of the plant in 1979, UCC engineers emphasized that their Indian colleagues should build a complex contingency plan to respond to a possible leak, however small, of hazardous MIC. UCIL managers said that there was a contingency plan but, as the investigation following the 1984 disaster revealed, the city and state governments were not aware of any such plans.¹²³ In spite of the possible threat of MIC to human health, and a series of MIC-related accidents, management at the Bhopal plant never informed the authorities about these risks to the city. However, plant workers complained several times to the government of the Madhya Pradesh state about poor safety conditions on the plant, but the resulting inspections did not lead to a halt in production at the plant, because the involved state government representatives had insufficient technical experience of the chemical industry.¹²⁴

In 1982, UCC again sent American engineers to inspect the plant at Bhopal. They found many shortcomings in the safety system and recommended UCIL to fix them. During the following years, UCIL was sending reassuring reports to UCC about safety measures, but some of these were either temporary or were never fully implemented across the plant.¹²⁵ Meanwhile, risk concealment was also shown to have happened at UCC's operations back in the U.S. Indeed, 67 leakage events occurred in the West Virginia MIC plant between 1980 and

¹²⁰Nancy G. Leveson, *Engineering a Safer World: Systems Thinking Applied to Safety*, MIT Press, 2011, pp. 25–27.

¹²¹M.J. Peterson, *Case Study: Bhopal Plant Disaster (with appendixes)*, University of Massachusetts—Amherst, 2009.

¹²²*Ibid.*

¹²³*Ibid.*

¹²⁴M.J. Peterson, *Case Study: Bhopal Plant Disaster (with appendixes)*, University of Massachusetts—Amherst, 2009.

¹²⁵M.J. Peterson, *Case Study: Bhopal Plant Disaster, Appendix A: Chronology*, University of Massachusetts—Amherst, 2009.

1984.¹²⁶ In September 1984, UCC engineers reported the following to UCC management in a survey on operational safety and health: “*There is a concern that a runaway reaction could occur in one of the MIC unit storage tanks and that response to such a situation would not be timely or effective enough to prevent catastrophic failure of the tank*”—but investigators could not find any proof that this information was transmitted to the Bhopal plant, where the design of the MIC unit was similar to that at the West Virginia plant.^{127,128}

On December 2, 1984, the plant and MIC unit were manned by incompetent staff. The safety systems installed were inadequate in the face of the existing amount of dangerous materials (more than 60 tons of MIC). Poor and low-cost maintenance over years had led to the progressive destruction of the integrity of the plant production system. There are two theories¹²⁹ about the origin of the disaster: the first holds that water poured into MIC tanks due to the operation of washing pipes. The second states that there was sabotage among Indian staff for unknown reasons. Either way, a significant amount of water poured into a tank of MIC and ignited a powerful chemical reaction. After hours of unskilled attempts by the operators to control the reaction, approximately 40 tons of MIC were released into the atmosphere of Bhopal.

2.1.3.2 Risk Concealment After the Disaster

The tremendous number of casualties at Bhopal was caused by a lack of transmission by the plant management of the information concerning the MIC leakage to local authorities and UCC headquarters.

Water was introduced in the E610 MIC tank at 10 p.m. on December 2, 1984 and the reaction started. By 0:50 a.m. on December 3, the operators understood that they could not control this leakage, and fled the plant. Earlier, at 0:30 a.m., they switched on a large siren which was heard outside the plant, but soon turned it off. When operational staff left the plant, a low-power siren was turned on, which could only be heard within the plant area.¹³⁰ Before the disaster, “*alarms at the plant sounded so often (the siren went off twenty to thirty times a week for various purposes) that*

¹²⁶Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 22.

¹²⁷Clouds of injustice. Bhopal disaster 20 years on. Amnesty International Publications. London, 2004.

¹²⁸Internal correspondence of UCC: operations safety/health survey MIC II Unit at Institute, West Virginia MIC plant, September 1984, http://bhopal.net/source_documents/institute.sep84.pdf.

¹²⁹Ashok S. Kalelkar, *Investigation of large-magnitude incidents: Bhopal as a case study*, Arthur D. Little, Inc., Cambridge, Massachusetts, USA, presented at the Institution of Chemical Engineers Conference on Preventing Major Chemical Accidents, London, England, May 1988.

¹³⁰M.J. Peterson, *Case Study: Bhopal Plant Disaster*, Appendix A: Chronology, University of Massachusetts—Amherst, 2009.

an actual alert could not be distinguished from routine events or practice alerts".¹³¹ None of the plant executives informed local authorities about the accident. Moreover, when the police began to receive hundreds of phone calls from Bhopal residents about a strange gas, bouts of coughing and people lying unconscious on the streets, the plant operators continued to reassure local police that "*Everything is OK*" and "*We do not know what [is happening]*". The plant manager flatly denied any leakage there: "*The gas leak just can't be from my plant*".¹³² This all resulted in a situation in which local officials, police and the military stalled the evacuation of local residents. Unbelievably, the authorities had never expected to evacuate people because nobody thought that the plant was a hazardous operation: the management of the plant never revealed the risks of MIC. Moreover, according to the Madhya Pradesh Town and Country Planning Board, the plant was classified in the "*general industry*" rather than in the "*hazardous industry*" category.¹³³

The second cause of mass mortality at Bhopal was the fact that medical institutes were unprepared for a large influx of patients. This city of almost a million people had only 5 hospitals, with 1800 hospital beds and 300 doctors, who were never trained to serve patients with chemical poisoning. Before the accident, UCIL did not provide any recommendations about medical treatment appropriate to the list of chemicals in use at the plant, and afterwards they declined to reveal the composition of the leaked gas.¹³⁴ This led to a complete absence of adequate treatment for the thousands of victims. Moreover, according to a statement by UCC executives in the United States, the first—still contradictory—information about the disaster reached headquarters more than 12 h after the accident.¹³⁵ By 8 a.m. on December 3, 1984, managers at the plant had been arrested by the local police, and UCC did not have top-level contacts within Bhopal to get reliable information about the accident. In addition, communication between UCC and the Bhopal plant and authorities became complicated by the insufficient capacity of the existing telephone network (a city of nearly a million people had only 10,000 numbers in the telephone network). All together, this led to the absence of detailed information about the accident reaching UCC executives, and consequently to a shortage of clear and strict recommendations about antidotes from UCC's advanced medical service to hospitals in Bhopal in the first few critical hours after the leak.

In addition, Bhopal also lacked the infrastructure and ground level preparation for an adequate and fast evacuation: there were no channels for the transmission of public information (e.g. networks of loudspeakers); 80 % of the people affected by

¹³¹Nancy G. Leveson, *Engineering a Safer World: Systems Thinking Applied to Safety*, MIT Press, 2011, pp. 25–27.

¹³²Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 81–82.

¹³³M.J. Peterson, *Case Study: Bhopal Plant Disaster (with appendixes)*, University of Massachusetts—Amherst, 2009.

¹³⁴Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, pp. 19, 64.

¹³⁵Browning, Jackson B. *Union Carbide: Disaster At Bhopal*. Union Carbide Corporation, 1993.

the accident had an income of less than US\$6 per month (half of the Indian subsistence level)¹³⁶ and could not even afford to have a radio receiver; and only a small number of residents had access to electricity, so most had no stable reception of radio or TV. In October 1982, after major MIC leaks, the labor union published a leaflet about possible threats to people from the plant to Bhopal, but the majority of slum residents could not understand the message and ignored it due to illiteracy. Nevertheless, due to the existence of a series of minor incidents on the plant over the preceding years, word-of-mouth communication has informed the residents of the slums of the potential danger posed by the plant and they understood the necessity to run away from the plant in case of emergency. But nobody had anticipated the magnitude of the potential disaster,¹³⁷ which occurred in December 1984, when the leaked chemicals covered almost the whole city of Bhopal.

After the accident the Indian government paid only US\$800 to relatives of the deceased, and just \$100 to the 20,000 victims who developed chronic diseases because of the disaster.¹³⁸ Moreover, in 1989, out-of-court agreements on compensation between the Indian government and the mother company Union Carbide Corporation stipulated a payment of just US\$470 million¹³⁹; the majority of this amount did not even reach the victims of the disaster. It took until 2010, that is 26 years after the disaster, for seven UCIL employees to be convicted by Indian courts, each receiving a two-year prison sentence and a fine of about US\$2000.¹⁴⁰

Bhopal Pesticide Plant Gas Leak: Why Risks Were Concealed

- The Indian government's desire to reach national industrial independence, and its negligence to reveal details of deliberate violations of safety rules at the plant. The **lack of experience or qualifications of government representatives**, which did not allow them to recognize the disastrous state of the plant years before the accident. In addition, without sufficient control by the parent corporation over Union Carbide India Limited, **management at the plant could manipulate data about real conditions at the plant** without fear to be punished by representatives of Union Carbide Corporation and Indian authorities.
- The **desire of Indian managers to appear in a good light** in the eyes of Union Carbide Corporation executives motivated them to **play down the existence of massive safety imperfections at the plant**.

¹³⁶Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 13.

¹³⁷Personal communication with Dr. Ingrid Eckerman (Feb. 28, 2015).

¹³⁸Paul Shrivastava, *Long-term recovery from the Bhopal crisis*, UN University Press, 1994.

¹³⁹Ingrid Eckerman, *The Bhopal Saga: Causes and Consequences of the World's Largest Industrial Disaster*, Universities Press, 2005, p. 132.

¹⁴⁰Bhopal trial: Eight convicted over India gas disaster, BBC News, 7 June 2010.

- The chronic unprofitability of the Bhopal plant, and **reluctance of plant managers to reveal the risks involved to local authorities that would likely oblige them to incur additional expense on safety measures**, or to suffer from increased wages to reward employees for hazardous work that would be known as such, or to support the costs for relocating the shantytowns, and so on.
- The **reluctance of Union Carbide Corporation executives to reveal statistics of accidents** at the West Virginia MIC plant, and the extreme danger posed by MIC, to their international subdivisions.
- **False reassurance/self-suggestion/self-deception among American and Indian executives** about the maximum possible scale of any chemical accident at the plant.
- The **absence of a prompt risk assessment system**: nobody among the managers of the plant could evaluate the possible volume of the chemical release or the direction of its movement, nor could they provide recommendations regarding antidotes, how the residents of Bhopal should respond, and so on.

2.1.4 Challenger Space Shuttle Disaster (USA, 1986)

You don't concentrate on risks. You concentrate on results.

No risk is too great to prevent the necessary job from getting done

Chuck Yeager

On January 28, 1986 at 11:39 a.m., the Space Shuttle Challenger exploded in the second minute after lift-off from the Kennedy Space Center. This resulted in the deaths of all seven astronauts.

2.1.4.1 Risk Concealment Before the Disaster

Constant Struggle Within the US Space Shuttle Program to Increase the Launch Frequency and Face US Government Financing Shortages

The US Space Shuttle program began in 1972. It was based on the idea that a reusable space shuttle system could make regular civil space launches possible, with the goal to achieve 24 flights per year.¹⁴¹ Expenditure would be reduced by

¹⁴¹Investigation of the Challenger accident. Report of the Committee on Science and Technology House of Representatives, Oct. 29, 1986, p. 22.

reusing the Shuttles and by having more frequent launches through economies of scale. Over the following 30 years, 135 Shuttle were launched at a total cost of US\$192 billion¹⁴²—or around US\$1.5 billion per launch in 2010 prices—and the annual launch rate did not exceed 4.5 flights per year. The Space Shuttle Program has been NASA's single most expensive activity.¹⁴³ Compared with unmanned space cargo programs, the cost of one kilogram of the Shuttle's payload exceeded the payload of existing programs by a factor between 2 and 10.^{144,145,146} High usage rates were critical to the Shuttle's economy because its huge development costs needed to be recouped within a reasonable amount of time.¹⁴⁷ For example, in 1976, NASA anticipated 49 flights in 1984 and 58 in 1985.¹⁴⁸ In contrast, in 1981 there were two launches, in 1982 three, in 1983 four, in 1984 five, and in 1985 nine (which is the record in the history of the Shuttle program). In 1985, NASA published a projection of about 24 flights per year by 1990. There were 14 flights scheduled for 1986.¹⁴⁹ The Space Shuttle flights were manned, imposing on the engineers of the Shuttle to improve its reliability, at the cost of expansive additional safety systems. As a result, launches were permanently delayed (*"Manpower limitations due to high workload created scheduling difficulties and contributed to operational problems"*¹⁵⁰). From the beginning of the program, underestimation of the cost of launches and the irregularity of flights became major managerial problems for NASA executives.

¹⁴²Roger Pielke Jr, Radford Byerly, Shuttle programme lifetime cost, *Nature*, 472(7341), 07 April 2011.

¹⁴³William Starbuck, Moshe Farjoun, *Organization at the Limit: Lessons from the Columbia Disaster*. Oxford: Blackwell, 2005, p. 31.

¹⁴⁴The final cost of one kilogram of payload amounted to US\$60,000; the Shuttle's payload, which was taken up to low earth orbit (LEO), was 24,400 kg. For example, the payload cost of the American expendable Titan IV space rocket, used by the U.S. Air Force, was calculated as US\$27,000/kg—US\$588 million per launch at 2010 prices with 21,680 kg of payload to low earth orbit; the Russian Proton rocket had a payload cost of US\$5,300/kg—US\$110 million per launch with 20,700 kg of payload to low earth orbit.

¹⁴⁵According to a report of the United States Air Force, the average unit cost of Titan IV rocket was US\$450 mln in 1999. The cumulative rate of US inflation between 1999 and 2000 is 30.9 %. This implies that expenditures on every launch was US\$588 in 2010 price. "Titan IV" report, United States Air Force, 1999, <http://www.dote.osd.mil/pub/reports/FY1999/pdf/99titaniv.pdf>.

¹⁴⁶Peter B. de Selding, ILS May Pitch Proton as Cost-saver Over Soyuz for Galileo Satellites, *Space News*, January 15, 2010.

¹⁴⁷John R. London III, *LEO on the Cheap Methods for Achieving Drastic Reductions In Space Launch Costs*, Air University Press, Maxwell Air Force Base, Alabama, Oct. 1994, p. 45.

¹⁴⁸Investigation of the Challenger accident. Report of the Committee on Science and Technology House of Representatives, Oct. 29, 1986, p. 120.

¹⁴⁹Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. VIII: Pressures on the system, Washington, D.C., June 6th, 1986.

¹⁵⁰Report of the Presidential Commission on the Space Shuttle Challenger Accident, Vol. 2: Appendix I—NASA Pre-Launch Activities Team Report, Washington, D.C., June 6th, 1986.

The initial plan implied developing towards self-sufficiency, but during program development, it became clear that NASA would always rely on Congress and government spending. The design of the Shuttle's solid rocket boosters was primarily based on the U.S. Air Force's Titan III solid rocket.¹⁵¹ In 1983, Ronald Reagan proposed the Strategic Defense Initiative—ground-based and space-based systems to protect the United States from attack by Soviet strategic nuclear ballistic missiles. On August 28, 1985, a Titan 34D rocket laden with military equipment exploded after take-off from the Vandenberg Air Force Base. This gave NASA additional leverage to convince Congress that the shuttle transportation system could deliver military staff and equipment, including components of the Strategic Defense Initiative program, to orbit in any conditions. Accordingly, NASA requested that military funding for developing the Titan IV program—US\$17.6 billion was to be spent for this purpose up to 1999¹⁵²—should be transferred to NASA. Ultimately, *“the nation's reliance on the Shuttle as its principal space launch capability created a relentless pressure on NASA to increase the flight rate”*.¹⁵³

Because of this, NASA executives could not accept cancellations or serious delays of Shuttle flights due to weather conditions or minor technical problems. Such confidence was based on the statistics of previous flights and the false perception that the probability of Shuttle failure was extremely low. By January 1986, NASA management interpreted the previous 24 successful Shuttle launches as a transition of the space shuttle program from the experimental phase to the operational phase, which meant that the Shuttle's design was now proven to be adequate for serial launches.

Masterful Encapsulation of the Problem

Richard Feynman, American theoretical physicist, participant in the Manhattan Project to develop an American atomic bomb, Nobel Prize laureate in Physics and member of The Rogers Commission Report, which was created to investigate the Space Shuttle Challenger disaster, wrote after the disaster what can be considered as an authoritative last word: *“There are enormous differences of opinion as to the probability of a failure with loss of vehicle and of human life. The estimates range from roughly 1 in 100 to 1 in 100,000. The higher figures come from the working engineers, and the very low figures from management. What are the causes and consequences of this lack of agreement? Since 1 part in 100,000 would imply that*

¹⁵¹Investigation of the Challenger accident. Report of the Committee on Science and Technology House of Representatives, Oct. 29, 1986, p. 106.

¹⁵²“Titan IV” report, United States Air Force, 1999, <http://www.dote.osd.mil/pub/reports/FY1999/pdf/99titaniv.pdf>.

¹⁵³Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chapter XV: Return to Flight: Richard H. Truly and the Recovery from the Challenger Accident by John A. Logsdon, Washington, D.C., June 6th, 1986.

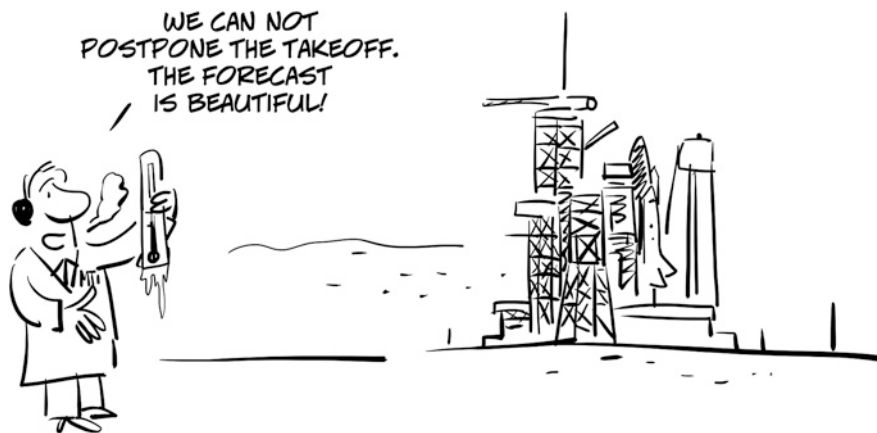
*one could put a Shuttle up each day for 300 years expecting to lose only one, we could properly ask ‘What is the cause of management’s fantastic faith in the machinery?’ An estimate of the reliability of solid rockets was made by the range safety officer, based on the study of all previous rocket flights. Out of a total of nearly 2,900 flights, 121 failed (1 in 25). This includes, however, what may be called early errors, rockets flown for the first few times in which design errors are discovered and fixed. A more reasonable figure for the mature rockets might be 1 in 50. With special care in the selection of parts and in the inspection process, a figure of below 1 in 100 might be achieved but 1 in 1000 is probably not attainable with today’s technology. Since there are two rockets on the Shuttle, these rocket failure rates must be doubled to derive the Shuttle failure rates from the Solid Rocket Booster failure rate... Engineers at Rocketdyne, the manufacturer, estimate the total probability as 1/10,000. Engineers at Marshal estimate it as 1/300, while NASA management, to whom these engineers report, claims it is 1/100,000. An independent engineer consulting for NASA thought 1 or 2 per 100 to be a reasonable estimate. NASA officials argued that the figure is much lower. They point out that these figures are for unmanned rockets but since the Shuttle is a manned vehicle ‘the probability of mission success is necessarily very close to 1.0.’ It is not very clear what this phrase means. Does it mean it is close to 1 or that it ought to be close to 1? They go on to explain ‘Historically, this extremely high degree of mission success has given rise to a difference in philosophy between manned space flight programs and unmanned programs; i.e., numerical probability usage versus engineering judgment’. It is true that, if the probability of failure was as low as 1 in 100,000, it would take an inordinate number of tests to determine it. Official management ... claims to believe the probability of failure is a thousand times less [the engineers’ estimation of 1 in 100]. One reason for this may be an attempt to assure the government of NASA perfection and success in order to ensure the supply of funds. The other may be that they sincerely believed it to be true, demonstrating an almost incredible lack of communication between themselves and their working engineers... The astronauts, like test pilots, should know their risks”.*¹⁵⁴

Problems of Timely Launching of Space Shuttles in 1985–1986

The 25th launch of the Shuttle (STS-51-L mission, Challenger) had been planned for July 1985. It was postponed until late November to accommodate changes in payloads. The launch was subsequently delayed again and finally was rescheduled

¹⁵⁴Report of the Presidential Commission on the Space Shuttle Challenger Accident, Appendix F. R. P. Feynman, Personal observations on the reliability of the Shuttle, Washington, D.C., June 6th, 1986.

to January 22, 1986.¹⁵⁵ However, due to problems with weather conditions (bad weather at transoceanic abort landing sites and unacceptable weather at the Kennedy Space Center itself¹⁵⁶), the launch was rescheduled for the morning of January 28, 1986. However, a major cause of delay to the STS-51-L mission was the delay of the previous mission (STS-61-C, Columbia), which launched only on January 12, 1986, after one month and 7 delays caused by a series of technical problems. During this month, journalists based at the Kennedy Space Center published critical and negative articles about NASA's ability to manage technical aspects of the Shuttle and launch schedule (the STS-61-C mission was sarcastically called "*Mission Impossible*"¹⁵⁷). For the next mission (STS-51-L, Challenger), more than 500 journalists were accredited to cover the launch from the Kennedy Space Center and Johnson Space Center in Houston. After several delays to the new mission, the media continued to ridicule NASA capabilities to adhere strictly to the schedule. Moreover, the delays meant that the STS-51-L mission could miss opportunities to reach the target orbit for the correct deployment of satellites.¹⁵⁸



Outdoor Temperature and O-Rings Problems

Weather forecasts for the night before the Challenger launch and early morning of January 28, 1986 predicted favorable conditions. However, engineers at Morton Thiokol Inc. (MTI), the main supplier of solid rocket boosters to NASA's Shuttle

¹⁵⁵Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chapter II—Events Leading up to the Challenger Mission, Washington, D.C., June 6th, 1986.

¹⁵⁶NASA—STS-51L history, NASA's John F. Kennedy Space Center, http://www.nasa.gov/mission_pages/shuttle/shuttlemissions/archives/sts-51L.html.

¹⁵⁷David Shayler, *Disasters and Accidents in Manned Spaceflight*, Springer, 2000, p. xxviii.

¹⁵⁸Documentary "Challenger: The Untold Story", National Geographic Channel, 2006.

program and USAF's Titan rocket family, were alarmed by one detail: extremely cold weather was predicted for Florida, dropping to minus 6.6 °C (20 °F) in the last 11 h before the launch.¹⁵⁹ Indeed, previous successful lift-offs all occurred at temperatures above +11.5 °C (53 °F). This low temperature of +11.5 °C (53 °F) was registered during the launch of mission STS-51-C (Discovery) on January 24, 1985. After this mission, the solid rocket boosters were salvaged from the Atlantic Ocean and Roger Boisjoly, one of the senior engineers on the MTI team, found out that the O-rings, which sealed the hot gases inside the combustion chambers of the solid rocket boosters while firing, were damaged. The O-rings were among 700 parts included on the "Critical 1" list. Of the 2 million components comprising the Shuttle, a failure of any one of the parts on this list would result in the loss of the spacecraft and/or crew. Boisjoly concluded that the main cause of damage to the O-rings was the low temperature on the day of the launch: +11.5 °C (53 °F). The rings had excellent resistance to high temperatures up to 327 °C (621 °F),¹⁶⁰ but lose their flexibility in cold conditions. The manufacturer of the O-rings expected that the product would retain resilience below −3.8 °C (25 °F), but there were no practical tests of O-rings on MTI solid rocket boosters in cold temperature conditions. In view of this and other factors, the recommended temperature range for the entire Shuttle launch was between +0.5 °C (31 °F) and +37.2 °C (99 °F).¹⁶¹ Some erosion of the O-rings was recorded during the 51-B mission (29 April, 1985, Challenger).

After the launches, MTI formally mentioned some problems with the rings in a report to NASA, but no action was taken. In July 1985, Boisjoly sent an internal report to MTI executives about his concerns about the need for an immediate redesign of the solid rocket boosters, but received an informal reply from a top MTI manager that *"this material is too sensitive to release to anybody. We will keep it a secret"*.¹⁶² Professor Leveson from MIT stated *"schedule and launch pressures in the Shuttle program created a mindset that dismissed all concerns, leading to overconfidence and complacency. This type of culture can be described as a culture of denial where risk assessment is unrealistic and credible risks and warnings are dismissed without appropriate investigation. Managers begin to listen only to those who provide confirming evidence that supports what they want to hear. Neither Thiokol nor NASA expected the rubber O-rings sealing the joints to be touched by hot gases during motor ignition, much less to be partially burned. However, as tests and then flights confirmed damage to the sealing rings, the*

¹⁵⁹Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chapter V: The Contributing Cause of the Accident, Washington, D.C., June 6th, 1986.

¹⁶⁰Information about fluoroelastomer (FKM), <http://en.wikipedia.org/wiki/FKM>.

¹⁶¹Diane Vaughan, The Challenger launch decision: risky technology, culture and deviance at NASA. Chicago: The University of Chicago Press; 1996, p. 155.

¹⁶²Documentary "Challenger: The Untold Story", National Geographic Channel, 2006.

reaction by both NASA and Thiokol was to increase the amount of damage considered ‘acceptable’”.¹⁶³

In fact, the problem of the O-rings was known from 1977,^{164,165} but “NASA and contractor management first failed to recognize it as a problem, then failed to fix it and finally treated it as an acceptable flight risk. [MTI] did not accept the implication of tests early in the program that the design had a serious and unanticipated flaw. [NASA executives] did not accept the judgment of its engineers that the design was unacceptable and, as the joint problems grew in number and severity, NASA minimized them in management briefings and reports. [MTI also stated that] the condition is not desirable but is acceptable”.¹⁶⁶ NASA executives were not informed in detail about the seriousness of the problem with solid rocket boosters during cold weather launches before January 27, 1986.¹⁶⁷ On the day before the launch of Challenger, during conference calls with NASA, Boisjoly tried to convince MTI executives and NASA managers to cancel the flight until the temperature on the launch pad at the Kennedy Space Center reached at least +11.5 °C (53 °F) when all of the solid rocket boosters would be defrosted. He demonstrated that damage had occurred to the material of the O-rings during flights in January and April 1985. Although the STS-61C mission (January 12, 1986, Columbia) was launched at temperatures lower than +5 °C (41 °F), MTI engineers did not provide any information concerning a possible erosion of the O-rings during the conference calls.¹⁶⁸ NASA executives exclaimed that they were “appalled at the given recommendations”, that “we can’t launch, we won’t be able to launch until April”¹⁶⁹ and argued that the evidence was “incomplete”.¹⁷⁰ Nevertheless, NASA officials emphasized that they would “not agree to launch

¹⁶³Nancy G. Leveson, MIT, Technical and Managerial Factors in the NASA Challenger and Columbia Losses: Looking Forward to the Future published within Kleinman, Cloud-Hansen, Matta, and Handelsman Controversies in Science and Technology Volume 2, Mary Ann Liebert Press, 2008.

¹⁶⁴Investigation of the Challenger accident: hearings before the Committee on Science and Technology, U.S. House of Representatives, Ninety-ninth Congress, June 15, 16, 23, 24, 1986, Vol.1, p. 69.

¹⁶⁵Diane Vaughan, The Challenger launch decision: risky technology, culture and deviance at NASA. Chicago: The University of. Chicago Press; 1996, p. 267.

¹⁶⁶Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chapter VI: An Accident Rooted In History, Washington, D.C., June 6th, 1986.

¹⁶⁷Diane Vaughan, The Challenger launch decision: risky technology, culture and deviance at NASA. Chicago: The University of. Chicago Press; 1996, p. 295.

¹⁶⁸Diane Vaughan, The Challenger launch decision: risky technology, culture and deviance at NASA. Chicago: University of Chicago Press; 1996.

¹⁶⁹Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. V: The Contributing Cause of the Accident, Washington, D.C., June 6th, 1986.

¹⁷⁰Richard P. Feynman, What Do You Care What Other People Think? 1988, W W Norton, p. 141.

against the contractor's recommendation".¹⁷¹ After NASA's comments, MTI managers organized a caucus for intensive discussion about the final decision regarding the launch, during which one executive proposed to one of the skeptical managers: "*It is time to take off your engineering hat and put on your management hat*".¹⁷² Ultimately, MTI executives approved the launch with the following comments: "*(1) there is a substantial margin to erode the primary O-ring by a factor of three times the previous worst case, and (2) even if the primary O-ring does not seal, the secondary is in position and will*".¹⁷³ NASA managers were satisfied with this decision from the contractor. In their turn, they informed their superiors (Levels I and II program officials and the Launch Director for 51-L) that the issue had been resolved and MTI did not have objections for the launch.

The next day, the Shuttle Challenger exploded in the 72nd second after lift-off. Hot gases from the combustion chambers had leaked through a breach, created by tremendous pressure—from 900 to 1200 psi (pounds per square inch) or 62 to 87 bars—on the frosted and stiff O-rings. The temperature at the launch pad during the launch was +2.2 °C (36 °F).^{174,175}

Disclosure of Continual Flawed Decision-Making Processes Within the Program

After the disaster, the Roger Commission stated...*"that testimony reveals failures in communication that resulted in a decision to launch 51-L based on incomplete and sometimes misleading information, a conflict between engineering data and management judgments, and a NASA management structure that permitted internal flight safety problems to bypass key Shuttle managers... Organizational response to the technical problem was characterized by poor communication, inadequate information handling, faulty technical decision making, and failure to comply with regulations instituted to assure safety"*.¹⁷⁶ The Commission found that NASA's safety system had many faults, including *"a lack of problem reporting requirements, inadequate trend analysis, misrepresentation of criticality, and lack of involvement in critical discussions... Problem reporting requirements are not concise and fail to get critical information to the proper levels of*

¹⁷¹Diane Vaughan, *The Challenger launch decision: risky technology, culture and deviance at NASA*. Chicago: University of Chicago Press; 1996, p. 312.

¹⁷²Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. V: The Contributing Cause of the Accident, Washington, D.C., June 6th, 1986.

¹⁷³Ibid.

¹⁷⁴Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. V: The Contributing Cause of the Accident, Washington, D.C., June 6th, 1986.

¹⁷⁵Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. IV: The Cause of the Accident, Washington, D.C., June 6th, 1986.

¹⁷⁶Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. V: The Contributing Cause of the Accident, Washington, D.C., June 6th, 1986.

management”.¹⁷⁷ *“The decision to launch the Challenger was flawed. Those who made that decision were unaware of the recent history of problems concerning the O-rings and the joint and were unaware of the initial written recommendation of the contractor advising against the launch at temperatures below 53 degrees Fahrenheit [$+ 11.5^{\circ}\text{C}$] and the continuing opposition of the engineers at Thiokol after the management reversed its position... If the decision makers [Levels I and II program officials, or Launch Director for 51-L] had known all of the facts, it is highly unlikely that they would have decided to launch 51-L on January 28, 1986”.*¹⁷⁸

Boisjoly declared during the commission testimony: *“I felt personally that management was under a lot of pressure to launch and that they made a very tough decision, but I didn’t agree with it”.*¹⁷⁹ Twenty years later, Boisjoly stated that *“I must emphasize that MTI Management fully supported the original decision to not launch below 53 °F [$+ 11.5^{\circ}\text{C}$] prior to the caucus. The caucus constituted the unethical decision-making forum resulting from intense customer intimidation. NASA placed MTI in the position of proving that it was not safe to fly instead of proving that it was safe to fly. Also, note that NASA immediately accepted the new decision to launch because it was consistent with their desires and, please note, that no probing questions were asked”.*¹⁸⁰ The Commission concluded that *“the Thiokol Management reversed its position and recommended the launch of 51-L, at the urging of Marshall and contrary to the views of its engineers in order to accommodate a major customer”.*¹⁸¹

Richard Feynman finally found out about the O-ring problem, about which NASA managers had known since 1977: *“If all the seals had leaked, it would have been obvious even to NASA that the problem was serious. But only a few of the seals leaked on only some of the flights. So NASA had developed a peculiar kind of attitude: if one of the seals leaks a little and the flight is successful, the problem isn’t so serious... Mr. Weeks said there was a rumor that the history of the seals’ problem was being leaked to the newspapers. That bothered him a little bit, because it made NASA look like it was trying to keep things secret... We had our emergency closed meeting to hear from the guy whose story was in the New York Times. His name was Mr. Cook. He was in the budget department of NASA when he was asked to look into a possible seals problem and to estimate the costs needed to rectify it. By talking to the engineers, he found out that the seals had*

¹⁷⁷Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. VII: The Silent Safety Program, Washington, D.C., June 6th, 1986.

¹⁷⁸Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chap. V: The Contributing Cause of the Accident, Washington, D.C., June 6th, 1986.

¹⁷⁹Ibid.

¹⁸⁰Roger M. Boisjoly, Telecom Meeting (Ethical Decisions—Morton Thiokol and the Challenger Disaster), 2006, <http://www.onlineethics.org/cms/7061.aspx>.

¹⁸¹Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chapter V: The Contributing Cause of the Accident, Washington, D.C., June 6th, 1986.

*been a big problem for a long time. So he reported that it would cost so-and-so much to fix it – a lot of money. From the point of view of the press and some of the commissioners, Mr. Cook's story sounded like a big expose, as if NASA was hiding the seals problem from us".*¹⁸²

The commission summarized major organizational problems related to the accelerated launch schedule. We here select a few that are relevant to our discussion¹⁸³:

- "1. The capabilities of the system were stretched to the limit to support the flight rate in winter 1985/1986. Projections into the spring and summer of 1986 showed a clear trend; the system, as it existed, would have been unable to deliver crew training software for scheduled flights by the designated dates. The result would have been an unacceptable compression of the time available for the crews to accomplish their required training.*
- 2. Spare parts are in critically short supply. The Shuttle program made a conscious decision to postpone spare parts procurements in favor of budget items of perceived higher priority. Lack of spare parts would likely have limited flight operations in 1986...*
- 3. The scheduled flight rate did not accurately reflect the capabilities and resources*
- 4. Training simulators may be the limiting factor on the flight rate: the two current simulators cannot train crews for more than 12–15 flights per year.*
- 5. When flights come in rapid succession, current requirements do not ensure that critical anomalies occurring during one flight are identified and addressed appropriately before the next flight".*

During hearings before the US Congress Committee on Science and Technology, one committee member made the following assessment of NASA's organizational culture prior to the disaster: *"[O]ne difficult question is this whole attitude, this whole new culture that grew up in NASA and perhaps in the Marshall Center; this culture that has been called arrogance, conceit that they knew it all; they didn't need to include in the information circle outside experts. They didn't need to listen to the Rockwell fears, expressed fears of the subzero temperatures. They pressured Morton Thiokol not to bother with a lot of chintzy concerns about safety. They excluded the astronauts themselves from the information circle. They had the feeling that they knew it all and didn't need any outside information. They didn't want anything to interfere with the schedule... [B]oth management and technical arrogance brought about by the mindset caused by a period of spectacular successes. We in Congress, as well as NASA and the aerospace industry, must never again be*

¹⁸²Richard P. Feynman, *What Do You Care What Other People Think?* 1988, W W Norton, p. 138.

¹⁸³Report of the Presidential Commission on the Space Shuttle Challenger Accident, Chapter VIII: Pressures on the system, Washington, D.C., June 6th, 1986.

*lulled into a sense of overconfidence that could contribute to such a tragedy. While history does not repeat itself, unfortunately people can repeat history”.*¹⁸⁴

In August 1990, the U.S. General Accounting Office mentioned that “NASA and the Air Force provide the majority of the contract dollars for the Thiokol Corporation [renamed Morton Thiokol Inc.]... Based on our interviews with Air Force and NASA officials, our study indicates that Thiokol will remain a viable part of the defense industrial base [Thiokol Corporation was also the manufacturer of the boosters for American ballistic missiles with nuclear warheads – Pershing, Peacekeeper/Trident, Poseidon, Minuteman¹⁸⁵]... Air Force and NASA officials said that it really is not economically feasible to keep two sources in operation for these items... [Therefore] [p]urchases of Thiokol’s solid rocket motors are planned through 1995 and beyond”.¹⁸⁶

Ultimately, the combination of these facts explains the passive position of MTI management when, in July 1985, Boisjoly sent the report about shortcomings in the O-ring design. MTI executives realized that the budget of NASA and the available time were insufficient for serious improvement of the scores of solid rocket boosters that were already ordered—after the accident, it indeed took 32 months to redesign the solid rocket boosters.¹⁸⁷ It thus seemed impossible for NASA and MTI to halt the program and confess that there had been flaws in the design of the O-rings during many years before the first launch of the Shuttle in 1981. Moreover, NASA and MTI have been concealing this information from astronauts, the government and the public during two dozen launches. NASA was the major client for MTI with more than a billion dollar contract each year, and MTI management wished to maintain its contract. This explains why MTI management made the decision, in compliance with NASA requests, to keep the cost of launches down and to minimize delays, the later being interpreted by the media and politicians as due to technical shortcomings of the whole Shuttle program; NASA was anxious to demonstrate to Congress that the Shuttle could fly in any conditions with military staff and materials.

Because of the disaster, the USAF got resources from Congress to develop its Titan IV program, delivering military staff into space independently from the Shuttle program. After the disaster, MTI admitted guilt and legal liability for the disaster, paid out-of-court compensation to the families of astronauts, thus diverting the blame from NASA management... and received lucrative new contracts from NASA and USAF for the decades to come. After the commission hearing,

¹⁸⁴Investigation of the Challenger accident: hearings before the Committee on Science and Technology, U.S. House of Representatives, Ninety-ninth Congress, June 15, 16, 23, 24, 1986, Vol.1, p. 53, p. 3.

¹⁸⁵Thiokol Chemical Corporation profile, <http://en.wikipedia.org/wiki/Thiokol>.

¹⁸⁶U.S. General Accounting office, Government Contracting: Review of Morton Thiokol Separation, NSIAD-90-220, August 1990, p. 3.

¹⁸⁷Columbia Accident Investigation Board, CAIB Final Report, Volume 1, August 26, 2003, p. 25.

whistleblower Roger Boisjoly found himself shunned by colleagues and managers of MTI and resigned from the company.¹⁸⁸

Richard Feynman summed it up as follows: *“Let us make recommendations to ensure that NASA officials deal in a world of reality in understanding technological weaknesses and imperfections well enough to be actively trying to eliminate them. They must live in reality in comparing the costs and utility of the Shuttle to other methods of entering space. And they must be realistic in making contracts, in estimating costs, and the difficulty of the projects. Only realistic flight schedules should be proposed, schedules that have a reasonable chance of being met. For a successful technology, reality must take precedence over public relations, for nature cannot be fooled”*.¹⁸⁹

Challenger Space Shuttle Disaster: Why Risks Were Concealed

- Unrealistic projections about the launch schedule and a **culture of continuously rushed organization**. NASA management’s desire to demonstrate to Congress and the military that the Shuttle program could send any load to space in any weather conditions on a timely basis.
- **Habituation/wishful thinking/false reassurance/self-suggestion/self-deception** among NASA and MTI decision-makers about the supposedly minuscule probability of a failure of the Shuttle. This also led to an attitude of arrogance among NASA executives.
- MTI management’s **fear of losing their main client** (NASA). General problem of incentives in risk management: if MTI had remained adamant and advised against the flight, how would the “success” of no disaster resulting from the flight cancellation be rewarded?
- The **reluctance of MTI management to confess their own mistakes** in the design of solid rocket boosters and in ignoring previous warnings (damage to the O-rings during previous launches).
- **“Success at any price” and “no bad news” culture**
- MTI management’s **fear of being accused of incompetence**. This question was also connected to **national security secrecy** because MTI was the supplier of solid rocket boosters for several American ballistic missiles.

¹⁸⁸Sidney Dekker, *Second Victim: Error, Guilt, Trauma, and Resilience*, CRC Press, 2013. p. 23.

¹⁸⁹Report of the Presidential Commission on the Space Shuttle Challenger Accident, Appendix F—Personal observations on the reliability of the Shuttle by R.P. Feynman, June 6th, 1986; Washington, D.C.

2.1.5 *Chernobyl Nuclear Disaster (USSR, 1986)*

Although the Soviet socialist press blamed capitalists and their dangerous and irresponsible working practices during the Bhopal accident, the Soviet nuclear industry and top officials did not implement the evacuation lessons learned from this American-Indian disaster in their own practice—and it was not long before the USSR faced quite a similar event. Previously, Soviet nuclear industry executives had not recognized any parallels between the situation within their industry and the American problems revealed during the Three Mile Island accident: insufficient exchange of risk information about incidents and near-miss cases, ignorance of the importance of the human factor in operating a nuclear power plant (NPP), self-deception about the overall reliability of reactors in any situation, and overconfidence about the impossibility of a worst-case scenario actually happening.

On April 26, 1986 at 1:23 a.m., during an experiment with the emergency power supply system at the Chernobyl nuclear power plant, a power excursion occurred in the RBMK-1000 Reactor #4 that led the reactor to burn uncontrollably. The plant was located in the Ukrainian Soviet Socialist Republic, which at the time was part of the Soviet Union. It was 700 km away from Moscow, 320 km from Minsk, and 140 km from Kiev. Because the reactor did not have a containment dome, the explosion led to the release into the atmosphere of 7.7 tons of uranium oxide fuel, amounting to 4 % of the total contained in the reactor; 96 % of the fuel, or 185 tons of uranium, stayed in the reactor.¹⁹⁰ Huge regions of Belarus, Russia and Ukraine were contaminated,¹⁹¹ and traces of chemical elements from Chernobyl NPP were later found in Northern and Western Europe. The accident resulted in the release of approximately 5200 PBq (1 PBq (Peta Becquerels) = 10^{15} disintegrations per second)¹⁹² of radioactive substances into the atmosphere.¹⁹³ This was the first accident since the beginning of the nuclear age to be classified as a level 7 event—the maximum level according to the International Nuclear Event Scale. More than 116,000 people were evacuated from the 30 km zone around the NPP.¹⁹⁴ Two workers died after the explosion, and 28 firefighters died in the first three months following the accident. Estimates from various sources of the total number of victims of the Chernobyl accident remain

¹⁹⁰Alexandr Borovoy, Evgeny Velihov. Experience of Chernobyl, National Research Center “Kurchatovsky Institute”, Moscow, 2012, p. 25.

¹⁹¹Frequently Asked Chernobyl Questions, IAEA, <http://www.iaea.org/newscenter/features/chernobyl-15/cherno-faq.shtml>.

¹⁹²PBq stands for Peta Bequerel, so 1 PBq = 10^{15} atomic disintegrations per second (1 million billion).

¹⁹³Chernobyl Accident 1986, World Nuclear Association, updated April 2014.

¹⁹⁴From April, 27 to May, 8, 1986, 99195 residents with a 30-km zone were evacuated. 17122 people were additionally evacuated from May, 14 till September 1986. Total number of evacuated residents was 116287. Source: 25 years of the Chernobyl accident (1986–2011). Results and Prospects overcoming its consequences in Russia, Ministry for Civil Defense, Emergencies and Disaster Management of the Russian Federation, Moscow, 2011, p. 20.

contradictory because of political indecisiveness, different scientific approaches and the unavailability of health statistics from Soviet officials. In 2005, the UN report “*Chernobyl’s Legacy: Health, Environmental and Socio-Economic Impacts*” contained a statement from an international team of more than 100 scientists that up to about 4000 people could eventually die of radiation from the Chernobyl NPP accident.¹⁹⁵

The financial cost of the Chernobyl disaster remains controversial too. Mikhail Gorbachev, General Secretary of the Communist Party of the Soviet Union from 1985 until 1991, cited that the Soviet Union spent 18 billion rubles¹⁹⁶ (approximately US\$27 billion¹⁹⁷) on dealing with the consequences of the disaster. The government budget of the USSR was around 360 billion rubles from 1985–1987,¹⁹⁸ and the GNP in that period was around 780–800 billion rubles; so the expenses for the response to Chernobyl were 5 % of the annual Soviet budget, or approximately 2 % of GNP. According to estimates from academician Valery Legasov, a key member of the government investigation committee on the Chernobyl disaster, the total damage caused by the Chernobyl accident was in fact 300 billion rubles in pre-1990 prices, or approximately US\$450 billion (of 1990 US\$). This amount exceeds the combined profits of all Soviet nuclear power plants for the duration of their existence.¹⁹⁹

In a nutshell, the Chernobyl disaster is the combination of (i) a fundamental design mistake on the class of RBMK reactors (leading to instabilities in certain conditions) that were hidden due to a culture of secrecy and arrogance, and (ii) bypassing safety rules due to structural lack of communication between competent agencies as well as amateurship actions of the Chernobyl staff who switched off all alarms during a standard feasibility test.

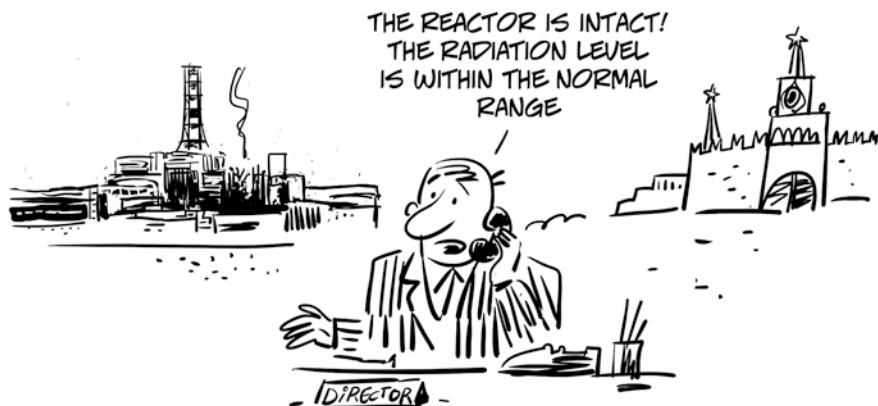
¹⁹⁵Chernobyl: the true scale of the accident, World Health Organization, 2009, <http://www.who.int/mediacentre/news/releases/2005/pr38/en/>.

¹⁹⁶Interview with Mikhail Gorbachev, documentary “The Battle of Chernobyl”, Director: Thomas Johnson, 2006.

¹⁹⁷Official exchange rate of State Bank of the USSR by the end of 1986: Soviet ruble/US dollar—0.6783, Archive of Bank of Russia, http://cbr.ru/currency_base/OldDataFiles/USD.xls.

¹⁹⁸Consolidated budget of the USSR and Russia, Information-Analytical Center “The budget system of the Russian Federation”, <http://www.budgetrf.ru/Publications/Magazines/Ve/1995/95-7illarionov/95-7illarionov020.htm>.

¹⁹⁹Valery Legasov, Problems of Safe Development of the Technosphere, Communist Journal, #8, 1987, pp. 92–101.



2.1.5.1 Risk Concealment Before the Disaster

Geopolitical Context and the Civil Nuclear Program Race

There was constant competition for innovation between the Soviet Union and the West, which manifested clearly in the development of nuclear weaponry and in space exploration. At the turn of the 1970s, the competition began in civil nuclear power. By 1972, the USSR was behind the USA and United Kingdom, which had constructed more than 50 reactors between them, while the Soviet Union had only 7.²⁰⁰ The Soviet Union had not tried to develop nuclear power in the 1950s and 1960s, because the assumption within the powerful Soviet Planning Commission was that coal from the Donbass—the Donetsk coal basin, located in the Ukrainian Soviet Socialist Republic—could provide enough energy for the Western part of the USSR. But double-digit industrial growth and massive construction of civil infrastructure in the 1960s and 1970s provoked energy shortage within the western part of the Union, and new calculations showed that the Donbass would not have sufficient coal resources for long-term supply. Although the Soviet Union had access to massive coal deposits, these were located beyond the Ural Mountains and would therefore put huge pressure on the railways to transport coal to plants in the western part of the Union. One promising strategy to solve growing energy needs was the intensive development of civil nuclear energy in the heavily populated and highly industrialized western part of the Soviet Union. Moreover, after the 1973 Arab oil embargo, the price of oil increased by a factor 2.5 in six months, from US\$4.90/barrel [US\$22 in 2010 prices] to US\$12 [US\$53 in 2010 prices].²⁰¹ Oil exports from the gigantic oil and gas fields recently discovered in Western

²⁰⁰Nikolaii Karpan, *Vengeance of peaceful atom*, Dnepropetrovsk, 2006, p. 255.

²⁰¹Andrew Scott Cooper, *The Oil Kings: How the U.S., Iran, and Saudi Arabia Changed the Balance of Power in the Middle East*, Simon and Schuster, New York, 2011, pp. 123, 149.

Siberia became very profitable for the USSR, because production costs there were very low, at only US\$0.80 per barrel [US\$3.50 in 2010 prices].²⁰² The export of hydrocarbons, principally oil, greatly increased the Soviet budget; so it was logical to focus on raising export revenue by reducing domestic oil and gas consumption for domestic electricity in parallel with large scale development of nuclear power plants for domestic uses. Nuclear power compares very favorably: burning just one ton of natural uranium oxide produces the energy equivalent of 16,000 tons of coal or 80,000 barrels of oil.²⁰³

The Politburo (the executive committee for the Communist Party of the Soviet Union) decided to invite the leading developers of the Soviet nuclear weapon (which worked within The Soviet Ministry of Medium Machine Building (Minsredmash)), to work on designing and building a new high-capacity reactor. Academician Anatoly Alexandrov, director of the Kurchatov Institute of Atomic Energy (subordinated to Minsredmash), which had researched the theoretical physics underlying the Soviet nuclear weapon program, was appointed as the scientific director of the new civil reactor project. Academician Alexandrov personally took part in the development of the Soviet nuclear submarine fleet, nuclear icebreakers and the civil Water-Water Energetic Reactor (VVER), a successful Soviet variant of the Western pressurized water reactor. Around 80 % of all operating civil nuclear reactors in the world are light water reactors: either pressurized water reactors (PWRs) or boiling water reactors (BWRs).²⁰⁴ An immensely respected scientist, he was president of the Academy of Sciences of the USSR from 1975 until 1986.

Strengths and challenges during the development of RBMK reactor

The chief design engineer of the new reactor was Nikolay Dollezhal, another respected member of the Academy and director of the Scientific Research and Design Institute of Energy Technologies (NIKIET), which was responsible for the design of the Soviet nuclear submarine fleet, the first Soviet uranium-graphite channel water-cooled reactors and the VVER reactor. Academician Dollezhal recounted the history of the development of the new reactor—the high power channel reactor or RBMK, a water-cooled uranium-graphite channel reactor: “*In 1965, the design [of the RBMK] was sent to the Ministry. There were supporters and opponents of the reactor. The opponents considered that only VVERs should be developed... In the construction of [RBMK], we could use cooperative ties*

²⁰²Gennady Shmal, Energy heart of Russia. 60 years of West-Siberian oil and gas province, Drilling and Oil Magazine, Moscow, November 2013.

²⁰³Uranium Quick Facts, Environmental Science Division of Argonne National Laboratory for the United States Department of Energy, <http://web.ead.anl.gov/uranium/guide/facts>.

²⁰⁴Günter Kessler, Anke Vesper, Franz-Hermann Schlüter, Wolfgang Raskob, Claudia Landman, Jürgen Päsler-Sauer, Safety Concepts of Light Water Reactors, Springer, p. 3.

between [existing] machinery plants, which were developed during the manufacture of the first industrial reactors [technologically speaking, RBMK reactors were an enlarged version of an existing military reactor developed for production of plutonium; so their construction required minimal restructuring of existing machinery plants, and RBMKs could use cheap natural uranium, while western analogs require more expensive enriched uranium]... It would allow us to cope with the task [of constructing each RBMK] in 5–6 years. As is known, the Americans construct large shell-type reactors [like PWRs and BWRs, which require sophisticated technological skills to manufacture the reactor vessel, which works under tremendous internal pressure] over 8–10 years; we [the Soviets] simply did not have the experience [to manufacture large reactors of this type], although we have a shell-type reactor of small capacity at Novovoronezhskay NPP... [The RBMK] did not require anything that would have been too far from the normal, no specialized engineering and manufacturing... Moreover, everything to do with the period [of construction] was important at that time: there was a difficult situation with power supply in the country [Politburo constantly put pressure on the developers in order to accelerate the pace of reactors' construction]... [Just for information,] the launch of the first VVER-1000 occurred only in 1979, but serial production of [this type of reactors began only in 1985, while in 1973 the first pilot RBMK-1000] was already online. By 1980, there was production of electricity from around ten serial RBMKs... The reactors were economical in terms of the cost of energy produced. Simple enough to run, of course, if [the operators] complied with all the requirements mentioned in the operating instructions".²⁰⁵

Academician Alexandrov also confirmed that "Soviet scientists were able to solve the problem of increasing the economic efficiency of nuclear power stations".²⁰⁶ In addition, the construction of the new reactor also implied the possibility of changing nuclear fuel without shutting down the reactor—unlike shell-type reactors, which require a compulsory shutdown—which made the RBMK very cost-effective in comparison with competitive reactor types.

Because the Soviet civil nuclear program originated from the military nuclear program, many approaches for designing and constructing civil reactors came from military experience. In the 1940s, USSR was eager to overtake Americans in the construction of nuclear bombs. In this race, drawing mainly from domestic assets and also from the German specialists they have been able to recruit, the Soviets were significantly constrained by a shortage of resources, both material and human, in comparison with the Americans who had invited the best nuclear physicists from around the world and had suffered no loss on their territory while the Soviets had to reconstruct after the most devastating war in the Union as well as Russian history with casualties mounting to more than 27 million people. Nevertheless, in 1949, the Soviets tested their first nuclear bomb (four years after the Americans). By 1953, the Union overtook the States in the development of

²⁰⁵Nikolay Dollezhal', *At the root the man-made world*, Moscow, 2010, 4th edition, pp. 160–162.

²⁰⁶Anatoly Aleksandrov, *October and Physics*, Pravda, November 10, 1967.

thermonuclear weapons. In 1954, Soviet nuclear scientists and engineers commissioned in Obninsk the first industrial civil nuclear reactor in the world: an uranium-graphite channel water-cooled reactor, it was a predecessor of the RBMKs. Academician Dollezhal outlined the experience of building this reactor as follows: *“In 1951, when designing of the reactor was in full swing ... building the world’s first nuclear power plant has already begun by laying the foundation of the plant ... During experiments [i.e. during the simultaneous design and construction of the reactor], more and more new knowledge was revealed that was impossible to ignore. Not often, indeed, but still sometimes, there was the need to reconstruct already designed components and devices [of the reactor]... One thing is beyond doubt: if the construction [of the reactors] had been carried out ‘by the rules’, where construction was started [only] after the final completion of the design of the reactor, then the nuclear power plant would have been launched several years later”*.²⁰⁷ This approach was continued in the 1970s for the RBMKs: many design solutions for the new reactor were practically tested during operation of the first pilot model, while the construction of the first serial RBMKs was already launched. Minsredmash constructed and launched the first pilot RBMK reactor near Leningrad (now St. Petersburg) in 1973, while the foundations of Chernobyl NPP was already laid in 1970. Academician Valery Legasov, an executive at the Kurchatov Institute of Atomic Energy during the Chernobyl disaster, recalled: *“The first launch of the pilot RBMK reactor at Leningrad NPP already showed [that running an RBMK reactor safely] is quite a difficult task for the plant’s operator. [There was] a problem with the instability of neutron fluxes and the challenges of managing them ... It should be said that, of course, a positive coefficient of reactivity in this reactor appeared unexpected [for the developers] ... We had to change the degree of nuclear fuel enrichment, and carry out a number of other technical measures in order to facilitate the operation of the reactor. Even after these measures, managing the reactor required tremendous attention from a plant’s operator and it was always quite difficult”*.²⁰⁸ This shows that knowledge of serious intrinsic problems with the RBMK was present, but rampant misinformation and lack of communication nurtured the Chernobyl catastrophe.

RBMK Reactor Design and the SCRAM Effect

There is no single universally accepted version of the cause of the reactor excursion, but the majority of investigators mention two main causes: a combination of imperfections of the RBMK reactor design—especially a phenomenon known as

²⁰⁷Nikolay Dollezhal’, *At the root the man-made world*, Moscow, 2010, 4th edition, p. 136.

²⁰⁸Valery Legasov, Record from cassettes, 1986–1988.

the “positive SCRAM effect”²⁰⁹—and unconscious mistakes by the executives and operators of Chernobyl NPP, who approved and conducted the experiment on Reactor #4. The reactor’s developers blame the staff of the plant and vice versa. The “positive SCRAM effect” first came to light during operation of the first RBMK reactor near Leningrad, in an incident in November 1975. There was a reactor reactivity excursion after SCRAM (emergency shutdown), which overheated a small part of the core, rupturing a channel of the reactor. The investigation commission in 1976 concluded that some elements of the reactor core needed to be redesigned in order to reduce the void coefficient, change some features of the control rods and increase the speed of the SCRAM system.^{210,211} But these recommendations were only implemented ten years later, after the Chernobyl disaster. The IAEA report after Chernobyl noted: “*The slow speed of the emergency protection system (the time for total insertion [of the control rods] into the core from the upper limit position is 18 s) and defects in the design of the rods (i.e. the positive reactivity excursion) resulted in a situation where, for a number of reactor operating modes, the emergency protection system not only did not function, but itself initiated a reactor runaway.*”²¹²

From 1976 onwards, Vladimir Volkov, head of the reliability and safety laboratory at the Kurchatov Institute, sent numerous memoranda to his supervisors about calculation errors in the design of the RBMK, and gave suggestions for their improvement. He mentioned the positive SCRAM effect, defined as a localized increase of activity in the bottom of the core of a nuclear reactor during emergency shutdown. But executives at the Kurchatov Institute and NIKIET did not pay serious attention to his warnings, or those of others.^{213,214} Academician Valery Legasov concluded: “*I did not see in the Soviet Union a single collective body, which more or less competently put together and considered [i.e. made a systematic search of sources of problems and critical shortcomings of existing reactors, which could lead to accidents at nuclear plants, and assessed the probability of each]... [On the contrary] the struggle against [critical shortcomings of the reactors] was conducted as a separate struggle within each particular case: if there was failure of the steam generator at a plant – than it launched a decision-making process about changing the design of steam generators. And, of course, sooner or*

²⁰⁹The SCRAM system refers to the control rods that are inserted into a nuclear reactor core to suppress nuclear fission. A “positive SCRAM effect” is a localized increase of activity in the bottom of the core of a reactor during emergency shutdown with low power range: introducing graphite rods leads to decreased absorption of neutrons by the xenon in the core (“xenon poisoning”) and accelerates the nuclear reaction.

²¹⁰The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, pp. 47–48.

²¹¹Anatoly Dyatlov, Chernobyl. How it was, Nauchtekhlitizdat, Moscow, 2003, p. 153.

²¹²The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 39.

²¹³Anatoly Dyatlov, Chernobyl. How it was, Nauchtekhlitizdat, Moscow, 2003, pp. 61–64, 91–93.

²¹⁴Nikolaii Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, pp. 294–296, 399.

*later, it led to improvements in the situation... [There would be an improvement of that exact shortcoming and things would then] calm down until the next case”.*²¹⁵

The developers of the RBMK assumed that the positive SCRAM effect would only manifest in rare cases, and preferred to take organizational measures to ensure the safe operation of the reactor (clear instructions, staff training, etc.) rather than making technical changes to the reactor design.²¹⁶ They were confident that the high quality of education and self-discipline of the staff at military-prone Minsredmash would compensate for any technical disadvantages of the RBMK when it became operational. Moreover, due to Western sanctions against the USSR during the Cold War, Soviet scientists and engineers were not able to use American supercomputers in the 1960s and 1970s to calculate technical solutions for the reactors at the design stage without testing their assumptions on prototypes. An IAEA report in 1992 mentioned the following: *“There are a number of explanations for the poor quality of the calculation analysis of the safety of the design of [RBMK reactors]. These include the fact that, until recently, Soviet computer techniques were chronically outdated and the standard of computer codes was very low. Three-dimensional non-stationary neutron-thermal-hydraulic models are required in order to calculate the physical parameters of a RBMK reactor under different operating conditions. Such models first became available only shortly before the Chernobyl accident and were not really developed until after the accident... As a result of the misguided selection of the core’s physical and design parameters by the designers, the RBMK-1000 reactor was a dynamically unstable system with regard to power and steam quality perturbations. The steam quality, in its turn, was dependent on many parameters characterizing the reactor state”.*²¹⁷

Economic and Political Pressure to Quickly Build Many RBMK Reactors

The Politburo put strong pressure on the RBMK developers to launch serial production of the reactors immediately in order to satisfy domestic electricity needs. So, in parallel with the test operation of the prototype RBMK in Leningrad, full-scale construction was initiated not only at the Chernobyl NPP near Kiev (in the Ukrainian Soviet Socialist Republic), but at Kursk and Smolensk in the Russian Soviet Socialistic Republic, and at the Ignalina NPP near Vilnius (in the Lithuanian Soviet Socialist Republic). The original RBMK design was not fundamentally redeveloped or revised for these serial units, and did not even include the improvements recommended after the 1975 accident at Leningrad NPP.²¹⁸ Academician Valery Legasov concluded that *“[The Soviet Union] built the world’s first nuclear power plant [in Obninsk], but later we slowed down the development*

²¹⁵Valery Legasov, Record from cassettes, 1986–1988.

²¹⁶Nikolaii Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, pp. 294–296.

²¹⁷The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, pp. 31, 59.

²¹⁸Ibid, p. 87.

*of this technology and the review of all safety issues associated with the operation of such plants [until changes in our energy supply strategy for the western part of the USSR, when we] began to hurry. Consequently this haste led to more units being built with limited funding. There was a need from the economy. Keeping the costs down began with [rejection to construct] containment [buildings over reactors, which would have increased the construction costs of Soviet NPPs by 30 % and lengthened the construction period for the plants]... We all began to show concern about the quality of education and training of the personnel responsible for the design, construction and operation of nuclear power plants, because the number of units increased dramatically, but the quality of the personnel involved in the process decreased [while developers of the RBMK expected that comprehensive organizational measures could compensate the technical shortcomings of the reactors]... There was a constant need for new buildings, new benches, new people for this job, because the number of units [reactors] increased. However this development was still not qualitative, [only] quantitative... [The problems of the Soviet nuclear energy, revealed in the Chernobyl disaster] generally originate from the organizational approach toward development, more rapid development, of new technology”.*²¹⁹ It was common practice for the Politburo to issue deadlines for the construction of nuclear plants according to the date of the next Congress of the Communist Party of the Soviet Union, with no regard for the availability of equipment for the plant or for the recommended schedule for proper construction. All this resulted in constant rush in the development of the Soviet civil nuclear industry in the 1970s and 1980s, repeating the practice that had prevailed during the nuclear arms race between the USSR and the West in the late 1940s and 1950s.

A Fatal Regulation Mistake

The Politburo issued another pivotal decision: responsibility for all the new RBMK NPPs would be transferred from the predominantly military Minsredmash to the civil Ministry of Energy and Electrification of the USSR. There were several explanations for this decision. The developers of the RBMK reactor—all nationally respected and honored scientists—convinced everybody, especially the senior executives of the Soviet Union, of the absolute safety of the RBMK reactor and the infallibility of Soviet nuclear technology.^{220,221,222,223} Their overconfidence persuaded Politburo members and executives at the Ministry of Energy and

²¹⁹Valery Legasov, Record from cassettes, 1986–1988.

²²⁰Anatoly Dyachenko, Experience of liquidation of Chernobyl disaster, Federal State Unitary Enterprise “Institute of Strategic Stability” of Rosatom, Moscow, 2004, <http://www.iss-atom.ru/book-7/glav-2-3.htm>.

²²¹Ibid.

²²²Interview with Mikhail Gorbachev, documentary “The Battle of Chernobyl”, Director: Thomas Johnson, 2006.

²²³Nikolaii Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, p. 401.

Electrification that it was safe to hand over the operation of nuclear power plants to personnel who had experience of running thermal power stations, but no education in nuclear science. For instance, the General Director of Chernobyl NPP, who was in place from the digging of the foundations of the plant in 1970, had training and experience as a turbine specialist and had worked on a coal power station before his appointment at Chernobyl. On one occasion before the accident, the director vividly revealed his wishful thinking about the harmlessness of nuclear reactors: “*What are you worried about, the nuclear reactor is a samovar [a traditional Russian pot used to heat water for tea]. It is much easier [to operate] than a thermal station, and we have experienced personnel – and nothing will happen*”.²²⁴ The background of the deputy of the Ministry of Energy and Electrification and department head, who was responsible for the construction of all nuclear plants in USSR, was in the building of hydropower plants. The head of the Ministry’s unit, who was responsible for the exploitation of all nuclear plants in USSR, was a former executive of the State Planning Commission without any experience in nuclear industry.²²⁵

In addition, the plant’s Chief Engineer was an electrician, who had worked previously on thermal power stations and the national electric grid. The Chief Engineer latter played a critical part in developing the plan for the experiment with the emergency power supply system on Reactor #4 that led to the disaster. This experiment was necessary because the emergency operating modes had not been properly tested prior to the RBMK being rolled out across the USSR.²²⁶ It involved testing the potential rotational energy of the turbine during emergency shutdown of the reactor, in order to produce emergency electrical power for the water pumps (for a duration around 1 min) until the emergency diesel generators on the plant could be started up to full capacity.²²⁷ The experiment was stipulated in the development project for the reactor, but the detailed steps involved were left to the personnel of each plant. In the case of Reactor #4, the plan for the experiment was not submitted to the developers because there was no requirement to obtain their approval for experiments.²²⁸ The Chief Engineer of the plant—with no experience of running nuclear plants and little understanding of the risks involved in such a test to be performed on an RBMK²²⁹—decided to conduct it as a routine

²²⁴Valery Legasov’ Record from cassettes, 1986–1988.

²²⁵Grigori Medvedev, Chernobyl Notebook, New World Magazine, № 6, 1989.

²²⁶The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 51.

²²⁷Günter Kessler, Anke Vesper, Franz-Hermann Schlüter, Wolfgang Raskob, Claudia Landman, Jürgen Päsler-Sauer, Safety Concepts of Light Water Reactors, Springer, p. 173.

²²⁸The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 52.

²²⁹“*The causes of the accident lie not in the programme [of the experiment] as such, but in the ignorance on the part of the programme developers of the characteristics of the behavior of the RBMK-1000 reactor under the planned operating conditions*”, The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 52.

electrotechnical test within a turbine-generator system, during a regular service break of Reactor #4 in April 1986, as part of compulsory measures stipulated by the reactor project.^{230,231} Obviously, staff at the Ministry of Energy and Electrification was less competent in nuclear matters than the Minsredmash team who had developed the reactor, and did not have advanced knowledge of the physics involved.

Overall, there was a deficit of qualified personnel to run the constantly growing number of nuclear plants in the USSR. After the accident, Academician Alexandrov explained his position regarding the safety of the experiment: *“Nobody within our institute (the Kurchatov Institute) knew about the impending experience or participated in its preparation. Academician Dollezhal, Chief Design Engineer of the reactor, was also unaware of it. [Later, after the accident], when I was reading the plan of the experiment, I was shocked. Many actions of this plan led the reactor beyond its design state... Let’s also ask who developed the plan. Executives of the NPP employed for this project – an organization that had no experience with the nuclear power plant [the organization was contractor of the Ministry of Energy and Electrification and specialized only in electric equipment]. Dilettantes can be well intentioned, but they could cause immense catastrophe – which happened at Chernobyl. The director of the station, without summoning even the deputy chief engineer of the plant who had education in physics, signed a contract with [the service contractor] to develop the plan of the experiment. The final version of the experiment was sent for consultation and testing by the Hydropower Institute [the designers of the Chernobyl plant]... Members of the Institute, who had some experience with nuclear power plants, did not approve the plan and refused to endorse it... I often think now what would have happened if the Hydropower Institute had informed us! However, the staff [of the Institute] could not even have imagined that the plant [staff] would dare to conduct the experiment. Minsredmash was not informed about the experiment because Chernobyl NPP had been transferred into the control of the Ministry of Energy... In Minsredmash ... were professionals with military-like discipline, who strictly followed the instructions, which in our case are extremely important... There are instructions, which must be followed by any NPP staff. This technical regulation is a guarantee of safety [of the plant]... [Furthermore], the experiment plan violated applicable instructions for operating nuclear power plants in twelve sections! We can say that the design of the reactor has flaws. However, the cause of the accident, after all – [was] a poorly prepared experiment, [in] flagrant violation of the instructions for NPP operations... I repeat, there are deficiencies in the reactor. Nowadays, these disadvantages are reduced. [Nevertheless], the problem is not the construction of the reactor. [Imagine] you are driving a car and turning the steering wheel in the wrong direction – and an accident takes place! Is it the fault of the engine? Or the designer of the car? Everyone will answer that it is the*

²³⁰Grigori Medvedev, Chernobyl Notebook, New World Magazine, № 6, 1989.

²³¹Nikolai Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, pp. 446, 451.

*fault of the unskilled driver”.*²³² In 1999, Academician Dollezhal also stated his position: *“We left our chairs with Alexandrov [after the Chernobyl accident]. We, of course, are guilty [as developers of the reactor]. I have my version of the accident. First of all, the personnel was terrible; we were sending warnings in all instances but without results; we warned about the negligent regime of operation”.*²³³ Nikolay Fomin, Chief Engineer of Chernobyl nuclear power plant during the disaster, confirmed also his responsibility and that of his staff with respect to the accident: *“I was largely blamed. Not everything that has been said about me was fair, as I see it. Nevertheless, one thing I blame myself for: I have always believed that the key to the work of the nuclear industry is technology – but it turned out that the main thing is people. I underestimated their value”.*²³⁴

Tragic Lack of Communication Between the Main Responsible Agencies

The situation was exacerbated by a total lack of communication about accidents between the military Minsredmash and the civil Ministry of Energy and Electrification, because of the culture of total secrecy^{235,236,237} that developed within Soviet military nuclear programs during the Cold War. Consequently, neither the developers of the reactor nor Minsredmash officials informed personnel at other Soviet NPPs with RBMK reactors about the accident at the Leningrad NPP in 1975, or about technical imperfections of the reactor design.^{238,239} Moreover, because developers did not eliminate defects revealed during the accident in 1975, the positive SCRAM effect within the RBMK series was observed again at Ignalina NPP, and during the launch of RBMK-1000 Reactor #4 at Chernobyl NPP in 1983.^{240,241} The Chief Design Engineer for the RBMK reactors discussed the problem with his colleagues by correspondence,²⁴² stating that design changes would be made to correct the problem. But he made no such changes, and the

²³²Anatoly Dyatlov, Chernobyl. How it was, Nauchtekhlitizdat, Moscow, 2003, p. 134.

²³³Sergey Leskov, Smart guys, Vremya publisher, Moscow, 2011. p. 65.

²³⁴Mikhail Moshkin, Went down in the history by sentence, Moscow News, № 22, April 26, 2011.

²³⁵Anatoly Dyatlov, Chernobyl. How it was, Nauchtekhlitizdat, Moscow, 2003, p. 134.

²³⁶Anatoly Dyachenko, Experience of liquidation of Chernobyl disaster, Federal State Unitary Enterprise “Institute of Strategic Stability” of Rosatom, Moscow, 2004, <http://www.iss-atom.ru/book-7/glav-2-3.htm>.

²³⁷Unapprehended atom. Interview with Victor Bryukhanov, “Profile” Magazine, Moscow, № 29(477), 24.04.2006.

²³⁸The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, pp. 47–48.

²³⁹Unapprehended atom. Interview with Victor Bryukhanov, “Profile” Magazine, Moscow, № 29(477), 24.04.2006.

²⁴⁰The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 43.

²⁴¹Nikolaii Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, p. 290.

²⁴²Anatoly Dyatlov, Chernobyl. How it was, Nauchtekhlitizdat, Moscow, 2003, p. 136.

procedural measures he recommended for inclusion in plant operating instructions were not adopted.²⁴³ At the Interdepartmental Science and Technology Council on Nuclear Power In December 1984, it was decided to postpone improvements of the RBMK—including the elimination of the positive SCRAM effect—for several years, until a period of planned reconstruction of the existing reactors.^{244,245} Apparently, there was a widespread view that the conditions under which the effect would be important would never occur.²⁴⁶ Personnel at the NPPs across the USSR were informed neither about these discussions within the development team, nor about near-miss cases of positive reactivity on other NPPs.

It important to ask the question: where were the regulators of the Soviet civil nuclear industry? Why did they allow 14 reactors with technical defects to go into operation? After the collapse of the Soviet Union, some supporters of Michael Gorbachev declassified secret shorthand records of Politburo meetings during the Chernobyl disaster. These records clearly show the complexity of the situation regarding the regulation of the developers of the RBMK, and the way shortcomings of the reactor were concealed to the Soviet government and the operators of the NPPs.

May 22, 1986. Mikhail Gorbachev declared: *“The Institute (the Kurchatov institute) was the only one [in the country] that was engaged in nuclear matters. It worked and nobody among us [the Politburo] knew what was going on. But it was only after Chernobyl that it was checked, ‘exposed’, and we saw a dangerous monopoly. The Director of the Institute, and President of the Academy of Sciences of the USSR [the collective Soviet body of advanced scientists from different fields, which could adequately assess any theoretical conclusions regarding the physics of the RBMK] is comrade academician Alexandrov in one person. He locked all things [regarding any criticism of nuclear matters] on himself... [There was] a 40-year friendly relationship [between the executives of the Kurchatov institute, NIKIET and Minsredmash] – and that’s what happened”*.²⁴⁷

June 5, 1986. Mikhail Gorbachev pronounced: *“[In this crisis situation, we have to eliminate the influence of] narrow departmental interests [when each ministry cares only about their field of responsibility at the expense of others]. Sometimes we hear [from ministers]: ‘I have only my own object’. Everyone has its own object. No, we all have one object – Chernobyl!”*.²⁴⁸ Such non-coordination led to a situation where the Kurchatov institute, NIKIET,

²⁴³The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, pp. 44–45.

²⁴⁴Nikolaii Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, pp. 262, 398.

²⁴⁵The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 31.

²⁴⁶Ibid, p. 13.

²⁴⁷Excerpts from transcripts of Politburo meetings concerning the Chernobyl disaster (April 1986–November 1989). The transcripts were published in the book “Within the Soviet Politburo... Records of Anatoly Chernyaev Vadim Medvedev, Georgy Shakhnazarov (1985–1991), The Gorbachev Foundation, Moscow, 2008, www.gorby.ru/userfiles/protokoly_politbyuro.pdf.

²⁴⁸Ibid.

Minsredmash and the Ministry of Energy and Electrification of the USSR did not transmit information about their problems or shortcomings, or critical information about the operation of the reactor to each other, and nobody understood the whole picture of risks associated with the RBMK; later there was similar non-coordination during response measures to the accident and Gorbachev called on ministers to enjoin them to cooperate.

The True Scale and Nature of the Faults Revealed in Meetings of Politburo in July 1986

July 3, 1986. Boris Sherbina (Deputy Chairman of the Soviet Council of Ministers—the Soviet government—and Head of the State Commission for liquidation of the consequences of the Chernobyl disaster) said: *“Evaluating the operational reliability of the RBMK reactor, a group of professionals working on behalf of the Commission concluded that its characteristics fall short of modern safety requirements... RBMK reactors are potentially dangerous... Apparently, all were under the impression that nuclear power plants were highly safe, as they were aggressively advertised to be... [Therefore] since 1983, the executive board of the Ministry of Energy and Electrification has never discussed the issues related to the safety of nuclear power plants... [Everybody] believed that the issue of civil nuclear safety was solved. A statement to this effect was in a Kurchatov Institute publication”.*

Mikhail Gorbachev declared: *“Over the last 30 years, we have heard from you [scientists, experts, and ministers] that everything here [in the nuclear industry] is reliable. In addition you expect that we will look at you as to gods. From this, all went wrong [concerning the regulation of the Soviet nuclear industry]. It occurred because all ministries and research centers were out of control [of the Politburo and the Soviet government]. Finally it ended in failure... It was the responsibility of the staff [of Chernobyl NPP] that the accident took place [because the experiment on Reactor #4 was approved by executives of the plant, while it was not endorsed by the Science Director and the Chief Design Engineer of the reactor; operators chose to deviate from the program of the experiment; several instructions were violated during the experiment, etc.], nevertheless, the scale of the accident [was caused by] reactor physics [and is therefore the responsibility of the developers of the RBMK]... [The Politburo] did not receive information about what was happening in reality... All [nuclear-related] matters were classified and kept away from the reach of the Politburo. No representative of the [Communist] Party was allowed to meddle in this sphere. Moreover, [the Soviet] government had no power to determine which type of nuclear reactor [the country] should develop. Within the entire system [the nuclear energy industry], there was a spirit of servility, fawning, factionalism, persecution of dissidents [as in the case of Vladimir Volkov, the whistle blower from the Kurchatov Institute], window dressing, personal ties and different clans around different executives”.*

A representative of the State Committee for supervision of the safe conduct in the nuclear industry of the USSR (Gosatomneregionadzor USSR) said: *“Everybody in the industry should be afraid of Gosatomneregionadzor!”*²⁴⁹ ... *It is impossible to ensure the complete safety of existing nuclear power units. However, if operators strictly follow standing orders and instructions [they could be operated safely]. With the approval of the reactor design, it was known that it would have ‘positive void’ and ‘positive temperature’ effects... Nevertheless, [Gosatomneregionadzor] never checked and studied the shortcomings [of the reactor] concerning the ‘physics’ and the degree of danger”*. The majority of the staff of Gosatomneregionadzor USSR during the Chernobyl disaster were former specialists from Minsredmash; obviously, they did not want to criticize former superiors, and thus the government oversight over the industry was not independent. In addition, academician Valery Legasov stated after the disaster that most of those at the Kurchatov Institute (part of Minsredmash) tried not to ask executives of Minsredmash embarrassing questions because they were receiving bonuses from the ministry. The general opinion was the following: *“If I say anything about [the necessity of] the containment [vessels at Soviet NPPs], obviously, I will not receive a premium [from the Ministry]! If I express anything [against the mainstream within the industry and the opinion of the management], I will not be published and [my] dissertation will be not defended”*...²⁵⁰

... Mikhail Gorbachev [question to representatives of Minsredmash]: *“What can you say about the RBMK reactor?”*

Alexander Meshkov (First Deputy Minister of Minsredmash): *“It is a proven reactor. However it does not have containment. If [the staff of the NPPs] comply strictly with the instructions, then it is safe”*.

Mikhail Gorbachev: *“Meshkov continues to assure us that the reactor is safe... So, is it [still] possible to operate them and to construct more? ... All that we collected about Chernobyl by this time leads to one conclusion – the reactor should be decommissioned. It is dangerous. And you [to Meshkov] defend esprit de corps”*.

Alexander Meshkov: *“No, I am advocating nuclear power”*.

... Mikhail Gorbachev: *“What should be done by the Kurchatov Institute?”*

²⁴⁹In IAEA's INSAG-7 report was noted that *“The USSR State Committee for the Supervision of Nuclear Power Safety was established only three years before the Chernobyl accident and, notwithstanding the safety culture concept, it could not be regarded as an independent body, since it was part of the same state authorities responsible for the construction of nuclear power plants and electricity generation. ... However, since the regulatory bodies have no legal basis, no economic methods of control, and no human and financial resources, and since it is very difficult to set up an institute of independent experts in this country, the system that existed and still exists is one consisting of many links providing step by step control and finicky supervision of nuclear power plants, rather than a full blooded regulatory system for the safe use of nuclear energy in the interests of the whole population”* [The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 88].

²⁵⁰Valery Legasov, Record from cassettes, 1986–1988.

Anatoly Alexandrov (Science director of RBMK, director of the Kurchatov Institute, president of the Academy of Sciences of the USSR): *“I’m sure that we will not build RBMK reactors in future. Concerning improvement [of the RBMK series], the costs will not be compensated. [Nevertheless], I think that [positive reactivity] of the reactor can be eliminated [on existing reactors]. We have some ideas about possible solutions to this problem. This could be done in one or two years... The existing reactors can be made safe. I put my head on the block... that they can be improved. I beg you to release me from the duties of President of the Academy of Sciences and give me a chance to correct my mistake about the shortcomings of this reactor”*.

... Mikhail Gorbachev speaks to representatives of Minsredmash: *“The reactor is unreliable. The reactor was transferred to the industry and [further] theoretical studies [of physics of the reactor] were suspended. Why was theoretical research not continued? ... Academician Alexandrov confirmed it [the unreliability of the reactor]. [Moreover] he missed something. He is [taking his mistakes] seriously, although he bears great responsibility for it [the defects of the reactor]. Whereas Meshkov lumps all accusations onto the operators [of Chernobyl NPP]”*.

Alexander Meshkov: ... *“[However, we] will not allow one [RBMK] reactor to be built every year [to solve urgent domestic energy needs]. This involves – constant rush. Consequently, it leads to [low] quality of the equipment and [poor] safety measures”*. ...

... Gennady Shasharin (First Deputy Minister of Energy and Electrification): *“The ministry believed that Chernobyl NPP was exemplary.²⁵¹ We appointed the best director to the plant ... [The main problem was] that we began to interact with nuclear energy on a first-name basis, but it [nuclear energy] requires respect. The staff [of Chernobyl NPP] did not know that the reactor can accelerate. Moreover, we [the Ministry of Energy and Electrification] did not know [about the ‘positive SCRAM effect’]. The staff [of Chernobyl NPP] is responsible for the accident. Nevertheless, I agree that the scale of the accident was caused by the physics of the reactor... Obviously, the first stages of Smolensk NPP, Kursk NPP and two reactors on Leningrad NPP should be closed. They are not subject for reconstruction... It is possible to get some units on these NPPs into shape. However, it will take one year. In addition, it will be very expensive”*.

Mikhail Gorbachev: *“The statement of Shasharin about [immediate] decommissioning of [RBMK] NPPs is not serious”*.

... Mikhail Solomentsev (member of Politburo) speaks to Gennady Shasharin: *“Did you know that the reactor was unreliable?”*

²⁵¹In 1985, the plant was called best nuclear plant within the Ministry of Energy and Electrification of USSR [Nikolai Karpan, *Vengeance of peaceful atom*, Dnepropetrovsk, 2006, pp. 410, 487]. In 1992 IAEA’s report, it was mentioned that *“As a whole, the Chernobyl personnel in 1986 were characterized as a fairly typical, mature and stable group of specialists with qualifications regarded in the USSR as satisfactory. They were no better, but no worse, than the personnel at other nuclear plants”* [The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, p. 31].

Gennady Shasharin: *"Yes, I did. But it was not acknowledged on paper. There was a lot of resistance. Alexandrov was against it. The Academy of Sciences too. Minsredmash required [the Ministry of Energy and Electrification] to increase the production of energy in nuclear power plants by 2000"...*

... Victor Bryukhanov (Director of Chernobyl NPP): *"We did not know that something similar had happened at the Leningrad nuclear power plant in 1975"...*

... Mikhail Gorbachev: *"The director of the plant ... was sure that nothing could happen [with an RBMK reactor] ... The Chief Engineer [of Chernobyl NPP] is an electrician. [His] main concern is supplying more electricity"...*

... Anatoly Mayorets (Minister of Energy and Electrification): *"This reactor does not ... and will never meet safety regulations even under ideal [conditions]. Sooner or later, it [catastrophe] could happen. Alexandrov says that [the RBMK] can be modified. In the meantime, what do we have to do [about electricity production for the Soviet economy]? ... It is necessary to bring all matters relating to the nuclear power plants together into one ministry. Moreover, we need to implement paramilitary discipline [within the new ministry]"*

Vladimir Dolgikh (Soviet-Russian political figure and head of the Metallurgical Department of the Central Committee Secretariat): *"Radical reconstruction of the reactor makes it uneconomical. For many years, we were unaware what might happen. We stubbornly moved towards the accident. It was inevitable as a result of such behavior. A legend was created about the safety of nuclear power"...*

Nikolay Ryzhkov (Chairman of the Soviet Council of Ministers: the equivalent of Prime Minister in Western countries and second in command within the Politburo after Mikhail Gorbachev): *"At the dawn of the nuclear industry, everything was conducted strictly and soundly. Gradually, the civil nuclear industry has gone beyond the boundaries [of Minsredmash], but [military] discipline 'has not fallen off' ... In addition, there was evidence of excessive authority in the hands of [the executives of Minsredmash] and Alexandrov. Things became less exacting and vigilant on all levels. After all, there was no single year without emergency situations at [Soviet nuclear] plants [according to data revealed at this meeting for the period 1981-1985, there were 1042 emergency showdowns among all nuclear reactors in the USSR, including 381 at RBMK reactors; at this time, there were 104 incidents at Chernobyl NPP]. There were no conclusions from the accident at Leningrad NPP. There were shortcomings ... and they were obscured, concealed in order to avoid publicity. Principalities took less responsibility. Without serious measures, we are not guaranteed against repetition [of the disaster]"*.

Egor Ligachev (Politburo member): *"This is the lesson [about what happens when we have] a monopoly in science and production! We need to fully replace the structure of the nuclear industry. The current structure implies irresponsibility. [We are witnesses that] within the Ministry of Energy [and] at the Academy of Sciences, there has been extreme self-confidence"...*

Mikhail Gorbachev: *"The accident could have been prevented. If there had been proper and timely information [about the features of the RBMK], then [the*

Politburo] could have taken action and we would have avoided this accident. However, we were faced with an extreme manifestation of irresponsibility”.^{252,253}

This meeting took place in July 1986; those present knew that a Soviet delegation had been invited to the International Atomic Energy Agency’s Conference on Nuclear Power Performance and Safety in Vienna the following month, to present the main causes of the disaster to the international nuclear community. The Politburo discussed this problem too as follows.

Anatoly Mayorets (Minister of Energy and Electrification): *“Based on analysis of foreign sources, we can see that they have carried out a reconstruction of the accident at Chernobyl. So, do we submit a lie to IAEA [by attributing responsibility for the accident to the plant staff and denying the existence of defects in the reactor]?”*

... Valery Legasov (Deputy Director of the Kurchatov Institute and a key member of the government investigation committee of the Chernobyl disaster): *“The reactor does not meet safety requirements in critical areas”.*

... Mikhail Gorbachev: *“We have suffered huge losses, not only economic, not only human. Huge political damage: there is some attempt to cast doubt on the level of our energy program. Throwing ideas around criticizing and dismissing the Soviet Union, Soviet science and technology, saying that our nuclear energy is ugly... In any case, we will not agree to ... hide the truth... [We have to] frankly inform the socialist countries, IAEA, the world public. All nations should be aware of the consequences of our actions and our response measures. Secrets will only bring losses for us. Openness will benefit us. We will lose if we do not say everything fully and clearly. Let’s give the world as much information as possible [about the accident]. In any case, the actual situation is [already] known to the West”.*^{254,255}

It is also interesting to note that the information deficit was not solved by the layers of bureaucrats watching others, such as KGB agents. The opened KGB archives about the disaster confirm the existence of a lot of confusion among Politburo members due, as we have shown, to a lack of comprehensive situation assessment before and during the disaster from advanced Soviet intelligence, quite similarly to the situation during TMI—nobody in Washington understood the severity of the accident during the first few days. It is fair to conclude that intelligence services are powerless to mitigate industrial disasters probably because their goals are actually quite different: gathering risk information about technical

²⁵²Excerpts from transcripts of the meetings of Politburo concerning Chernobyl disaster (April 1986–November 1989). The transcripts was published in book “Within the Soviet Politburo... Records of Anatoly Chernyaev Vadim Medvedev, Georgy Shakhnazarov (1985–1991), The Gorbachev Foundation, Moscow, 2008, www.gorby.ru/userfiles/protokoly_politbyuro.pdf.

²⁵³Nikolaii Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, pp. 400–404.

²⁵⁴Excerpts from transcripts of the meetings of Politburo concerning Chernobyl disaster (April 1986–November 1989). The transcripts was published in book “Within the Soviet Politburo... Records of Anatoly Chernyaev Vadim Medvedev, Georgy Shakhnazarov (1985–1991), The Gorbachev Foundation, Moscow, 2008, ww.gorby.ru/userfiles/protokoly_politbyuro.pdf.

²⁵⁵Nikolaii Karpan, Vengeance of peaceful atom, Dnepropetrovsk, 2006, pp. 400–404.

problems of NPPs is a side job compared to antiterrorist surveillance. Other KGB reports and documents about the disaster are still classified and are likely to remain closed from public access until the decommissioning of the last RBMK reactor in 25–50 years.

Official Declarations Covering up the Truth

Nevertheless, in August 1986, Soviet officials headed by academician Valery Legasov declared to the IAEA that the major responsibility for the accident fell to the staff of Chernobyl NPP, not the developers of the RBMK. They even claimed the developers had informed the NPP operators about the positive SCRAM effect.²⁵⁶ The official Soviet press also blamed mainly the operators, not the developers. In addition, there was a closed court hearing resulting in ten-year prison terms for key staff at the plant. In April 1988, on the second anniversary of the Chernobyl disaster, academician Valery Legasov committed suicide. Right before his suicide, he recorded on audio cassettes his confessions about previous concealment actions regarding flaws of RBMK and challenges concerning the development of the civil nuclear industry in USSR, excerpts of which we mentioned above.

After the collapse of the Soviet Union in 1991, the free press of Russia and Ukraine conducted several interviews with former personnel at the Chernobyl NPP, some of whom also published their own books. All of them asserted that they had not known about any technical shortcomings of RBMK reactors, and had believed that these reactors were absolutely safe. Moreover, they did not have any special instructions on how to handle RBMK reactors to avoid the positive SCRAM effect.^{257,258,259} So, on April 26, 1986, when the operators of Chernobyl NPP pushed the emergency SCRAM button of Reactor #4 during the experiment, they were unaware of the existing technical shortcomings of this type of reactor and were convinced that an accident beyond the reactor design parameters could not happen.²⁶⁰

The truth of the matter was only revealed to the world community in 1992, when the IAEA published the INSAG-7 report—an updated version of their 1986 report, including new conclusions issued by the Soviet state committee for the supervision of safety in industry and nuclear power in 1991: “*The reactor designers were aware that the dangerous property of the reactor they had developed could be a cause of nuclear instability, but failed to estimate quantitatively its*

²⁵⁶The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, pp. 13, 30.

²⁵⁷Anatoly Dyatlov, Chernobyl. How it was, Nauchtekhlitizdat, Moscow, 2003, p. 102.

²⁵⁸Unapprehended atom. Interview with Victor Bryukhanov, “Profile” Magazine, Moscow, № 29(477), 24.04.2006.

²⁵⁹Vladimir Shunevich, Victor Bryuhanov: I was expelled from the party directly at a meeting of the Politburo, Fakty newspaper, Kiev, July 7, 2012.

²⁶⁰Anatoly Dyachenko, Experience of liquidation of Chernobyl disaster, Federal State Unitary Enterprise “Institute of Strategic Stability” of Rosatom, Moscow, 2004, <http://www.iss-atom.ru/book-7/glav-2-3.htm>.

*possible consequences and attempted to protect themselves by imposing operating limitations which, as it turned out, provided extremely poor protection... However, the defects identified in the reactor design and its unsatisfactory physical parameters have not been widely publicized among the scientific community and general public in the Soviet Union. They were also not included in the papers presented to the IAEA [in August 1986]... The design deficiencies and instability of the physical and thermal-hydraulic characteristics of the RBMK-1000 reactor had been theoretically and experimentally determined prior to the accident on 26 April 1986. However, no adequate remedial action was taken, firstly, to eliminate the defects and, secondly, to warn the personnel about the consequences of these dangerous characteristics and to provide them with appropriate training in the operation of the reactor, the parameters of which did not comply with the requirements of the technical documentation standards. The designers and authors of the standard operating procedures for the RBMK-1000 reactor did not inform the personnel about the very real danger of a number of reactor characteristics if certain possible personnel actions (including erroneous ones) were taken, because they failed to understand the possible cost of the consequences of personnel actions in operating such a reactor... The personnel violated the Operating Procedures... Some of these violations did not affect the initiation and development of the accident, others created favorable conditions for the manifestation of the negative design characteristics of the RBMK-1000 reactor. The violations were largely the result of the poor quality of the operating documentation and its contradictory nature caused by the poor quality of the RBMK-1000 reactor design”.*²⁶¹

It is noteworthy that these imperfections in the design of RBMK reactors were eliminated shortly after the accident^{262,263} and, for more than two decades, a dozen RBMK units have been operating without severe accidents in the ex-Soviet Union countries until their gradual decommission. After Chernobyl, only one new RBMK reactor was commissioned—at Smolensk NPP in 1990—while the remaining eight RBMK units under construction were cancelled. Nowadays, RBMKs represent only 3.4 % of all operating nuclear power plants in the world.²⁶⁴

2.1.5.2 Risk Concealment After the Disaster

Information Misrepresentation Due to Disbelief in the Improbable

Only many months after the disaster was the whole picture concerning operating risks of RBMK reactors recognized by all parties involved in the Soviet nuclear

²⁶¹The Chernobyl Accident: Updating of INSAG-1, IAEA Publications, Vienna, 1992, pp. 31, 48, 87.

²⁶²Ibid, pp. 27, 48–49.

²⁶³Mikhail Moshkin, “Evgeny Adamov: ‘The repetition of the Chernobyl scenario is impossible’”, Moscow News, № 22, April 26, 2011.

²⁶⁴Günter Kessler, Anke Vesper, Franz-Hermann Schlüter, Wolfgang Raskob, Claudia Landman, Jürgen Päsler-Sauer, Safety Concepts of Light Water Reactors, Springer, p. 3.

industry. Before that time, many of the people responsible were working without a full understanding of the real situation, which led to huge mistakes in their response in the first critical days and weeks after the accident. Immediately after the explosion, personnel at the plant did not believe that the worst-case scenario had actually happened. During the trial of the plant personnel who had conducted the experiment on that tragic night, they shared their perception of what happened in the first hours after the accident: *“Everyone was shocked... Total shock... Frankly speaking, I still believed that something had happened with the turbine... In spite of the night and poor lighting, it was clear enough. The roof and two walls of the reactor building were gone... This was Hiroshima... Walking around the reactor building, it became clear to me that the reactor was wrecked... [As Deputy Chief Engineer of the plant, with huge experience of running military and civil nuclear reactors], I’m probably guilty in that in my haste I did not explain to anyone [to the reactor operators in the control room, to the Chief Engineer and the Director] that the reactor had perished and that cooling [by pumping water into the destroyed reactor] was not necessary... I have been running uranium graphite reactors for 34 years, but never, never, have I known them to explode”*.²⁶⁵

Several hours after the accident occurred, the Director of Chernobyl NPP arrived at the plant and saw that there had been an explosion, which had blown off the roof of Reactor #4 and caused a fire that was still burning. Obviously, the reactor was no longer there. Nevertheless, the director was given assurances from the operators who had been running the reactor during the accident that it was not damaged. He could not immediately verify this statement²⁶⁶ and, during the first few hours, felt obliged to send encouraging reports to his superiors in Kiev and Moscow: *“The reactor is intact, continuing to pump water into the reactor; the radiation level is within the normal range”*.²⁶⁷ One hour after the accident, the chief of the Civil Defense Service reported to the director that radiation levels near the plant were 80,000 times the maximum acceptable level. However, the plant director did not believe him and ordered his arrest for spreading rumors and causing panic.²⁶⁸ He continued to send reports to his superiors giving understated levels of radioactivity at the plant.²⁶⁹ This misinformation of the authorities delayed

²⁶⁵Nikolaii Karpan, *Vengeance of peaceful atom*, Dnepropetrovsk, 2006, pp. 339–342.

²⁶⁶Seven hours after the accident (at 10:00 a.m. on 26 April 1986), one of the engineers of Chernobyl NPP explored the reactor room and found out that the reactor was demolished, but the Director of the plant did not believe his statement. It took a helicopter ride 12 h after the accident (around 3:00 p.m. on 26 April 1986) to establish the fact that Reactor #4 was destroyed and was throwing out radioactive material into the atmosphere (Alexandr Borovoy, Evgeny Velihov. *Experience of Chernobyl*, National Research Center “Kurchatovsky Institute”, Moscow, 2012, p. 11).

²⁶⁷Alexandr Borovoy, Evgeny Velihov. *Experience of Chernobyl*, National Research Center “Kurchatovsky Institute”, Moscow, 2012, p. 11; Grigori Medvedev, *Chernobyl Notebook*, New World Magazine, № 6, 1989.

²⁶⁸Documentary “Chernobyl. Chronicle of silence”, Director: Irina Larina, 2006.

²⁶⁹Nikolaii Karpan, *Vengeance of peaceful atom*, Dnepropetrovsk, 2006, p. 427.

by more than 36 h the evacuation of the residents of Pripyat, a town of 47,000 inhabitants located near the nuclear power plant.²⁷⁰ Twenty-five years later, Mikhail Gorbachev revealed: “Regarding information [about real condition of damaged Chernobyl NPP], we tried to obtain it [immediately after the accident], but we could not do it. Even people, who, I believe, were honest and open with me (Academician Velikhov and many other young smart, intelligent, energetic academics) could not initially assess what happened [on the plant]”.²⁷¹ And because top-level managers in the Soviet central government were deceived by false reassurances from the plant, they did not understand the real scale of the accident, and could not take appropriate managerial decisions. The government commission, which arrived at the site of Chernobyl NPP from Moscow in the late evening on the day of the disaster, found that managers and all services of plants were demoralized. Later, the plant director said: “People have been doing this [misrepresentation] with no malice. This was the practice within the industry: nothing bad to report. We always had to say – everything is going well”.²⁷² Ukrainian writer Boris Oleynik characterized the communication between industry executives and Communist Party officials in the following way: “Talk more and prettier, in order to please your boss. You can act as you think best, even if your work is the polar opposite of your words”.²⁷³ In a crisis situation, this common practice of passing on completely inaccurate information led, as already mentioned, to a critical delay in the evacuation of a city of some forty seven thousand people.

The behavior of the operators and of management of Chernobyl NPP—their certainty that a worst-case scenario was impossible, their unwillingness to believe extreme instrument readings, their misjudged if not consciously misleading status reports to superiors during the first and most important hours after the disaster—all these resemble the actions of the staff at the TMI-2 reactor of Three Mile Island in the US, seven years before Chernobyl. Unfortunately, openly published accounts of what happened at TMI-2—including the recommendations of protagonists and regulators regarding human factors, managerial decisions in a crisis situation and problems with timely and accurate communication about the plant status—were obviously not accessible to common Soviet nuclear specialists.

After the disaster, a middle manager at the Soviet Ministry of Energy and Electrification in the early 1980s confirmed the lack of communication about risks within the Soviet nuclear industry and the impossibility of accessing accident reports from abroad: “In those years, information about any accidents and

²⁷⁰The accident occurred at 1:24 a.m. 26 April 1986, but evacuation was started only at 2:00 p.m. 27 April. Central government officials arrived in Chernobyl by the end of 26 April, and recognized that the real picture differed completely from the one in reports.

²⁷¹Online-interview with Mikhail Gorbachev, BBC Russian Service, March 8, 2002, http://news.bbc.co.uk/hi/russian/talking_point/newsid_1861000/1861942.stm.

²⁷²Maria Vasil', “Victor Bryuchanov, former director of Chernobyl NPP: ‘If they could find to me appropriate criminal article, I think, they will execute me’”, Fakty newspaper, Kiev, October 18, 2000.

²⁷³Boris Oleynik, Literaturnaya Gazeta, Moscow, № 39 (5105), September 24, 1986.

*malfunctions at NPPs was strongly filtered by the Ministry: the publicity of such information was allowed only if superiors found it necessary to publish. I well remember a landmark event of those years – the American nuclear power plant accident at Three Mile Island on March 28, 1979, which inflicted the first serious blow to the nuclear industry and dispelled the illusion of the safety of NPPs... [Nobody among my colleagues] had complete information about this accident. Details about the accident in Pennsylvania were published only as a restricted memo. However, it was common practice: only senior management had access to negative information, while subordinates [had to be] satisfied with truncated information, which did not contradict the official point of view about the complete safety of nuclear power plants”.*²⁷⁴

Refusal to Learn from Western Experience and Soviet Arrogance

Vladimir Asmolov was a middle manager at the Kurchatov Institute at the time of the Chernobyl accident (he is now an executive at Rosenergoatom, the operator of all Russian NPPs). He recalls: “[We presented to superiors] the first documents about the structured protection [of Soviet NPPs] in 1982, but we received ... very simple feedback: ‘In the West, they have oppression, capitalism, they do not think about the people and they have breakdowns in their reactors, as at Three Mile Island, for example. However, we have safe reactors, because they [the reactors] are Soviet!’”²⁷⁵ This arrogant dismissal of the experience of their colleagues from other industries and countries could naturally lead to the repetition of tough lessons. The case of Chernobyl clearly confirms this thesis—but unfortunately on a much bigger scale than Three Mile Island. On October 2, 1986, during a Politburo meeting, Mikhail Gorbachev accused Soviet nuclear scientists of not exchanging experience with international colleagues: “It is a disgrace when we avoid participating in international scientific symposia about civil nuclear safety and we do not send our delegations to these for 10 years. [At these symposia], the experience of nuclear accidents occurring in the West has been summed up. What is it? Overconfidence, carelessness or the absence of a mechanism for regulating such participation? Chernobyl in this regard should provide a lesson – that people should not try to reinvent the wheel”.²⁷⁶ Indeed, the preventive implementation of many recommendations from the TMI-2 accident could have reduced the magnitude of the disaster. If the Soviet nuclear industry had been able to take into account what was learnt in America—about the common practice of concealing minor shortcomings in the hardware, about the human factor during the operation

²⁷⁴Grigori Medvedev, Chernobyl Notebook, New World Magazine, №6, 1989.

²⁷⁵H. Seldon, Chernobyl in the mirror three generations, Druzhba Narodov, № 7, 2006, p. 169.

²⁷⁶Excerpts from transcripts of the meetings of Politburo concerning Chernobyl disaster (April 1986–November 1989). The transcripts was published in book “Within the Soviet Politburo... Records of Anatoly Chernyaev Vadim Medvedev, Georgy Shakhnazarov (1985–1991), The Gorbachev Foundation, Moscow, 2008, www.gorby.ru/userfiles/protokoly_politbyuro.pdf.

of reactors in emergency situations, and about the need to communicate correct information and organize timely evacuation in the first hours after an accident—the story of Chernobyl might have been very different.

In the days following the disaster, the Politburo could not get reliable information about the conditions at the plant and the possible consequences of the event in Chernobyl.²⁷⁷ A commission of Soviet executive scientists was sent to the site of the accident but, at this stage, the real scale of the disaster was unclear.^{278,279} Because of the lack of scientifically verified information about the accident in the first few days, the Politburo adopted a policy of keeping quiet and underplaying any possible threat. The central press issued a small statement in the evening of April 28, 1986: *“There was an incident at Chernobyl nuclear power plant. One of the reactors was damaged. Measures are being taken to eliminate the consequences of the incident. Necessary assistance is being given to victims. A government commission is investigating the accident”*.²⁸⁰ The IAEA was informed on the same day—only 60 h²⁸¹ after the disaster. Two days later, the Party leaders had the residents of Kiev—140 km from Chernobyl NPP—out on the streets for the First of May celebrations without any warning or precautionary measures. After the Soviet Union collapsed, documents were published demonstrating that the level of radiation on that day in Kiev exceeded normal background radiation levels by a factor of 125.²⁸²

Mismanagement of Information Communication to Soviet Citizens

The first official government statement to the people of the USSR about the situation at the plant was made by Michael Gorbachev on the central TV channel, a full 18 days after the accident.²⁸³ Even at this stage, the scale of the accident was played down to avoid alarm. Meanwhile, the international media were in hysteria, publishing data from Scandinavian countries about the heightened level of radiation there without any information from the Soviet Union. Through various unofficial channels, information about the accident eventually began to trickle to Soviet

²⁷⁷Documentary “Chernobyl. Chronicle of silence”, Director: Irina Larina, 2006.

²⁷⁸For example, it would take two years of intensive scientific research to draw the overall picture of the distribution of nuclear fuel lava in the reactor and nearly two decades to create a model of the flow disturbance—the formation and spread of nuclear lava (Alexandr Borovoy, Evgeny Velihov. Experience of Chernobyl, National Research Center “Kurchatovsky Institute”, Moscow, 2012, p. 33).

²⁷⁹Documentary “The Battle of Chernobyl”, Director: Thomas Johnson, 2006.

²⁸⁰ITAR-TASS announcement (April 28, 1986), BBC, http://www.bbc.co.uk/russian/specials/1550_chernobyl_chro/page9.shtml.

²⁸¹Documentary “The Battle of Chernobyl”, Director: Thomas Johnson, 2006.

²⁸²Alla Yaroshinskaya, Lies without borders, Rosbalt, May 8, 2013, <http://www.rosbalt.ru/blogs/2013/05/08/1126494.html>.

²⁸³Documentary “Chernobyl. Chronicle of silence”, Director: Irina Larina, 2006.

citizens from abroad. This led to huge public disappointment in the ability of Mikhail Gorbachev and other communist leaders to deal adequately with the situation. Later, Mikhail Gorbachev stated that Chernobyl disaster was one of the triggers for the collapse of the Soviet Union.²⁸⁴

However, communist leaders still had a unique chance to convince their own citizens and the wider international community of their competence, power and ability to manage the country. In the first days after the accident, an operation unprecedented in world industrial history had been launched to liquidate the consequences of the Chernobyl disaster. For this mission, a group was established that included not only top scientists, but also military experts on chemical warfare, the air force, both military and civil engineers, civil defense forces, military logistics, controls and communications units, as well as coal miners to dig beneath the reactor and construct a core melt trap. Between 1986 and 1987, 240,000 military personnel and civilians took part in the liquidation. By the end of the operation, more than 600,000 people had been involved.²⁸⁵ Finally, the emission of radioactive particles was halted and the temperature inside the reactor began to fall. By November 1986—only 7 months after the accident—a massive concrete cover known as the Sarcophagus had been constructed over Reactor #4, and most of the radioactive material released in the explosion had been collected and stored inside the reactors, or in special landfills.

Unfortunately, the strategy initially adopted by officials of misinforming their own citizens had created a situation where the Soviet population responded negatively and with distrust to any subsequent news about Chernobyl. As a result, the liquidation operation—which was one of the most remarkable and heroic achievements of the Soviet Union—was lost in the rhetoric of accusation. One devastating result of concealing the real information about the consequences of irradiation, and about the availability of effective antidotes, was psychological: a widespread phobia of radiation that seized thousands of Soviet citizens, leading to psychosomatic disorders, chronic heart disease and psychological problems. According to the Nuclear Safety Institute at the Russian Academy of Sciences, the death rate from such diseases was much higher than the death rate from radiation.²⁸⁶

²⁸⁴Mikhail Gorbachev, *Turning Point at Chernobyl*, Project Syndicate, April 14, 2006, <http://www.project-syndicate.org/commentary/turning-point-at-chernobyl>.

²⁸⁵Occupational Radiation Protection in Severe Accident Management. Interim Report, Organisation for Economic Co-operation and Development, Nuclear Energy Agency, January 7, 2014, pp. 65–66.

²⁸⁶25 years of the Chernobyl accident (1986–2011). Results and Prospects overcoming its consequences in Russia, Ministry for Civil Defense, Emergencies and Disaster Management of the Russian Federation, Moscow, 2011, p. 20.

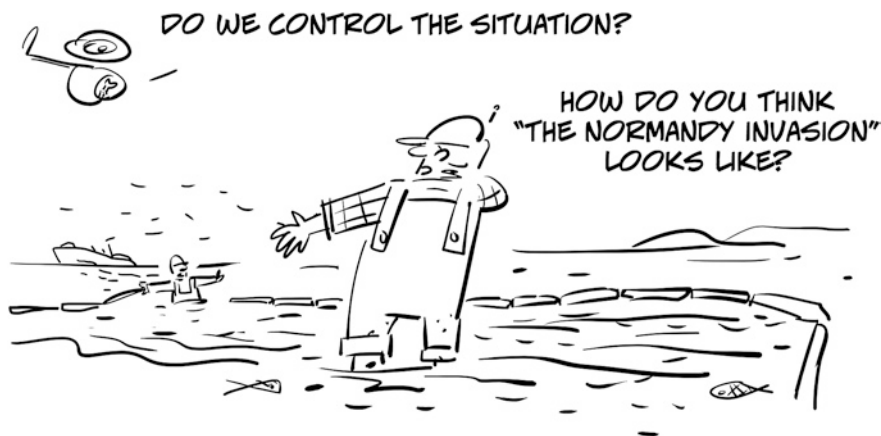
Chernobyl Nuclear Disaster: Why Risks Were Concealed

- **Short-term profitability**, and the production of cheap nuclear energy in the Soviet Union, **took priority over the long-term resilience of the Soviet nuclear industry** and the protection of the environment.
- A **“rush culture”** was established by the Politburo in order to increase the speed of construction of nuclear power plants to meet urgent domestic energy needs. This environment of constant haste encouraged people to ignore possible measures to correct minor shortcomings of the reactor, which were perceived by developers as insignificant and unlikely to cause a serious problem in practice.
- The **nationalistic arrogance** of Soviet nuclear executives, and their **over-confidence** in the infallibility of Soviet nuclear technology.
- **Habituation/wishful thinking/self-suggestion/self-deception** among representatives of the Soviet civil nuclear industry about the minuscule probability of severe accidents at Soviet nuclear reactors: they totally **refused to believe that a serious disaster could happen**. As a result, the Politburo allowed the transfer of the control of nuclear power stations to the civil Ministry of Energy and Electrification, which was unprepared for such a complicated task.
- The Kurchatov institute, NIKIET, Minsredmash and the Ministry of Energy and Electrification **focused only on their narrow departmental interests**, which **prevented timely and adequate communication of risk information between different agencies**.
- **National security secrecy**. Before the accident, **operators at the plant did not receive any information about the accidents that had occurred previously** at other Soviet NPPs, or about international nuclear accidents.
- The developers of the RBMK reactor were **reluctant to confess their own mistakes** in the design of the reactor. They were **afraid of accusations of incompetence**. The prosecution of the plant’s operators that would inevitably follow from such accusations was again **question of national security** because the developers of the RBMK reactor were members of the development team for the Soviet nuclear weapon. If they were found guilty, it would then cast doubts on the reliability of the Soviet civil nuclear program and of the Soviet nuclear weapons.
- It was common practice among Soviet bureaucrats to present themselves to superiors in the best possible light, which created an **organizational culture of “Success at Any Price” and “No Bad News” within the industry**. So the real defects of the RBMK were concealed from the Politburo - who also received misleading information about the real condition of the plant during the first hours after the accident, delaying the evacuation of the residents of Pripyat.

- The Politburo's delay in making any public announcement about the accident to the Soviet people and the international community was caused by the following factors: **uncertainty about the real scale of the disaster** in the first few weeks, the **absence of objective estimates of the possible consequences of the disaster**, and the **fear of panic** in the region of Kiev because, in the public perception, nuclear accidents and radiation constitute the most dangerous threats.

2.1.6 Exxon Valdez Oil Spill (USA, 1989)

On March 24, 1989 at 12:04 a.m., the oil tanker Exxon Valdez ran aground on Bligh Reef in Prince William Sound in Alaska (USA). The vessel was carrying approximately 1.2 million barrels of North Slope oil, which was loaded in port Valdez (40 km from the site of the accident). In the collision, eight of the ship's eleven cargo tanks were punctured, resulting in the leakage of around 250,000 barrels of oil during the first 3.5 h after the accident.²⁸⁷ The total amount of leaked oil is estimated to be between 250,000 and 260,000 barrels.²⁸⁸ The slow and inadequate response to the spill resulted in extensive oil contamination of 2000 km of pristine coastline on the Gulf of Alaska.



The main cause of the collision with Bligh Reef was the decision of Joe Hazelwood, the Exxon Valdez's captain, to deviate from the approved tanker route

²⁸⁷Final Report "SPILL: The wreck of the Exxon Valdez", Alaska Oil Spill Commission, State of Alaska, February 1990, p. 5.

²⁸⁸Ibid, p. iii.

in order to avoid colliding with small icebergs from the nearby Columbia glacier. However, the third mate failed to properly maneuver the ship and collided with Bligh Reef.²⁸⁹ At the time of the accident, the captain may have been drunk²⁹⁰ and the third mate was suffering from exhaustion.²⁹¹ The exceptional size of the oil spill was caused by the lack of oil spill response equipment and professional personnel at the Alyeska Pipeline Service Company, which was the responsible party in the first hours and days after any oil spill in the Valdez harbor and some areas of Prince William Sound. According to the Alyeska contingency plan, the oil spill response barge should have reached the area during the first 5 h after the accident but, in the case of Exxon Valdez, the spill response team arrived at the site only after 14 h.²⁹² The tanker was fully surrounded by containment booms only within 36 h after the accident. In the first 72 h, less than 3000 barrels of spilled oil were collected in spite of Alyeska's previous assurances that they could collect 100,000 barrels in less than in 48 h.²⁹³ In addition, Alyeska, Exxon and the government of Alaska underestimated the possibility of a large oil spill in this area and, as a result, none of the parties had the essential amount of oil spill response equipment installed in the Valdez port area at the time of the accident. The clean-up operation in the summer of 1989 required 10,000 people, 1000 vessels, 38 oil skimmers and 72 aircraft. Over the 4 years following the accident, Exxon exerted huge efforts to clean the beaches of the Gulf of Alaska. Exxon's total expenses to deal with the consequences of the accident including penalties exceeded US\$4.3 billion.²⁹⁴

2.1.6.1 Risk Concealment Before the Disaster

Pledge of Oil Companies to Protect the Pristine Environment of Alaska During the Exploitation of the Trans-Alaska Pipeline and Marine Oil Transportation

In 1968, the supergiant Prudhoe Bay Oil Field, the largest in North America with estimated resources of 25 billion barrels, was discovered on the Alaska North

²⁸⁹Exxon Valdez Oil Spill Trustee Council, Questions and Answers, <http://www.evostc.state.ak.us/facts/qanda.cfm>.

²⁹⁰Final Report "SPILL: The wreck of the Exxon Valdez", Alaska Oil Spill Commission, State of Alaska, February 1990, p. 13.

²⁹¹Ibid, p. 11.

²⁹²Ibid, p. 17.

²⁹³Ibid, p. 49

H. Russel Holland, U.S. District Judge, Stanley Sporkin, U.S. District Judge, Exxon Valdez Oil Spill, Prince William Sound, Alaska, U.S. House of Representatives, April 8, 1991, p. 6 and Patrick Lee, Alaska Oil Co-op Accused of Plan to Ignore Spills: Energy: Rep. George Miller contends that before the Exxon Valdez disaster, the Alyeska pipeline consortium decided against cleaning up slicks. The group denies the charge, Los Angeles Times, April 10, 1991.

²⁹⁴Anne C. Mulkern, BP's oil spill bill could dwarf Exxon's Valdez tab, The New York Times, May 3, 2010.

Slope on the Arctic Ocean. The main problem facing oil companies exploiting this field would be the transportation of extracted oil. Due to the continuous ice and severe wind conditions of the Arctic Ocean, year-round oil export by icebreakers and oil tankers seemed risky and unpredictable. A trans-Canadian pipeline route was rejected because of U.S. energy security concerns. In the end, oil companies proposed the 1,287 km Trans-Alaska pipeline from the Arctic Ocean (Prudhoe Bay) to the Pacific Ocean, emerging at the year-round ice-free port of Valdez. For the construction and management of the Trans-Alaska Pipeline System (TAPS) pipeline, the Alyeska Pipeline Service Company (Alyeska) was established. Majority of shares in Alyeska were distributed between BP Pipelines (50.01 %), ARCO Pipeline Company (21.35 %) and Exxon Pipeline Company (20.34 %).²⁹⁵ In the early 1970s, the idea of a Trans-Alaska pipeline met with opposition from environmentalists and Alaskan native tribes, but after the 1973 oil crisis, when oil prices dramatically increased from US\$3 to US\$12 per barrel, the pipeline development went ahead. The project was finished by July 1977. By the end of the 1980s, TAPS was carrying 25 % of US domestic oil production—around 2.2 MMbbl/day.²⁹⁶

Alyeska pledged to focus on the safe transportation of North Slope oil through the last American wilderness—and especially on the safe marine transportation from port Valdez through the pristine Prince William Sound. In March 1977, Alyeska promised regulators to deploy so many booms in the case of large oil spill that it “*would be like the Normandy invasion*”.²⁹⁷ The company demonstrated to officials the existence of booms stored along the U.S. West Coast (26.6 km of booms in total from sites spanning Prudhoe Bay to San Francisco) and assured that a sufficient number could be transported by air in case of emergency; however, response times were not indicated.²⁹⁸ Alyeska’s worst-case scenario was estimated at 200,000 barrels of oil spill, but the probability of such an event was calculated as once in every 241 years.²⁹⁹ The company never believed the worst-case scenario could happen, declaring that the most likely spill volume for vessels operated by the Valdez terminal “*appears to be in the 1000 to 2000 barrel range*” and “*we feel Alyeska has adequately addressed the major issues*”.³⁰⁰ After the accident, Frank Iarossi, president of Exxon Shipping Co., said that “*there is no*

²⁹⁵Final Report “SPILL: The wreck of the Exxon Valdez”, Alaska Oil Spill Commission, State of Alaska, Feb. 1990, p. 35.

²⁹⁶Oversight hearing before the subcommittee on Energy and Mineral Resources of the Committee on Natural Resources, U.S. House of Representatives, One Hundred Twelfth Congress, First Session, June 2, 2011.

²⁹⁷Patti Epler, Blueprint For Disaster: Despite Years of Warnings From Its Field Staffers About Alyeska’s Poor Oil Spill Preparedness, The DEC Did Next To Nothing, Anchorage Daily News, Oct. 22, 1989, p. A1.

²⁹⁸Final Report “SPILL: The wreck of the Exxon Valdez”, Alaska Oil Spill Commission, State of Alaska, Feb. 1990, p. 41.

²⁹⁹Ibid, p. 55.

³⁰⁰Ibid, p. 55.

*doubt that all of these contingency plans and all of this planning and everything did not anticipate ever having to respond to a spill this big. I do not know why it didn't. I wasn't involved in the plan, but clearly no one ever anticipated trying to handle 250,000 barrels of oil on the water. This spill just overwhelmed everybody. No one was organized to control a spill of this magnitude".*³⁰¹ With such optimistic risk assessment, Alyeska decided in 1977 that 5.5 km of oil spill booms were enough for Port Valdez.³⁰²

Weak State Government Control Over the Activities of the Main Taxpayer of Alaska's Budget

From the first months after the launch of the Valdez terminal, Alyeska neglected the maintenance of the oil spill response equipment and team. Thus, in December 1977, a representative of the Alaska Department of Environmental Conservation (ADEC) found out that 137 pieces of oil spill response equipment were broken or missing from a compulsory list of 170 items at the Valdez terminal.³⁰³ Alyeska was the major taxpayer of the State of Alaska and had a strong influence on the State decision-making process for decades. In spite of a considerable increase in the budgets of both the State of Alaska and ADEC, which went from US\$125 million in 1969 to US\$2 billion in 1989 for the former, staff complained that ADEC's Prince William Sound District Office *"has been under-budgeted and under-staffed to adequately inspect the terminal and keep in touch with their day-to-day operations"*.³⁰⁴ Valdez oil terminal was just one of 93 onshore oil terminals under the oversight of ADEC. The regulator was responsible for more than 400 facilities (tankers, barges, and drilling platforms). In 1988, when ADEC asked for an additional US\$0.5 million to hire inspectors to review contingency plans and inspect facilities, the department received only US\$0.15 million.³⁰⁵ Over many years, ADEC Prince William Sound District Office representatives pointed out problems at the terminal, including outdated oil spill recovery equipment, reduced training programs and questionable equipment reliability. They criticized the practice of staff-only drills, which showed that *"Alyeska's spill response activities have regressed to a dangerous level"*. The reaction of the president of Alyeska to these revealed shortcomings illustrates well the real power of Alyeska within the State of Alaska: instead of making safety improvements, he changed the procedures for

³⁰¹*Exxon Shipping Company vs Grant Baker*, The Supreme Court of the United States, Joint Appendix Volume Two, Oct. 29, 2007, p. 1237.

³⁰²Final Report "SPILL: The wreck of the Exxon Valdez", Alaska Oil Spill Commission, State of Alaska, Feb. 1990, p. 41.

³⁰³*Ibid.*, p. 45.

³⁰⁴Final Report "SPILL: The wreck of the Exxon Valdez", Alaska Oil Spill Commission, State of Alaska, Feb. 1990, p. 50.

³⁰⁵Harold R. Linstone, Multiple Perspectives on the Alaska Oil Spill, Prepared for the Alaska Oil Spill Commission, Aug. 22, 1989, p. 22.

the access of ADEC to the terminal! He decided that ADEC officials should give “preferably one day’s notice” before inspections, he refused to allow them to bring video cameras and he assigned a designated Alyeska representative “who will accompany them at all times during their stay on the terminal to answer any questions or address any concerns they may have at the time”.³⁰⁶

This dangerous lack of maintenance continued for a decade. Thus, Jim Woodle, U.S. Coast Guard commander at the Marine Safety Office of the Port of Valdez, testified that the equipment was not in good shape. He said five booms were physically in the inventory—although the contingency plan required all booms to be situated on the oil spill barge for quick response. Moreover, Alyeska reduced the number of response team members from 18 to 10 or 8 people. Woodle asked to test all booms and inflate them, but the Alyeska oil spill response team said that “they didn’t have 1) the capability of activating all five at one time from the standpoint of manpower; 2) they weren’t sure that three of them could operate. They basically kept two available for drill purposes, and the other three had never been used”. In 1984, Woodle wrote a letter to the president of Alyeska concerning oil spill recovery: “Due to reduction in manning, age of equipment, limited training opportunities, and lack of experienced coordination personnel, serious doubt exists that Alyeska would be able to contain and clean-up effectively a medium or large size oil spill”.³⁰⁷

Concealment of Alyeska’s Inability to Respond Adequately to Large Oil Spills

Apparently, the management of Alyeska did not react adequately to such information over the following few years. The reasons were as follows. Firstly, the statistics of oil spills in Prince William Sound made a large oil spill seem unlikely. For instance, from 1977 to 1989, 8700 oil tanker transits occurred, with only 400 small oil spills, the majority of which were located in the Port of Valdez during oil tanker loading.³⁰⁸ The largest oil spill happened when the Thompson Pass oil tanker leaked 1700 barrels (150 times less than Exxon Valdez) within the terminal area.³⁰⁹ Secondly, in 1982, the Exxon Company stated that “for most tanker spills, the response plan outlined in the Alyeska plan will suffice. However, in the event of a major spill by an Exxon owned and operated vessel, it is anticipated that the Exxon Company, U.S.A. Oil Spill Response Team... would be activated to manage

³⁰⁶Final Report “SPILL: The wreck of the Exxon Valdez”, Alaska Oil Spill Commission, State of Alaska, Feb. 1990, p. 50.

³⁰⁷Ibid, p. 49.

³⁰⁸Patti Epler, Blueprint For Disaster: Despite Years of Warnings From Its Field Staffers About Alyeska’s Poor Oil Spill Preparedness, The DEC Did Next To Nothing, Anchorage Daily News, Oct. 22, 1989, p. A1.

³⁰⁹Mary Evans, Effects of U. S. Coast Guard Enforcement Performance on Oil Tanker Safety, Prepared for the Alaska Oil Spill Commission, Dec. 4, 1989, p. 23.

the spill response".³¹⁰ Thirdly, the oil companies that owned Alyeska came to a mutual agreement that Alyeska's area of responsibility should be limited to "Valdez Arm and Valdez Narrows only. Further efforts in the Prince William Sound would be limited to use of dispersants and any additional efforts would be the responsibility of the spiller".³¹¹ However, the authorities, including ADEC representatives and the U.S. Coast Guard, were not informed about these internal organizational issues between Alyeska and its owners. This was a violation of Alyeska's agreements with both the United States and the State of Alaska. In 1973, in exchange for the right to build the Trans-Alaska pipeline on public lands, Alyeska signed an agreement where, in the section on oil spill contingency plans, they promised to control and clean up any oil spill: "*If during any phase of the construction, operation, maintenance or termination of the Pipeline, any oil or other pollutant should be discharged from the Pipeline System, the control and total removal, disposal and clearing up of such oil and other pollutant, wherever found shall be the responsibility of Permittees, regardless of fault... Full scale, company-wide field exercises will be held at least once per year to insure overall readiness for response to large scale oil spills... Alyeska will direct cleanup operations of spills resulting from operation involving tankers carrying or destined to carry crude oil transported through the Trans-Alaska Pipeline System, occurring at Valdez terminal, in Port Valdez, Valdez arm or Prince William sound*".³¹² Because of the agreement, it was widely anticipated within Alaska that Alyeska would immediately react to any oil spill in the first days after an accident while the spiller was launching an independent oil spill response plan.

On 6–7 April 1988, ten months before the accident, Theo L. Polasek, vice president of operations of Alyeska, made a presentation to an internal operation subcommittee comprising representatives from BP Pipelines (Alaska), ARCO Pipeline Company, Exxon Pipeline Company and other companies participating in the Alyeska consortium. In the presentation, entitled "*Alyeska Response Capability to Spills at midpoint of Prince William Sound*", Polasek stated that an "*immediate, fast response to midpoint of Prince William Sound [is] not possible with [the] present equipment complement*".^{313,314} One of the members of the operations subcommittee, who represented BP Pipelines (Alaska), proposed an "*acceptable compromise*", which stated that "*[the] current stockpile of clean up*

³¹⁰Final Report "SPILL: The wreck of the Exxon Valdez", Alaska Oil Spill Commission, State of Alaska, Feb. 1990, p. 49.

³¹¹H. Russel Holland, U.S. District Judge, Stanley Sporkin, U.S. District Judge, Exxon Valdez Oil Spill, Prince William Sound, Alaska, U.S. House of Representatives, Apr. 8, 1991, p. 10.

³¹²Ibid, pp. 3, 5.

³¹³Ibid, p. 8.

³¹⁴Patrick Lee, Alaska Oil Co-op Accused of Plan to Ignore Spills: Energy: Rep. George Miller contends that before the Exxon Valdez disaster, the Alyeska pipeline consortium decided against cleaning up slicks. The group denies the charge, Los Angeles Times, Apr. 10, 1991.

equipment is adequate” for spills at the terminal, but “*should be maintained to the highest state of readiness*”. It was offered to use dispersants “*on a widespread basis*” for possible spills occurring in Prince William Sound.³¹⁵ Ultimately, Alyeska’s proprietors secretly decided that Alyeska would not respond to an oil spill in Prince William Sound in the way prescribed in the contingency plan.³¹⁶ Apparently, information about the real condition of the Alyeska oil spill response team, and about the decision not to respond to an oil spill in Prince William Sound, was withheld not only from regulators and the government of Alaska, but even from management of oil companies included in the Alyeska consortium. For example, after the Exxon Valdez accident, Don Cornett, CEO of Exxon Company in Alaska and spokesman on the accident, said that he was not aware of any cut-backs in Alyeska’s response team,³¹⁷ which suggests that he was probably also unaware of the inadequate amount of equipment for first response actions and of its poor condition. The same lack of awareness of the risks prevailed among local communities: the majority of them believed in Alyeska’s promise, issued during discussions about the Trans-Alaska Pipeline System (TAPS) project, that “*the contingency plan which will be drawn up will detail methods for dealing promptly and effectively with any oil spill which may occur, so that its effect on the environment will be minimal... operations at Port Valdez and in Prince William Sound [will be] the safest in the [w]orld*”.³¹⁸

Nobody Among Oil Executives Understood the Whole Picture of Risks Associated with Transportation of Oil Through Alaskan Waters

There is no evidence that executives of Exxon Shipping Co. (the oil transportation subdivision of Exxon Company) were informed about the real level of Alyeska’s response capability, either by Alyeska representatives or by the Exxon Pipeline Company. In the 1980s, Exxon Shipping Co. practiced the risky strategy of reducing the running costs of its oil tankers because the industry was in depression, with a third of the world’s supertankers out of business. In the early 1980s, the government of Alaska tried to impose additional requirements on oil transportation, with wide-ranging authority over the design, equipment, navigation, operation, certification, inspection, financial responsibility, oil spill liability, cleanup capability and responsibility of oil tankers entering Alaskan waters.³¹⁹ However, in 1984, the

³¹⁵H. Russel Holland, U.S. District Judge, Stanley Sporkin, U.S. District Judge, Exxon Valdez Oil Spill, Prince William Sound, Alaska, U.S. House of Representatives, Apr. 8, 1991, p. 9.

³¹⁶Ibid, p. 9.

³¹⁷Exxon Reduced Its Staff of Oil Spill Experts, AP, Mar. 30, 1989.

³¹⁸Harold R. Linstone, Multiple Perspectives on the Alaska Oil Spill, Prepared for the Alaska Oil Spill Commission, August 22, 1989, p. 19.

³¹⁹Final Report “SPILL: The wreck of the Exxon Valdez”, Alaska Oil Spill Commission, State of Alaska, February 1990, p. 44.

industry organized a lawsuit (*Chevron v. Hammond*), which claimed that Alaska's new oil transportation laws and regulations were unconstitutional.³²⁰ This enabled oil companies to reduce the cost of tankers and to continue using single-hulled tankers instead of safer but more expensive double-hulled tankers. Exxon Shipping Co. also cut down expenses on tanker staff. By 1989, the required number of crewmembers shrunk by a factor 18 as a result of the automation of oil tankers and their transformation to diesel propulsion.³²¹ Thus, on the Exxon Valdez in 1989, there were only 0.35 crewmembers per million gallons of oil. This meant that the tanker's crew had little time for rest, and felt constantly tired because of the excessive workload.³²² In addition, Exxon Shipping Co. did not implement the agreed system of health checks on all crewmembers before shifts, and made no effort to prevent alcohol and other restricted substances. After the accident, Exxon officials confirmed that they were aware that Captain Hazelwood had gone through a program of alcohol detoxification, but allowed him to command the Exxon Valdez nonetheless.³²³ However, Exxon Shipping Co. emphasized that Captain Hazelwood concealed from his supervisors that he kept drinking while on duty. Exxon Valdez crew members, who later admitted drinking with Hazelwood aboard, knew they had violated company rules and had concealed it from the company's management.³²⁴

As a result, nobody within the Alyeska consortium of oil companies, the hierarchy of Alyeska itself, the Exxon Shipping Co., or the regulators of the State of Alaska understood the whole picture of risks, namely that oil was being shipped in tankers with chronically fatigued and in some cases alcoholic staff, in areas that were dangerously vulnerable to large oil spills because of a total lack of oil spill response equipment and reliable personnel.

Exxon Valdez Oil Spill: Why Risks Were Concealed

- **Short-term profitability won priority over the long-term sustainability** of the Trans-Alaska Pipeline System and over environmental protection.
- **Habituation/wishful thinking/overconfidence/self-suggestion/self-deception** among representatives of the Alyeska consortium about the low probability of a severe oil spill in Prince William Sound after more than

³²⁰Ibid, p. 45.

³²¹Ibid, p. 11.

³²²National Transportation Safety Board, *Safety Recommendation*, Washington, D.C., September 18, 1990.

³²³O.C. Ferrell, John Fraedrich, *The Wreck of the Exxon Valdez*, *Business Ethics: Ethical Decision Making and Cases*, Third Edition, Boston: Houghton Mifflin, 1997.

³²⁴*Grant Baker VS Exxon Mobil Corporation*, Supreme Court of the United States, No. 07-276, p. 19.

a decade of intensive shipping of supertankers. This led the consortium being reluctant to admit the importance of readiness in the case of a large oil spill and to pay for a high-capacity oil spill response team.

- **Lack of consideration of scenarios** that could lead to large oil spills, such as a super-tanker collision: only past spills that had occurred were considered as representative of possible future events. This is well-known as historical sampling bias.
- **Cozy relationships between the Alyeska consortium and representatives of the State of Alaska**, who allowed Alyeska to exert a strong influence on state government decisions concerning the regulations of the consortium's activity, the funding of the state government environmental regulator (ADEC) or heeding its warnings. This helped the Alyeska consortium to conceal for years and with impunity the risks resulting from the inadequately prepared oil spill response.
- **A fragmented perception of risks** (i.e., the **absence of the whole picture of risks**) among decision-makers of the stakeholders led companies to resist revealing their own risks to members of the oil spill response team. Ultimately, nobody understood the risks existing in other involved organizations.
- **A permanent rush culture** among the crew of Exxon Valdez, because of unrealistic projections about the shipping schedule, which compelled the crew to conceal their chronic fatigue from employers. **Crew members were also afraid to lose their jobs** during the depression occurring in the oil supertanker market.

2.1.7 Ufa Train Disaster (USSR, 1989)

On the night of June 3–4, 1989, about 50 km from the city of Ufa in the Bashkiria region of the Ural Mountains, the Western Siberia/Ural/Volga natural gas liquids pipeline ruptured, causing the build-up of a potentially explosive hydrocarbon-air mixture. At 1:15 a.m., two passenger trains came into the zone of gas contamination, passing in opposite directions with a total of 37 railroad cars carrying 1284 passengers and 86 crew members. Apparently, a spark from a susceptor on one of the electric locomotives ignited the lethal gas mixture, causing an explosion in which 575 people perished and 623 were injured.³²⁵ The explosion, equivalent to 300 tons of TNT, became the most deadly railway accident in the history of the Soviet Union and of the Russian Federation. The leader of the USSR, Mikhail Gorbachev, stated that this disaster was “*caused by mismanagement, irresponsibility, [and] disorganization*”.³²⁶

³²⁵Alik Shakirov, In Bashkiria will hold a memorial ceremony dedicated to the 18th anniversary of the tragedy at the station Ulu Telyak, RIA Novosti, May 31, 2007.

³²⁶Bill Keller, 500 on 2 Trains Reported Killed By Soviet Gas Pipeline Explosion, The New York Times, June 5, 1989.



2.1.7.1 Risk Concealment Before the Disaster

Contrast Between the “Crude Oil Pipeline” of Official Documents Versus the “Natural Gas Liquids Pipeline” in Reality

In December 1980, the Minister of Petroleum of the USSR sent a letter to the Council of Ministers of the USSR, pointing out the serious deficit in raw materials for the Soviet petrochemical industry in the Volga region. He proposed reallocating a surplus of assorted petroleum gas from the gigantic oil fields of Western Siberia by constructing an 1852 km Western Siberia/Ural/Volga natural gas liquids (NGL) pipeline, to transport a mixture of methane, propane, butane and pentane. He also mentioned that, because there were as yet no rules and regulations for the proposal of such large NGL pipelines in the USSR, the design stage of the pipeline alone would take more than two years. To speed up the construction of the pipeline, he offered to use standard blueprints for oil and gas pipelines and begin construction immediately in parallel with the design of the pipeline.³²⁷ We have already seen how the Soviet civil nuclear industry adopted the practice of simultaneously designing and building sophisticated technological facilities, leading to the tragic consequences revealed in 1986 at Chernobyl. In the case of Soviet petroleum, the consequences of this practice became clear in 1989.

Less than a month later, in January 1981, the Council of Ministers of the USSR issued permission to the Soviet Ministry of Petroleum for the construction of a “crude oil pipeline”, while everybody in the industry was aware that this “crude oil pipeline” would in fact be the proposed NGL pipeline. The development was launched immediately. Because the Ministry had available the documentation for standard crude oil pipelines with a diameter of 720 mm, this diameter was chosen

³²⁷Determination of session of Supreme Court of USSR under the chairmanship of Judge V.I. Cherkasov, Dec. 26, 1991, pp. 8–11.

for the NGL pipeline. In making this decision, Ministry executives were ignoring the main condition for safe NGL transportation through pipelines, which requires that the diameter of such a pipeline should not exceed 400 mm including the bold wall of the pipe. At that time, nobody in the world was operating NGL pipelines wider than this diameter of 400 mm³²⁸; this requirement is dictated by the physical features of the hydrocarbon mix in NGLs, which reduces the temperature of the pipe. Moreover, to provide anticorrosive insulation, the constructors used polymer films designed for oil pipelines,³²⁹ not suitable for NGL transportation characterized by continuous temperature changes. The combination of the thin wall of the pipe and of the temperature changes as the mixture flowed through it made the pipeline a highly dangerous structure. And in the case of a break, faster leakage of hydrocarbons from the wrecked segment of a wider-diameter pipeline could greatly increase the magnitude of the disaster. The experience obtained from safe operation of NGL pipelines showed that reducing the diameter of the pipeline to below 400 mm, and constructing several parallel pipelines with lower capacity in each line, constitute efficient preventive measures against giant leaks. During his testimony before the Supreme Court of the USSR, the chief engineer of the project admitted that, with the normal sequence of research, design and construction, the development of the pipeline would have taken 5 to 6 years. But in the design of this pipeline, there had been violations of the normal technological process: the blueprints were provided directly from the Ministry, the design of the pipeline was changed four times and all works were carried out in a rush in order to launch within four and a half years. Other witnesses also confirmed that there had been undue haste, compromising the quality of construction.³³⁰

By 1984, the “crude oil pipeline” was in the final stage of construction, and the Ministry of Petroleum proposed the urgent re-commissioning of the pipeline from oil to NLG.³³¹ Naturally, the USSR had a state regulatory body for the construction industry, responsible for checking project documentation to ensure the safety of buildings and prevent the development of facilities that would violate the rights of individuals or other organizations. But—based on existing construction norms and rules—the regulator rejected re-commissioning of the existing 720 mm pipeline. Obviously, when the pipeline had originally been proposed to transport oil, the pipe diameter and the route were judged to be acceptable; but the new project would involve transporting a far more flammable mixture through highly populated areas of the Ural Mountains. The safe transportation of NGLs through a 720 mm diameter pipeline demanded a total replacement of the type of pipes used. Nevertheless, the Soviet Ministry of Petroleum lobbied the Council of Ministers of the USSR to waive the requirement to assess the new project; and ultimately the

³²⁸A.Usoltsev, S. Shkaev Where will pipeline explode? Soviet Russia, October 17, 1990.

³²⁹Sergei Kudryashov, History of one disaster, Kommersant, №126, July 8, 1995.

³³⁰Determination of session of Supreme Court of USSR under the chairmanship of Judge V.I. Cherkasov, Dec. 26, 1991, pp. 8–11.

³³¹Shamil Rahmatullin, Large pipe at the cost of life, The Chemical Journal, August 2011, pp. 36–38.

pipeline was re-commissioned according to the parameters mentioned above.^{332,333} A French international expert in NGL pipeline construction warned Soviet petroleum officials at the design stage that the proposed pipeline would be dangerous to operate. This cautioning warning was ignored by Soviet petroleum representatives, and was not revealed to the Council of Ministers of the USSR, pipeline operators or railway representatives.³³⁴

Because of the tormented landscape of the Ural mountains, and in order to reduce costs and give easy access to maintenance using nearby transport infrastructure, the pipeline was constructed dangerously close to the railway: for 273 km, they were less than 1 km apart. Moreover, the pipeline crossed the bed of the railroad, which included the high traffic Trans-Siberian railway, in 14 places.³³⁵ In this connection, another French expert warned construction team managers that heavy freight trains could generate intensive vibration and that the pipeline would thus require special joints to cope with the impact of this vibration on the pipes; but builders replied that *“all necessary safety measures are stipulated in the design of the pipeline in Moscow and that the joints are not necessary”*³³⁶

Massive Cost Reduction on Safety Matters During Construction and Exploitation of the Pipeline

Furthermore, in May 1984, executives of the Soviet Ministry of Petroleum canceled the installation of an automatic telemetry system for real-time control of possible leaks from the pipeline.³³⁷ The Supreme Court enquiry did not find an adequate explanation of this decision, but some witnesses testified that there had been a shortage of investment, others about the lack of import equipment or service contractors qualified to install the system.³³⁸ Nevertheless, regular helicopter sorties to check for possible high concentrations of methane in the atmosphere near the pipeline, and squads of trackmen with gas leakage detectors, worked effectively during the first years after the launch of the pipeline in October 1985.

³³²Alexey Skripov, Asha explosion. Why the largest in the history of the country's rail disaster occurred, Rossiyskaya Gazeta—Week—Ural, June 11, 2009.

³³³Shamil Rahmatullin, Large pipe at the cost of life, The Chemical Journal, Aug. 2011, pp. 36–38.

³³⁴Personal communication with executive representative of association of relatives of people, which were perished and injured in the accident.

³³⁵History of NGLs pipeline “Western Siberia—Ural—Volga”, JSC “Yamal-Volga”, <http://yamal-povolzhye.ru/project-history>.

³³⁶I sounded the alarm, Literaturnaya Gazeta, #24, June 14, 1989.

³³⁷The torch of death, 18 years ago there was an accident in Bashkortostan, which world did not face before, MediaKorSet (Ufa), Jun. 3, 2007.

³³⁸Minutes of session of the Supreme Court of the USSR under the chairmanship of Judge V.I. Cherkasov, Dec. 26, 1991, pp. 8–11.

Constructors of the pipeline were aware of the risks posed by possible NGL leakage to human habitation areas. Therefore, in September 1985, builders returned to one segment of the pipeline to construct a bypass around the village of Sredniy Kazayak, which was less than 1 km from the pipeline. According to the project schedule for the pipeline, the residents of the village should have been relocated elsewhere, but in 1985 the village was still inhabited. (There were 35 places along the pipeline where the pipes were very close to populated localities³³⁹). By the end of October 1985, the bypass was built and connected to the main pipeline by special valves. During the construction process, a powerful excavator caused considerable mechanical damage to the pipe close to the valves, which became the main cause of the NGL leakage in 1989. Moreover the soil in the area was rocky, but there was no special protection—like, for instance, a cushion of sand—where the vulnerable pipeline ran among rocks. In addition, nobody from the construction and maintenance crews checked the condition of the pipe—by ultrasonic scanning or even visual checks—before resuming the flow of hydrocarbons through the bypass section.³⁴⁰ The pipeline operator was not aware of these hidden defects, but had a very low opinion of the quality of the pipeline construction and design in general: *“When in 1987 the pipeline was transferred from builders to us [the pipeline operator], we conducted an investigation of the condition of the pipeline and recognized that the pipeline was not fit for operation. We drew up a statement with remarks [to the Ministry], but nobody wanted to listen to us – we were forced to accept the transfer of the pipeline into full operating regime”*.³⁴¹ The initiators and builders of the pipeline received government awards for developing the project in record time.

In the next four years, more than 50 incidents occurred over the whole length of the pipeline, fortunately with no casualties. Nevertheless, because of pressure from executives of the Soviet Ministry of Petroleum to keep costs down, the helicopter sorties stopped and the teams of trackmen with gas leakage detectors were disbanded. Until this point, up to 15–20 workers—on horseback because of the steep slopes of the Ural mountains—had been conducting regular monitoring of the pipeline, and the condition of the pump equipment, on the segment where the accident took place. But after the budget cuts, the maintenance team had to rely on information from locals about leaks on the pipeline! Four days before the disaster, the maintenance team published a warning in a local newspaper about possible leaks, with a request to be immediately informed about them if they were to be noticed by local inhabitants. The warning included the following: *“...before the arrival of representatives of the pipeline, there is necessity to cordon off [the*

³³⁹A. Usoltsev, S. Shkaev Where will pipeline explode? Soviet Russia, October 17, 1990.

³⁴⁰Alexey Skripov, Asha explosion. Why the largest in the history of the country's rail disaster occurred, Rossiyskaya Gazeta—Week—Ural, June 11, 2009.

³⁴¹A. Usoltsev, S. Shkaev Where will pipeline explode? Soviet Russia, Oct. 17, 1990.

hazardous area] and prohibit the movement of equipment and people..."³⁴² But inexplicably, the administration of the pipeline did not inform railway officials or local rail traffic controllers of possible leaks in the area, or of the dismissal of the monitoring teams.³⁴³ Railway representatives were of course aware of the existence of the pipeline near their lines, but they assumed that it was perfectly safe because originally it had been an oil pipeline.³⁴⁴ They were not told about the lack of specialist equipment or regular surveillance by the NGL pipeline operators to detect leaks, but would presumably not have realized such measures were necessary.

Failure of Inter-organization Risk Transmission Led to Catastrophe

A critical difference between NGL pipelines and conventional oil and gas pipelines is the fact that the hydrocarbon mixture stays in a liquid state only if there is sufficient pressure within the pipeline – in this case at least 10 atmospheres. Below this pressure, it will revert to the more unstable gaseous state. So, for safe transportation, operators should use a pressure of around 84 atmospheres. But in this instance, the operators generally maintained only 36–38 atmospheres, because of fears that the pipeline would not sustain such high pressure due to the thin wall of the pipes, the low quality of construction and certain features of the NGL mix.³⁴⁵ Several hours before the disaster, operators received a call from one of their NGL consumers, the Minnibaevsky Gas Processing Plant, that the plant had detected reduced pressure within the pipeline and that the NGL delivery rate had gone down. The pipeline control room was located 250 km from the wrecked segment—and as we have seen, the staff did not have the resources to immediately verify the pressure drop, because there was no telemetry system and the pipeline monitoring squads had been disbanded. To make matters worse, the conversation between the operator and the refinery took place just before a shift change in the pipeline control room, and the outgoing operator was in a hurry to catch the bus home; so all he said to the next operator was that the pressure had dropped and would need to be increased.³⁴⁶ Because a constantly high pressure had to be maintained within the system, the new operator just turned up the NLG flow at the

³⁴²Advertisement page, *Light of October* [local newspaper, which was distributed within Iglinki district of Bashkiria, where the accident took place], № 65, May 30, 1989, p. 4.

³⁴³Igor Makarov, 575 dead, 623 injured ... Can we forget about it? 20 years from the tragedy at Asha, ChelNovosti Information agency, June 6, 2009.

³⁴⁴Personal communication with executive representative of association of relatives of people, which were perished and injured in the accident.

³⁴⁵Personal communication with executive representative of association of relatives of people, which were perished and injured in the accident.

³⁴⁶Personal communication with executive representative of association of relatives of people, which were perished and injured in the accident.

nearest compressor station to get the pressure back to normal.³⁴⁷ Reduced pressure in a given section of the pipeline was common practice, and a regular occurrence for the operators: usually the pressure had been cut intentionally because of maintenance works on the pipeline. So, on the night of the disaster, the operator simply assumed that the drop was not dangerous. The investigation after the accident concluded that a 1.7 m crack had developed in the pipeline only 20–40 min before the explosion, at the exact point of the bypass construction in 1985.³⁴⁸ Nevertheless, some locomotive drivers and local residents later testified that they had noticed the smell of gas for 20–25 days before the explosion.^{349,350} This would mean that the pipeline lost integrity at least three weeks before the disaster but, in the absence of regular monitoring, the leak was not identified. On the night of the disaster, when the operator increased the pressure in the system, it provoked a more serious rupture of the pipe at the already weakened joint—and the massive gas release that ensued caused the explosion.

A few hours before the disaster, the driver of a freight train informed a traffic controller that there were serious gas levels in that area, but the controller was unwilling to stop the trains. Obviously, several factors influenced the decision not to close the line despite gas warnings. Firstly, there had been no information about previous and potential leaks from the pipeline administration, and the railway dispatchers had no direct contact line with the pipeline control room. Secondly, the timing of the gas warnings in the night from Saturday to Sunday made it difficult to launch a prompt and detailed investigation of the cause of the gas smell by railway workers. Finally, because railways were the major means of transport for industrial goods and passengers alike in the Soviet Union, local traffic controllers had to follow an intensive train schedule—more than 100 trains a day in both directions; they had no authority to decide, without consulting supervisors, to halt a key section of the Trans-Siberian railway. In the hour before the accident, nine freight trains passed the contaminated section. Consequently, passenger trains were given the green light to enter what was to become the disaster zone.

2.1.7.2 Risk Concealment After the Disaster

After the disaster, the pipeline was finally shut down and abandoned. Remarkably, immediately after the disaster, the pipeline's designer issued a special order prohibiting the construction of NGL pipelines with diameters greater than 400 mm

³⁴⁷William R.Doerner, Communism: Soviet Union Hard Lessons and Unhappy Citizens, *Time* magazine, June 19, 1989.

³⁴⁸Minutes of session of the Supreme Court of the USSR under the chairmanship of Judge V.I. Cherkasov, Dec. 26, 1991, pp. 8–11.

³⁴⁹The torch of death, 18 years ago there was an accident in Bashkortostan, which world did not face before, *MediaKorSet* (Ufa), June 3, 2007.

³⁵⁰Alexey Skripov, Asha explosion. Why the largest in the history of the country's rail disaster occurred, *Rossiyskaya Gazeta—Week—Ural*, June 11, 2009.

and without a leakage telemetric system. And Soviet railway management issued permission for locomotive drivers and dispatchers to suspend traffic if gas contamination was suspected.

The investigation that followed the disaster was biased. From the beginning, prosecutors focused mainly on scapegoating among subordinates, especially the members of the bypass team who had carried out such a poor quality job in 1985. These were the executives of the Soviet Ministry of Petroleum who had ordered costs to be cut and safety rules to be violated at all stages of the project's development: lobbying for the construction of a dangerous piece of industrial infrastructure within highly populated areas; promoting an environment of total rush and the constant raising of productivity targets during construction of the pipeline, at the expense of construction quality and safety³⁵¹; canceling the telemetry system, the helicopter surveillance and the manual monitoring of leaks; and neglecting to inform other organizations operating in the immediate vicinity about the absence of leakage detection equipment on the pipeline. Ministry executives were ultimately charged, but they were amnestied during the preliminary investigation because they were highly respected captains of industry—with numerous Soviet state awards (including for the fast construction of this pipeline) and merits. The investigation dragged on for six years, and the court hearing eventually took place after the collapse of the Soviet Union—when Russian society paid little attention to the lenient sentences handed down to the defendants, because there were too many other serious challenges facing the newly independent Russia.

Neither Soviet government officials nor petroleum executives published any investigation reports describing the causes of the disaster. This led to a situation where executives of the Russian oil, gas and petrochemical industries did not learn lessons out of it. Thus, more than twenty years after the disaster, Russian oil and petrochemical lobbies are proposing the construction of new NGL pipelines with a diameter of more than 400 mm, instead of the more expensive option of doubling the lines to keep the diameter below the 400 mm diameter known to be safer.^{352,353} Moreover, one of the consortiums bidding to develop a NGL pipeline plans to transport a mixture with up to 27 % ethane—even though such a high proportion of ethane reduces the temperature of the NGL mixture and thus of the pipe walls to -66°C . This makes the pipeline dangerously unreliable due to the fragility of metal at such extremely low temperatures.^{354,355} In the absence of officially

³⁵¹Minutes of session of the Supreme Court of the USSR under the chairmanship of Judge V.I. Cherkasov, Dec. 26, 1991, pp. 8–11.

³⁵²Shamil Rahmatullin, Large pipe at the cost of life, *The Chemical Journal*, Aug. 2011, pp. 36–38.

³⁵³Routes of NGLs pipeline “Western Siberia—Ural—Volga”, JSC “Yamal-Volga”, <http://yamal-povolzhye.ru/products-pipeline-route>.

³⁵⁴Shamil Rahmatullin, Large pipe at the cost of life, *The Chemical Journal*, Aug. 2011, pp. 36–38.

³⁵⁵Alexey Skripov, Asha explosion. Why the largest in the history of the country's rail disaster occurred, *Rossiyskaya Gazeta—Week—Ural*, 11 June, 2009.

recognized findings or recommendations from the inquiry after the Ufa disaster, and with inadequate implementation of that previous experience, a similar disaster could well occur again.

UFA Train Disaster: Why Risks Were Concealed

- **Short-term tasks** (timeline, productivity, carrier opportunities and awards) **took priority over long-term consequences** (quality of works, safety and reliability of the pipeline in the long term).
- There was a **rush work culture** prevailing during development and construction of the pipeline.
- **Executives of the Soviet Ministry of Petroleum were reluctant of to admit their own mistakes** during the redesigning and lobbying for the pipeline, or their negligence during its subsequent operation (long-term spending cuts on the maintenance of the pipeline; cancellation of the telemetry system for real-time monitoring of leaks; scrapping the helicopter and ground monitoring teams; poor quality of reconstruction works, and so on).
- The **lack or absence of communication between representatives of the pipeline, Soviet railways, and local residents**, in spite of the fact that the pipeline had 50 leakage incidents over 3 years and was constructed parallel to the railway for a length of more than 270 km. In addition, **nobody could imagine that such a catastrophic event could ever take place**.
- The fact that railway traffic controllers had **no authority** to preventively halt traffic on any section of the Trans-Siberian railway during the detailed investigation of the causes of the gas smell.

2.1.8 Sayano-Shushenskaya Hydropower Station Disaster (Russia, 2009)

The Sayano-Shushenskaya Hydropower Station (SSHPS), on the Yenisei River in south-central Siberia, is the largest hydroelectric power plant and the largest power producing facility in Russia in terms of its installed capacity (6400 MW). The station produces 2 % of all Russian electricity, and 15 % of the country's hydroelectricity. In 2009, the station was the sixth largest hydroelectric plant in the world, exceeded in average annual power generation only by Three Gorges in China, Itaipu in Brazil/Paraguay, Guri in Venezuela, Tucuruí in Brazil, and Churchill Falls in Canada. On August 17, 2009, the rotor of SSHPS Turbine 2 shot out. This flooded the turbine hall of the station, damaged nine of SSHPS's ten turbines and killed 75 station workers. After the disaster, the Minister of Emergency Situations for the Russian Federation evaluated the event as "*the biggest man-made*

*emergency situation [in Russia] in the past 25 years [after Chernobyl] – for its scale of destruction, for the scale of losses it entails for our energy industry and our economy”.*³⁵⁶ Recovery costs after the accident came to over US\$1.5 billion and the reconstruction of the station took more than 5 years.



2.1.8.1 Risk Concealment Before the Disaster

The Problems Coming from Simultaneous Design and Construction of Highly Sophisticated Energy Infrastructure (Common Soviet Practice, as We Have Seen in Previous Cases)

In 1962, one year after the Soviet Union launched the first human being into space, the Communist Party set an ambitious new goal for Soviet engineers—to construct the largest hydropower plant in the world at that time on the powerful Yenisei River in Siberia, to provide extremely cheap electricity for large non-ferrous metal plants. In 1963, an initial design for the plant was developed. In 1968, construction started on a unique arch-gravity dam, 245 m high. It was ten years before the first turbine of SSHPS began to generate electricity, and another ten years before the whole project was completed. The erection of the dam and the completion of the station took such a long time because of Siberia's extreme continental climate: during the winter months, temperatures can fall to -44°C . These conditions required special treatments to enable the solidification of massive amounts of concrete, and innovative approaches to many other areas of design and construction, which had never been tested in other projects before the installation of SSHPS.

The design of this hydropower station proceeded in parallel with its construction in a manner similar to the design/construction of several of the major Soviet energy projects we have already seen: the first Soviet civil nuclear plant in Obninsk in the 1950s, the RBMK reactor series in the 1970s and the Western

³⁵⁶Joe P. Hasler, Investigating Russia's Biggest Dam Explosion: What Went Wrong, Popular Mechanics, February 2, 2010.

Siberia/Ural/Volga natural gas liquids pipeline in the 1980s. As in these cases, the motive of parallel design and construction was to accelerate the commissioning of SSHPS to solve an energy shortage for the heavily industrialized economy of the USSR: the cost of construction had to be minimized, and the USSR lacked the automated computational capabilities to calculate design solutions for such a complex technical project, so the developers had no choice but to test many of their ideas on real operating facilities.

In 2000, before a full-fledged operating permit was issued for SSHPS, a report noted: *“The essential disadvantages of organizing the construction [of the station] include the fact that the general scheme of construction was not finally adopted before construction was started and for [both] objective and subjective reasons, the station’s design was changed in the middle of construction... [This] caused several negative consequences (incidents) which were eliminated during [the] operation [of the station in the 1990s]... The existing expertise for [the] construction [of hydropower stations in the USSR], coupled with a lack of funding, did not allow [developers to carry out] a full program of preparatory works [or] ensure the readiness of construction phases stipulated in the design, resulting in a significant lengthening of the construction period. The actual duration of the preparatory period was 12 years (against 5 years provided for the design), and the total duration of construction of the station – 27 years (against 9 years)”*.³⁵⁷

Moreover, the turbines were commissioned while the construction of the dam body was still incomplete. For example, the Politburo and the State Planning Commission set a deadline for Turbine 1 to be commissioned by December 1978, despite the fact that the builders were behind schedule on the paving by 0.9 million m³ of concrete: by the deadline, they had laid only 3.2 million m³ while the design required 4.1 million m³ to be in place before Turbine 1 could be fully commissioned. This decision to launch Turbine 1 before the dam was fully developed led to changes in the water flow circuit during flooding in 1979, as a result of which the passage of floodwater could not be fully controlled, and the station building and turbine warehouse were flooded. And the subsequent launching of other turbines with the body of the dam still incomplete led to cracking processes in the concrete of some of the dam pillars, and the decompaction of the bedrock foundation, resulting in increased water seepage through the body of the dam and partial degradation of the concrete in these zones. The consequences of these violations of the station’s design were subsequently eliminated by the operating personnel when the station was running.³⁵⁸

In addition, during the construction of the station in the 1960s and 1970s, important safety features for the turbines were not included in the master plan. The absence of these elements predetermined the enormous scale of the accident in 2009 when, due to the failure of just one turbine, the other nine were flooded and damaged. For example, blueprints for the turbines had initially included penstock

³⁵⁷The act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Rostekhnadzor, October 3, 2009, pp. 32–33.

³⁵⁸The Ibid, pp. 32–33.

butterfly valves, which would shut off water flow through the turbines in case of an emergency. If the turbines at SSHPS had been fitted with such valves, the scale of the accident could have been limited to the destruction of Turbine 2 and water would not have uncontrollably flooded other turbines. However, penstock butterfly valves were eliminated from the station's master plans: it was simply beyond the limits of Soviet technology at that time to produce such valves on a scale gigantic enough for the tallest dam in the USSR, and strong enough to withstand the tremendous water pressures involved. Some other safety elements specified in the initial plans (e.g., a shore spillway) were also dispensed with during construction to cut costs and save time; but the projected parameters of power generation and load on the equipment—which had only been envisaged together with these safety elements—were not changed.

Finally, in 1988, the station got its permit for trial operation. Obtaining a fully-fledged operating permit was postponed because technical shortcomings had emerged in the design of the station, which would require further improvements to resolve. Then in 1991, the Soviet Union collapsed; for the next decade, the new Russian government, which now owned SSHPS, did not have the budget to invest in the station to eliminate these imperfections in the dam and the turbines. From 1988 until 2009, the station had no severe accidents; nevertheless, there were a significant number of minor turbine incidents, and minor breaches in the body of the dam when water seepage went beyond the design specifications.^{359,360}

Lack of Communication About Minor Incidents in the Soviet Electro-Energetics Industry in the 1980s as a Key Cause of the Accident at SSHPS in 2009

On July 9, 1983, there was an incident with Turbine 1 at Nurek hydropower station, in what was then the Soviet Socialist Republic of Tajikistan. At 304 m high, the Nurek dam was the tallest in the world at that time. The radial vibration of the turbine bearing led to metal fatigue in the stud-bolts of the turbine cap, and 50 out of a total of 72 bolts finally broke off from the cap. Fortunately, the station staff quickly detected the water flowing out of the turbine shaft into the generator hall, and used the penstock butterfly valve to shut down Turbine 1 with no consequences to the other turbines. Despite the prompt and effective resolution of the problem, information about this incident was not widely distributed by the Soviet Ministry of Energy and Electrification among engineers and managers of other Soviet hydroelectric stations. The event was only mentioned in a classified annual

³⁵⁹N.Vulfovich, L. Gordon, N. Stefanenko, Arch-gravity dam of Sayano-Shushenskaya HPP. Technical evaluation according to field observations, St. Petersburg, 2012, pp. 45, 53–55, 60.

³⁶⁰Dissenting opinion of R.M. Haziahmetov (member of investigation commission of Rostekhnadzor) regarding the Act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume III, Hydrotechnical Construction, Moscow, 2013, p. 273.

review of accidents and other disturbances at Soviet power stations and electric networks for 1983.³⁶¹ This review was available to executives and special engineering staff of Soviet hydropower stations—although not to the public—but information about the incident was scant and the majority in the industry paid little attention to it.

After the incident, staff at Nurek hydropower station carried out obligatory six-monthly tests on the condition of stud-bolts by ultrasound; between 1983 and 2009, 154 stud-bolts on the turbine caps failed the test.³⁶² Nevertheless, no special ministerial requirement was issued to make this practice mandatory at other stations, including SSHPS.³⁶³ There are several reasons why obligatory ultrasound testing of the stud-bolts on turbine caps was not implemented on all Soviet hydropower stations. Firstly, because Nurek Turbine 1—like all the turbines of the station—was fitted with a penstock butterfly valve, the water flow was cut off as soon as the turbine cap started to tear away from the body of the turbine; so the event remained a minor incident at one of many Soviet power stations, rather than a major nationwide disaster. But because the incident was perceived as relatively unimportant, nobody took it as a diagnostic of a more systemic problem. Secondly, the specialist engineers on any particular hydroelectric facility tend to see their site as absolutely unique: a unique master plan is drawn up for each station, taking into account the specific natural features of the area in which the station will be located, and consequently specific technical solutions will be proposed for the generation of electricity with a given dam height and river flow rate. Although hardware vendors also develop unique equipment for different hydroelectric stations, their experience shows that they often use generally the same technical solution for different stations. Nevertheless, hydropower engineering specialists hold to the belief that their site is unique. This assumption means there is generally far less communication about risks—and even actual incidents—between different hydroelectric station operators than between the operators of thermal power plants, which are built to a broadly unified master plan for a whole plant series. In the case of the Nurek hydropower station, neither the turbine manufacturer from Kharkov nor the Ministry of Energy and Electrification of the USSR could imagine that similar processes of turbine bearing vibration and turbine cap stud-bolt fatigue would also be observed on other equipment produced by other manufacturers; in the case of SSHPS, for example, the turbines were designed and manufactured in Leningrad. So, the Kharkov turbine manufacturers

³⁶¹Rostehnadzor: the accident at the Sayano-Shushenskaya HPP is not unique, in 1983 was a similar situation at Nurek HPP, Interfax, Oct. 3, 2009; Review about accidents and other disturbances on power stations and electric networks of USSR energy system for 1983, Soyuztechenergo, Moscow, 1984.

³⁶²S. Pryganov, Analysis of possible accidents on hydropower stations and response measures, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 327.

³⁶³Ivan Sliva, Sayano-Shushenskaya HPP: conclusions have been drawn, RusHydro Herald, #5, May 2011, p. 3.

made changes according to the repair checklist for its equipment; and when the Ministry were informed by Kharkov about the changes, they passed this information to other producers but did not require them to change their regulations on repairing their turbines. Finally, the operators at SSHPS received no information about the incident at Nurek beyond a brief paragraph in the report we have mentioned.

After the disintegration of the Soviet Union, risk information exchange between stations from different republics was dramatically reduced, because the responsibility for running the electric utilities of each republic was transferred from the Soviet Ministry of Energy and Electrification to the governments of the 15 republics.³⁶⁴ Moreover, there was very little international collaboration between hydroelectric industries, because different countries used completely dissimilar equipment and the Soviet and Western energy systems operated in very different ways—so Russian specialists did not receive detailed information about an accident at Manitoba Hydro's Grand Rapids hydropower station in Canada in 1992, when turbine failure led to the flooding of the turbine building. The problem was subsequently traced to the stud-bolts of the turbine cap, which had apparently failed.³⁶⁵ Russian hydroelectric specialists only became aware of the Canadian accident in 2011, during the investigation of the accident at SSHPS.

Soviet Electro-Energetics in the Post-Soviet Russian Market-Oriented Economy

During communist rule, a single technological electro-energetics complex called the Unified Energy System of the USSR was developed across the entire Soviet Union, which covered 12 time zones from the Pacific to the Atlantic. It enabled the transmission of electricity to be organized across the largest country in the world from more than 1000 power stations. A reliable electricity supply was ensured by coordinating the operations of all these stations within a single nationwide technological complex. The efficiency of the Unified Energy System was achieved by optimizing the modes of operation of different stations and by the construction of trunk transmission lines, which reduced production costs and ensured low tariffs for both the industrial and domestic sectors.

In 1992, a year after the collapse of the Soviet Union, a joint stock company was formed called the Unified Energy System of Russia (RAO UES), in which the Russian Federation—represented by the Federal Agency for Federal Property Management—had a majority of shares. RAO UES became the legal successor

³⁶⁴S. Pryganov, Analysis of possible accidents on hydropower stations and response measures, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 331.

³⁶⁵Fabian Acker, Fatal failures: Siberia's hydro disaster, The Institution of Engineering and Technology Magazine, July 11, 2011.

on Russian Federation territory of the Unified Energy System of the USSR, taking control of 72 regional grids—which comprised 70 % of the country's installed electric capacity including the majority of its hydropower stations, 96 % of its high-voltage grids and over 70 % of its transmission lines. The only sites not included in RAO UES were those that had already been transferred to the control of regional authorities or privatized. Around a decade into the post-Soviet era, Russian electro-energetics was generally working well without severe accidents or massive blackouts, in spite of very tough economic conditions for industrial consumers of electricity during the country's dramatic transition from a planned economy to a market economy. At that time, the industry did not receive real money for generated electricity—only 15 % of the total revenue was in cash—and used a system of netting, bill obligations and barter. The absence of severe accidents on electric facilities during this period suggests that Soviet engineers in general had laid solid foundations for the resilience of the nationwide electrical system, even under extreme conditions, for decades into the future.

The new Russian liberal government that replaced the Politburo was strongly oriented towards financial efficiency. This led to a situation where financiers and managers—loyal to the new anticommunist government but with no experience in electro-energetics—became executive managers of RAO UES, and began to implement massive savings by cutting back on capital renewals and investment on safety. In the early 2000s, less than 25 % of RAO UES board members had qualifications in the field of electricity, and most were not competent to manage a potentially dangerous high-tech power generation grid like the Unified Energy System of Russia.³⁶⁶ In addition, the Russian liberal government was constrained by the terms of the International Monetary Fund and the World Bank, which in exchange for loans required the reform of Russian monopolies in natural gas production, railways and electro-energetics.³⁶⁷ International financial institutions expected the dissolution of former Soviet unified energy and transport complexes through the promotion of free-market relations between different parts of the complexes. With regard to electro-energetics, this involved the separation of the Unified Energy System of Russia into numerous mutually independent companies for the production, transmission, distribution and sale of electricity. This led to the disintegration of centralized supervisory control over Russian electro-energetics. Thus, the departments responsible for unified technical development, and industry-wide technical inspections of all electric power plants and infrastructure, were eliminated. Research work on maintenance and repair operations, and even the

³⁶⁶Platonov V.V., Russian electroenergetics: reform and development, Materials of public seminar "Economic Problems and Energy Complex", Institute of Economic Forecasting of the Russian Academy of Sciences, Dec. 18, 2009, pp. 4, 26.

³⁶⁷Platonov V.V., Russian electroenergetics: reform and development, Materials of public seminar "Economic Problems and Energy Complex", Institute of Economic Forecasting of the Russian Academy of Sciences, Dec. 18, 2009, p. 12.

development of specialized equipment, was stopped.³⁶⁸ From 2003, the system for reporting on equipment reliability and on emergencies occurring on Russian electrical installations ceased to function. Professor Vasily Platonov analyzed the disintegration of the Unified Energy System of Russia between 1998 and 2005 and came to the conclusion that profits amounting to US\$39.5 billion were not invested in modernization and repair of electric equipment, while cash accumulated in the accounts of the vast number of independent companies created during the reforms of Russian electro-energetics.³⁶⁹ Consequently, decades of investment shortage and the elimination of professional staff from all levels of the industry resulted in severe accidents in several Russian regions: in the winter of 2000/2001, a massive black-out occurred in the Far East of Russia and Eastern Siberia; and in 2003, the Ural interregional accident took place.

In spite of the fact that unified Russian electro-energetics infrastructures were clearly deteriorating during these monopoly break-up reforms, an executive of RAO UES, during a discussion of the massive Northeast blackout in the United States and Canada in August 2003—when 50 million people were affected for a period of 44 h—arrogantly claimed: *“For us [Russians, who have a united and centralized electricity network] it is impossible. Obviously, Americans have systemic problems [with their nonintegrated national electricity network]”*.^{370,371} These statements were shown to be vacuous in May 2005, when the massive Central Russia blackout initiated 35-h power cuts for more than 6.5 million people—half of Moscow, Tula, Kaluga, Ryazan and other regions—resulting from an unskilled response by dispatchers to an accident at the Chagino substation. The substation was equipped with six high-to-low transformers, three of which were built in 1958 and had not been maintained adequately after the collapse of the Soviet Union. An investigation concluded that the equipment at the substation had badly deteriorated—90 % of the equipment was still in operation after replacement age.³⁷² Other causes of the blackout were attributed to the disintegration of the formerly unified Moscow region energy system. It had been divided into several separate units, each of which was involved in generating, transporting, distributing or selling electricity without strong and efficient coordination between its own dispatchers and those of other units. The Moscow blackout revealed the urgent need for massive investment in Russian electro-energetics, in order to compensate for decades of shortage of capital investment to replace the equipment. If Russia wanted fast economic growth in the mid 2000s, there was an urgent need to

³⁶⁸Victor Kudryavy, Systemic causes of accidents, Hydrotechnical Construction, Moscow, #2, 2013.

³⁶⁹Vasily Platonov, Analysis of development strategies and problems of reforming Russian electroenergetics, Novochoerkassk, 2006.

³⁷⁰Eugene Arsyukhin, Who is responsible for the accident? Rossiyskaya Gazeta, May 27, 2005.

³⁷¹Vasily Platonov, Electricity crisis in Russia on American maner, Industrial Vedomosti, 2005, № 4–5.

³⁷²Report about investigation of accident in RAO UES May 25, 2005, Joint Stock Company of Power And Electrification RAO “UES Of Russia”, Moscow, June 2005.

get new electric capacity into operation and modernize the existing stations and infrastructure. President Vladimir Putin and his government agreed with the proposal of the liberal, pro-market senior management of RAO UES that they should continue to dismantle the system into generation, transportation, distribution and electricity sale units, which could compete with one another in a free market. The idea of dividing the formerly Unified Energy System of Russia into privatized sections was based on the assumption that these smaller units could be easily controlled and managed by invited domestic and foreign investors. The rationale was that these new private owners would invest billions in Russian electro-energetics, instead of the government having to find the budget for the whole Unified Energy System of Russia. However, it became clear from the outset that these investors were focused on getting short-term return on their investment by raising electricity prices, rather than on the public-service priorities of the Unified Energy System of the previous USSR—whose aim had been to provide a reliable electro-energetics network in a gigantic country with a tough climate, while keeping tariffs low for consumers.

By July 2008, the Unified Energy System of Russia had been dismantled. In its place were six wholesale thermal power generation companies; 14 regional thermal power generation companies; the hydropower giant RusHydro – which operated 53 hydropower stations, including SSHPS, and became the world's third largest hydroelectric power producer and the largest power-generating company in Russia; the Federal Grid Company; the System Operator of the Centralized Dispatching Administration; and other companies. The former chief engineer of RAO UES (1993–1996) and Deputy Minister of Energy of Russia (1996–2003) estimated that after the reorganization, the number of electricity sale companies quadrupled and exceeded 320; and the total number of power grid companies reached an astronomical level at around 3600.³⁷³ Only about US\$36 billion of private investment was attracted³⁷⁴ in spite of forecasts by the management of RAO UES before the reorganization of a potential \$79 billion of investment.³⁷⁵ Between 2008 and 2012, only 16.1 GW of new capacity was installed, instead of the 21.8 GW that RAO UES management had estimated before reorganization.³⁷⁶ During this period, the world economic crisis, climaxing with the collapse of Lehman Brothers investment bank and the bailout by the US government of AIG, the largest insurance company in the world, in September 2008,³⁷⁷ led to a suspension of any significant private investments; and the Russian government through state-owned companies was forced to become once again the major investor in Russian electro-energetics after the apparent failure of RAO UES's reforms.

³⁷³Victor Kudryavy, *Mister kilowatt*, The Soviet Russia, Nov. 28, 2013.

³⁷⁴Chubais agrees with the Rostekhnadzor's investigation conclusion concerning accident at SSHHPP—comment the former head of RAO UES of Russia, Interfax, Oct. 3, 2009.

³⁷⁵Neil Buckle, Russia seeks \$79 bn electricity funding, *Financial Times*, Sep. 4, 2006.

³⁷⁶Neil Buckle, Russia seeks \$79 bn electricity funding, *Financial Times*, Sep. 4, 2006.

³⁷⁷Didier Sornette and Peter Cauwels, 1980–2008: The Illusion of the Perpetual Money Machine and what it bodes for the future, *Risks* 2, 103–131 (2014) (<http://ssrn.com/abstract=2191509>).

Ten years of reforms within the industry had seen electricity tariffs increase by a factor of ten, from US\$0.01/kWh in 1998 to US\$0.1/kWh in 2008, and the reliability of the nationwide power supply had gone down as a result of the disintegration of the unified system.³⁷⁸ Moreover, electricity prices in Russia reached a level 1.5 times higher than those in China and the United States—which made several Russian industries, which had been dependent on cheap power supply, less competitive on the international market.³⁷⁹ This rise in tariffs was influenced by the need for the industry to attract/recoup investment. Because most of the units of the former RAO UES were now public companies, their managers began to focus on maximizing profits and financial efficiency, instead of the reliability of the sites and infrastructure they were supposed to be running. These became the priorities for the partly government-owned RusHydro—and at SSHPS in particular, according to one member of the Russian parliamentary commission, which investigated the accident at SSHPS: *“The operation of the station was subordinated to the main task – to generate profit... Therefore, financiers and economists were the main force in RusHydro and, perhaps, they had influence or put pressure on engineering services. It is hard to explain in any other way, why in spite of the fact that the technical lifecycle of Turbine 2 was practically expired, a new turbine had not been ordered and a special plan for the safe operation of the obsolete turbine was not even developed”*.³⁸⁰

Tragic Consequences of the Ultra-Liberal Reforms of RAO UES on the Safe Operation of SSHPS

SSHPS had been producing hydroelectric power on a provisional operating permit from 1988 until 2000, because of several technical shortcomings that the Soviet Ministry of Energy and Electrification expected to eliminate during the 1990s. Nevertheless, in the wake of the collapse of the Soviet Union and the complicated financial situation of RAO UES, nobody could afford to plough hundreds of millions into constructing the shore spillway for the dam at SSHPS or changing the station’s still unperfected turbines. During the 1990s, only minor, inexpensive and urgent maintenance works were carried out. When RAO UES top management began to discuss the reorganization of the Unified Energy System, managers came to the conclusion that the largest hydropower station in Russia could not be recognized as an asset for a prospective public company like RusHydro, given its

³⁷⁸Platonov V.V., Russian electroenergetics: reform and development, Materials of public seminar “Economic Problems and Energy Complex”, Institute of Economic Forecasting of the Russian Academy of Sciences, Dec. 18, 2009, p. 55.

³⁷⁹Platonov V.V., Russian electroenergetics: reform and development, Materials of public seminar “Economic Problems and Energy Complex”, Institute of Economic Forecasting of the Russian Academy of Sciences, Dec. 18, 2009, p. 78.

³⁸⁰Victor Khamraev, Responsibility for the accident on was laid on principle, Kommersant, Dec. 22, 2009, 239 (4294).

provisional operating permit. Consequently in May 2000, RAO UES executives issued a fully-fledged operating permit for SSHPS despite the existence of unsolved technical shortcomings at the station in previous years. The forms accompanying the permit mentioned many shortcomings of the station, and the management of the station and RAO UES received recommendations regarding these imperfections. For instance, several problems with the turbines were emphasized: *“In the initial period of operation of [SSHPS], some design flaws were identified in several parts of the turbines [abnormal vibration of turbines during different operating regimes], which were partially eliminated by operating staff and manufacturers. Nowadays, works to improve the reliability of individual components of the turbines are continuing, in particular, the station’s staff [are eliminating] cracks on the blades of the turbines... More than 20 years... after the start of electricity production at SSHPP, therefore, there is the necessity to replace obsolete equipment and facilities ([the automatic process control system], the turbine impellers, [etc.])... After 50 thousand hours of operating time [of the turbines], the volume of repairs has increased significantly. Annually, such repairs are performed on 4–5 turbines [SSHPS has 10 turbines in total]; [such activity] requires large labor costs and an increase of turbine downtime due to repair... Replacement of turbines is required”*.³⁸¹

In spite of these recommendations for major corrections to the flaws of the turbines and other imperfections, there was little serious investment from RAO UES at the beginning of the 2000s. The focus of top managers was on demonstrating the financial efficiency of the assets in order to attract potential investors and raise capitalization value: for ten years from 1998 to 2008 the capitalization of RAO UES rose from US\$12 to \$50 billion, while the degree of asset deterioration on RAO UES sites increased from 50 % in 1999 to 59 % in 2006; this measure had been 43 % in 1995.^{382,383,384} Increasing the flow of water in SSHPS’s reservoir, instead of dumping water vainly through the spillway embedded in the body of the dam, made for greater profitability because it raised electricity production on the station. Furthermore, dumping water was even more dangerous for the body of the SSHPS dam, because the idle discharge of water could destroy the base of the tail-race of the dam due to the absence of a shore spillway at that time. Thus, in 2006, the station generated record electricity outputs due to the heightened water inflow to the Yenisei River. In 2006, the net profit of RusHydro was US\$47 million, and it continued to rise in the following years: in 2008, it increased more than 12 times

³⁸¹The act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Rostekhnadzor, Oct. 3, 2009, pp. 30–34.

³⁸²Profile of the company. History transformations, RAO “UES of Russia”, <http://www.rao-ees.ru/ru/info/history/show.cgi?prof.htm>.

³⁸³Anatoly Kuzovkin, Assets of Russian energy complex: how much eaten, how much is left, Industrial Vedomosti, Sep. 2001, № 16–17 (27–28).

³⁸⁴Accounts Chamber of the Russian Federation: the degree of asset deterioration of RAO UES is 59 %, Finam, Dec. 17, 2007.

to \$605 million.³⁸⁵ On July 3, 2009—45 days before the disaster—the station issued a press release celebrating new record levels of electricity production due to a higher than average inflow of water to the river: “*In June, the historical maximum output of hydroelectric power generation on SSHPS was recorded... More than 100 million kWh per day were produced*”.³⁸⁶ This record was reached with obsolete turbines, in spite of the recommendations issued in 2000 to replace them. At the time of the disaster, Turbine 2 had been in operation for 29 years and 10 months. The maximum period of operation during which the manufacturer guaranteed full compliance with design specifications was 30 years; but naturally this guarantee assumed timely and comprehensive routine maintenance of the turbine, provided by station personnel or special repair contractors. However, the fact is that at the moment of the accident, no plan was in place for Turbine 2, which would soon come to its 30-year safe operating limit, whether to extend its operation into the following decade or withdraw the turbine from service and replace it. Incidentally, it should also be noted that the station never worked at its full capacity (6400 MW), because the existing electrical network to the station was not able to take a load of more than 4000 MW.

Running obsolete turbines with known deficiencies and giving priority to economic concerns should have been compensated by serious attention to thorough equipment monitoring and the complex maintenance of the turbines. However, the reorganization strategy of RAO UES stipulated that the repair departments in all power stations had to be independent business units with a profit-based approach, and that all maintenance contracts should take place on a tender basis. This meant that the repair staff of SSHPS, who had decades of experience and knowledge, had to be transferred into a separate company. This company, Sayano-Shushensky HydroRepair—100 % of which was owned by SSHPS—now had to compete with other repair organizations on tenders and provide the lowest possible prices for maintenance of the unique equipment of the station. The separation of repair departments from Russian power stations was influenced by the prevailing free-market ideology among executives of RAO UES, which assumed that competitive markets would always be more effective.

Another reason for the transfer of repair staff from station to a separate company stems from the fact that, during Soviet times, there were several huge nationwide repair holdings, which had multi-station repair experience and were far more effective than the repair staff at any ordinary station in carrying out major overhauls; local staff focused on ongoing minor repairs. However, these holdings collapsed during the 1990s due to privatization and the total lack of funds at power stations to pay for outsourced repairs—so by the time RAO UES was reorganized, the most advanced repair staff in the industry were within the stations rather than with any of the external repair holdings.

³⁸⁵Annual Report of Joint-Stock Company “RusHydro”, 2008, p. 57.

³⁸⁶On Sayano-Shushenskaya hydropower plant recorded maximum power output, press release of SSHPS, July 2, 2009, <http://www.sshges.rushydro.ru/press/news/33083.html>.

In the case of SSHPS—which is located in a remote mono-industrial city in the Siberian taiga near the Mongolian border, 3500 km from Moscow and 600 km from Novosibirsk—the only qualified service staff available to repair the turbines were former and current personnel of the station. In order to comply with the formalities of tenders dictated by the reform of RAO UES, the management of SSHPS founded a company called HydroRepair, which began to “compete” with Sayano-Shushensky HydroRepair for the station’s tenders. Among the founders of HydroRepair were the CEO of SSHPS, the station’s chief engineer (who formulated the tender requirements, and after repairs made formal acceptance of the work carried out), the chief financial officer and other executives of the station.³⁸⁷ This looks like a clear example of a conflict of interests with signs of corruption. But SSHPS management were forced to go through the motions of running both Sayano-Shushensky HydroRepair and HydroRepair in order to prevent inexperienced companies, with no competence in repairing the station’s sophisticated turbines, from winning repair contracts. Such companies could easily win contracts simply by offering the lowest price on maintenance work: Russian contracting legislation is flawed in that it requires the buyer to choose the lowest bid on tenders, without taking into consideration the experience of the bidding organizations or the quality of their previous performance (moreover, according to Russian legislation concerning turbine repair works, service companies are not required to obtain licenses, therefore, a company without any experience in repairing turbines can participate in the tenders).

The tender system had another grave shortcoming. The high-quality repair of sophisticated and unique equipment during its life cycle requires a constant accumulation and transfer of knowledge about previous repairs—so that long-term contracts, which guarantee ongoing work if the repair company fulfils its obligations, are beneficial and even necessary for safe operation. But after the reform of RAO UES, stations had to make contracts only for precisely defined maintenance tasks; along with the requirement to give work to the lowest bidder, this resulted in a high turnover of contractors. Therefore, in response to the demand of RAO UES for the withdrawal of repair units from the station staff, SSHPS managers chose what seemed for them to be the option that would minimize damage to the station—they founded and established the HydroRepair company, transferred the maintenance personnel from the station to the company and reduced the likelihood of tenders being won by unscrupulous competitors.

In 2005, the turnover of Sayano-Shushensky HydroRepair was around US\$10 million, but the company began to lose contracts to the management-affiliated HydroRepair. Between 2005 and 2008, the total turnover of HydroRepair reached US\$30 million. By 2009, the company was winning the majority of the repair contracts for SSHPS; and in particular, it was HydroRepair who repaired Turbine 2

³⁸⁷Ibid.

from January until March 2009.^{388,389} Only five months after this medium scale repair, it was damage to this turbine that became the main cause of the disaster at SSHPS. Nowadays, it is hard to determine the quality of the repair work that was performed on Turbine 2, because of the total destruction of the turbine. Moreover, after the accident, investigators did not look into the legality of contracts with HydroRepair and there was no investigation of the quality of the repairs carried out on Turbine 2 early in 2009. All opinions expressed after the accident about this repair can only be considered as personal assessments by experts and officials, which are not supported by judicial decisions. And these opinions are radically different. For example, a senior representative of the plant designers concluded that the repair of Turbine 2 was made properly according to all existing standards³⁹⁰; on the other hand, an executive member of the Russian parliament's investigation commission, who was on the board of directors at RAO UES between 1997 and 1998 and has been on board of RusHydro since 2013, declared: *"They [the staff of HydroRepair] repaired [the turbines], but did not in reality make full-scale repairs, in spite of documentation which they provided describing fully-fledged repairs... We had assumptions that the management of the hydropower station had affiliated companies. This is true. Some repairs were not made at all [however, funds for these repairs were received by HydroRepair]"*.³⁹¹ Later Vladimir Putin, during meetings about the accident, commented on the situation: *"It would be irresponsible and even criminal to save money on safety or entrust repairs to companies that are 'affiliated' with anyone, but especially with the management of facilities... The audit conducted by the Energy Ministry in some state-funded companies ... show[s] that many senior officials of these state-funded companies are also involved with commercial companies. [T]here was a conflict of interests, meaning that officials of state-funded companies should not use their position to conduct other commercial activity in the interests of private, generally speaking, family businesses... [W]e must fundamentally improve technological discipline in industry. Performance at sophisticated technological facilities is ... bad. Technological discipline is very low"*.^{392,393,394} Shortly after these harsh

³⁸⁸Irina Tumakova, Sergey Teplyakov, Firm-disaster, Izvestia, September 22, 2009.

³⁸⁹Elena Mazneva, Anna Peretolchina, Repair on trust, Vedomosti, September 21, 2009.

³⁹⁰Boris Yurkevich, About causes of the accident on Turbine 2 of The Sayano-Shushenskaya Hydropower Station, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 459.

³⁹¹Repairs on the 2nd turbine of SSHPS were not made in full—the commission of the State Duma, Interfax-Russia, October 30, 2009.

³⁹²Prime Minister Vladimir Putin chaired a meeting at the National Crisis Management Centre of the Ministry for Emergencies held to discuss the relief efforts at the Sayano-Shushenskaya power plant, September 21, 2009, <http://archive.premier.gov.ru/eng/events/news/5032/>.

³⁹³Vladimir Putin meets with Deputy Prime Minister Igor Sechin, December 30, 2011, <http://archive.premier.gov.ru/eng/events/news/17554>.

³⁹⁴Prime Minister Vladimir Putin chaired a meeting of the Government Presidium, August 20, 2009, <http://archive.premier.gov.ru/eng/events/news/4757/>.

assessments following the disaster, some senior managers of RusHydro were forced to resign, and just over a month later RusHydro—whose main shareholder is the Russian government—appointed a new CEO.

The Problems of Assessing the Real Characteristics of the Vibrations in Turbine 2

Operation of the repaired Turbine 2 was resumed on March 16, 2009 without detectable abnormal vibrations during the following 35 days. According to RusHydro comments given after the disaster, the sophisticated tender scheme for repairs on SSHPS was disclosed by management in April 2009, and consequently HydroRepair lost all contacts.³⁹⁵ Nevertheless, the founders of HydroRepair all remained in their positions; this was explained by the fact that in previous years there had been no cause for complaint about the quality of repair work produced by HydroRepair.³⁹⁶ But during spring 2009, when the station began to generate electricity under additional pressure caused by the spring flood and high reservoir levels, increased vibration levels were registered in all the turbines.^{397,398} From April 21, staff at the station began to detect abnormally high vibrations in Turbine 2, based on data from one of sensors installed inside the turbine. By August 17, according to this sensor, the vibration amplitude of the bearing of Turbine 2 rose to 840 μm , more than five times the maximum permitted safe level of 160 μm .³⁹⁹ Station safety instructions dictate that, in case of any sudden increase of vibration of the turbine bearing over 160 μm , the chief engineer must be consulted and the turbine must be unloaded or stopped immediately.⁴⁰⁰ Nevertheless, SSHPS executives—including the founders of HydroRepair—took no action to investigate the vibration, eliminate this technical failure during the months before the disaster or order an emergency stoppage of Turbine 2.

There are several explanations for this inaction.

Firstly, SSHPS executives were not able to properly assess the risks involved in operating the turbines at the station, and the operators did not even consider that a

³⁹⁵Anastasia Lyrchikova, RusHydro has been uncovered machinations on SSHPS, Reuters Russia and CIS, Sep. 18, 2009.

³⁹⁶Personal communication with RusHydro's executives.

³⁹⁷Dissenting opinion of R.M. Haziahmetov (member of investigation commission of Rostekhnadzor) regarding the Act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume III, Hydrotechnical Construction, Moscow, 2013, p. 276.

³⁹⁸N. Baykov, Analysis of the circumstances of the accident at the Sayano-Shushenskaya HPP, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 158.

³⁹⁹The act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Rostekhnadzor, Oct. 3, 2009, p. 66.

⁴⁰⁰Ibid, p. 75.

serious accident could occur. In fact, engineers had been recording minor vibrations in the station turbines over decades—especially in Turbine 2 during the first years after the station was launched in 1979, when the turbine was equipped with a poor-quality interim rotor.^{401,402,403,404} In spite of that, there had been no serious turbine accidents. This is a clear example of habituation—the unwillingness to believe that the worst could happen, and the growth of a misplaced confidence in the soundness of the system.

Secondly, during routine maintenance on the turbines of SSHPS, the condition of the turbine cap stud-bolts was checked visually, without ultrasonic scanning. We have seen that similar accidents had occurred at Nurek hydropower station in 1983 and Grand Rapids in 1992, but that information about these accidents was not widely distributed among executives and engineers of the station for the reasons we described—so nobody thought that unusual vibrations could lead to such catastrophic consequences.⁴⁰⁵ After the disaster, laboratory tests revealed that the average degree of fatigue in the stud-bolts was about 60–65 %, and that the majority of them had fatigue cracks.⁴⁰⁶ But the laboratory did not estimate when the fatigue had started to develop, and thus could not establish whether it dated from 1979–1983, when a poor-quality interim rotor was installed on the turbine causing excessive vibration, or from the more recent period when HydroRepair had begun to service the turbine. The scanning of stud-bolts on other turbines did not reveal the same massive levels of fatigue seen in those of Turbine 2.

Thirdly, the systems in place to track and monitor the functioning of the turbines at SSHPS were not being used effectively. In 1999, the former director of SSHPS, who had been in post from 1977 and remained until 2001, wrote in a monograph about the development of the station: “[*The laboratory of technical diagnostics at SSHPS*] conducted a study aimed to develop a system for permanent tracking of the mechanical state of critical components of the turbines. This

⁴⁰¹Valentine Bryzgalov, Monograph “From the experience of establishment and development of Krasnoyarsk and Sayano-Shushenskaya HPSs”, Krasnoyarsk, Surikov Publisher, 1999, p. 541.

⁴⁰²Vladimir Demchenko, Andrew Krassikov, Sergey Teplyakov, Irina Tumakova. Was Turbine #2 on SSHPS shaking during 10 years? *Izvestia*, September 14, 2009.

⁴⁰³F. Kogan, Abnormal operating conditions and reliability of modern hydro turbines, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 49.

⁴⁰⁴N. Baykov, Analysis of the circumstances of the accident at the Sayano-Shushenskaya HPP, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 153.

⁴⁰⁵Rostekhnadzor: the accident at the Sayano-Shushenskaya HPP is not unique, in 1983 was a similar situation at Nurek HPP, *Interfax*, Oct. 3, 2009 and review about accidents and other disturbances on power stations and electric networks of USSR energy system for 1983, Soyuztechenergo, Moscow, 1984.

⁴⁰⁶B. Skorobogatykh, N.Shepilov, S.Kunavin, V.Ushakov, Investigation of the metal and the nature of damage studs of turbine cover of Turbine 2 of Sayano-Shushenskaya Hydropower Station, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 373.

system should provide information about malfunction and, eventually, provide recommendations for halting a [problem] turbine. Unfortunately, up to now in most cases, the vigilance of operators in the control room and the dial indicator remain the main monitoring instruments of the mechanical condition of turbines at the majority of HPSs in Russia. [The laboratory of technical diagnostics at SSHPS has made] repeated attempts to install and use modern instruments of vibration control to continuously monitor the mechanical state of turbines in order to receive a warning signal in case of off-limit vibration. However, the low level of accuracy, narrowness of frequency band, absence of full-scale spectrum of the diagnosed signal, and low reliability of the monitoring equipment did not lead to a practical positive result”.⁴⁰⁷ By the late 2000s, the station was equipped with more than 11,000 sensors for controlling all aspects of operation.⁴⁰⁸ In March 2009, a new vibration monitoring system was installed on SSHPS’s turbines on a trial basis, but it was working only as an internal information system: there were no specifications from the government regulation body, or requirements from the turbine manufacturer, as to how such systems should be used with the turbines. After the accident, an investigation by the Federal Service for Ecological, Technological and Nuclear Supervision of the Russian Federation (Rostekhnadzor) concluded that “*The continuous vibration monitoring system installed on Turbine 2 in 2009 was not put into operation and the station’s operating personnel and management did not take into account [the data it provided] during decision making*”.⁴⁰⁹ In other words, this system was collecting information about the vibrations—we know about this because investigators demonstrated an array of recorded vibration data regarding the turbines at SSHPS—but information from the detectors was not recognized by the technical staff as a reliable basis for decision-making. This was because there were four sensors attached to Turbine 2, but only the one for the turbine bearing indicated abnormal vibration levels (up to five times the approved limit), while the others registered acceptable levels of vibration.^{410,411} Technical staff had been used to high vibration levels on Turbine 2 for decades, and as we have seen were unaware of the accidents on the Nurek and Grand Rapid stations; so they evaluated the abnormal vibration of the turbine bearing on Turbine 2 during the summer of 2009 as incorrect/inexact, because the

⁴⁰⁷Valentine Bryzgalov, Monograph “From the experience of establishment and development of Krasnoyarsk and Sayano-Shushenskaya HPSs”, Krasnoyarsk, Surikov Publisher, 1999, p. 541.

⁴⁰⁸L.Godron, Assessment of condition of dam of the Sayano-Shushenskaya Hydropower Station before and after accident, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 206.

⁴⁰⁹The act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Rostekhnadzor, Oct. 3, 2009, p. 66.

⁴¹⁰Dissenting opinion of R.M. Haziahmetov (member of investigation commission of Rostekhnadzor) regarding the Act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume III, Hydrotechnical Construction, Moscow, 2013, p. 271.

⁴¹¹Victor Kudryavy, Systemic causes of accidents, Hydrotechnical Construction, Moscow, #2, 2013.

other sensors on Turbine 2 did not demonstrate serious deviation from their approved limits. Moreover, even when Turbine 2 was temporarily suspended during the summer months of 2009, the sensor still showed that the vibration of the suspended turbine bearing was 160 μm .⁴¹² Believing that the sensor was recording the vibration level incorrectly, station managers neither logged this “faulty sensor” in their records nor carried out tests on the actual level of the vibration with portable diagnostic equipment. They perceived it as an unimportant defect, which they were not obliged to report to RusHydro headquarters.

After the disaster, during restoration work on SSHPS in 2010–2011, an advanced vibration monitoring system was installed on the turbines. Nevertheless, 15 cases of faulty sensors within Turbines 3, 4, 5, and 6 were registered. The main cause of incorrect turbine vibration measurements was “*multidirectional dynamic impulses of forces from the flow of water coming off the rotor blades*”.⁴¹³ However, during the investigation of the accident, a laboratory examination of the assumed faulty sensor was carried out and its results were presented to the court—it turned out that the sensor was fully functional.⁴¹⁴ But why it showed abnormal vibration when other sensors indicated the turbine’s vibration to be within the normal range, will never be known, because the turbine was completely shattered in the accident and all electrical circuits were also destroyed in the ensuing flooding. This means that after the event, nobody can draw any conclusions about the real vibration characteristics of the bearing of Turbine 2 on the day of the accident. It would be unreasonable to claim that the possibility of a sensor fault implies that there was no vibration in the turbine before the disaster. But there is further compelling evidence against such a claim: the head of Rostekhnadzor revealed that “*seismologists recorded abnormal vibration at Sayano-Shushenskaya Hydropower Station 15–45 minutes before the accident*”.^{415,416} Therefore, a combination of evidence allowed investigators to conclude that “*the cause of the destruction of the turbine cap stud-bolts was fatigue cracks in the body of the stud-bolts. The origin and intensive development of [these] cracks resulted from actions and efforts*

⁴¹²Dissenting opinion of R.M. Haziahmetov (member of investigation commission of Rostekhnadzor) regarding the Act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume III, Hydrotechnical Construction, Moscow, 2013, pp. 271–278.

⁴¹³Victor Kudryavy, Systemic causes of accidents, Hydrotechnical Construction, Moscow, #2, 2013.

⁴¹⁴From the sentence of Sayano-Gorsky District Court, Respublic of Khakasia, Russia, Dec. 24, 2014.

⁴¹⁵A. Abakumov, M. Abdulin, D. Soloviev, V. Ustinenko, Numerical simulation of a possible accident scenario on Sayano-Shushenskaya Hydropower Station, Destruction of Tubine 2 of Sayano-Shushenskaya Hydropower Station: causes and lessons, Volume I, Hydrotechnical Construction, Moscow, 2013, p. 151.

⁴¹⁶Dmitry Malkov, The Hydro power station was closed for construction, Kommersant, Aug. 28, 2009, № 158 (4213).

influenced by the horizontal vibration of the turbine bearing".⁴¹⁷ In December 2014, a court supported this accusation.

A fourth probable reason for the unwillingness to shut down Turbine 2 relates to another hydropower station in the region. In 1988 SSHPS, with its operating output of 6,400 MW, had been combined with the smaller Bratsk HPS for power regulation under the supervision of the System Operator of the Unified Energy System (SO UES) within the whole Siberia region. Bratsk HPS was located 700 km from SSHPS on the Angara River, and had an output of 1,400 MW. At midnight on August 17, 2009, there was a fire affecting the communication channels of Bratsk HPS, which led to loss of control over the station by the dispatcher of the Siberian branch of SO UES. Therefore, the operator ordered SSHPS to launch all available turbines in order to compensate for any possible suspension of output from Bratsk HPS. At 3:14 a.m. on August 17, 2009, Turbine 2 was resumed and was operating automatically as part of the "*regulator group for active and reactive power*" of the Siberian branch of SO UES. On the day of the disaster, the reservoir level at the SSHPS dam was 212 m instead of the optimum level of 197 m. The turbines of SSHPS only had a narrow range of adjustment to their output if the reservoir level was higher than 197 m. This meant that the turbines could operate safely with the reservoir at 212 m only from 0 to 265 MW and from 570 MW to 640 MW. Therefore, during load changes with this heightened reservoir level, the turbines would pass through a "*not recommended for use*" zone between 265 and 570 MW, during which there would be transient hydrodynamic processes, pressure fluctuations and high vibration. From the resumption of operation during the incident at Bratsk HPS, the load regime of Turbine 2 was changed twelve times and the turbine passed six times through the "*not recommended for use*" zone; in the longer period from March 2009, Turbine 2 passed through this zone 210 times—regulations allowed it to pass through the zone not more than 750 times annually—and was there for 2520 s. Thirteen minutes before the disaster, when the dispatcher of the Siberian branch of SO UES gave the order to reduce the output of Turbine 2 from 600 MW to 475 MW, the vibration amplitude of the turbine bearing rose by 240 μm according to the detector, from 600 μm to 840 μm . It is likely that the station's chief engineer and operator staff did not stop Turbine 2 in spite of the obvious extreme vibration within the machine, because of the continuing incident at Bratsk HPS, which was fully eliminated only by 2:03 p.m. on August 17, 2009—roughly 6 h after the disaster at SSHPS.⁴¹⁸

Finally, SSHPS executives were obviously afraid to shut down Turbine 2 over many months because of the potential scandal with the questionable tender practice and inevitable questions about the quality of the repairs over the previous three years. Five months earlier, SSHPS executives had lost an affiliated business

⁴¹⁷Andrei Mitrofanov, former chief engineer of SSHPP, considers that the accident could be repeated, Khakasia News Agency, Dec. 14, 2013.

⁴¹⁸The act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Rostekhnadzor, Oct. 3, 2009, pp. 55–76.

with US\$30 million turnover due to suspicions about conflicts of interests and evidence of corruption; they did not wish to give any occasion for more inconvenient scrutiny about the business activities they were engaged in on top of their managerial duties. The main reason for such concealment lays in avoiding potential criminal charges against the management of SSHPS for using questionable repair tender schemes as well as in steering clear of questions about the quality of repair of the station's equipment. Long before the disaster, RusHydro had a very long chain of communication of risk information. Typically, RusHydro's top management actually received information about technical incidents—even insignificant ones—not from the managers of hydropower stations but from the RusHydro security services, which monitored the station environment independently from the station's personnel.⁴¹⁹ Thus, a typical reply from stations to any question from Moscow about their reliability was *"everything is under control"*.⁴²⁰ In this case, RusHydro security services also missed the existence of abnormal vibrations in the plant. This is reminiscent of the KGB falling short of recognizing the importance of the SCRAM effect in RBMK nuclear plants.

2.1.8.2 Risk Concealment After the Disaster

After the disaster, Rostekhnadzor issued an investigation report about the technical causes of the disaster. Rostekhnadzor's findings were selected as the basis for a criminal investigation by Russian prosecutors towards the management and staff of SSHPS. Finally in December 2014, more than five years after the accident, the court found the director of SSHPS, the station's chief engineer and other technical managers of the station guilty of violations of safety regulations at work—in particular through their disregard of the signs of excessive vibration within Turbine 2—causing the death of more than two persons. The main defendants were given six-year prison sentences. Nevertheless, the accused staff of the station did not accept the judgment, and filed an appeal declaring that the main causes of the accident were the imperfection of the turbine design and the poor quality of production of Turbine 2 at the manufacturer's Leningrad plant, and wider shortcomings in the design of the station.⁴²¹ As we mentioned earlier, the prosecutors did not conduct a detailed investigation of HydroRepair's tender practice and the evident conflict of interests involved; nevertheless, most of the founders of HydroRepair were ultimately found guilty by the court in their principal roles as executives of SSHPS, but not as executives of the dubious HydroRepair.

The lack of interest from state prosecutors towards HydroRepair was hardly surprising: if they revealed this scheme to the public, the Russian government would have to admit their own mistake in allowing the reform of Russian electro-energetics

⁴¹⁹Personal communication with RusHydro's executives.

⁴²⁰Personal communication with RusHydro's executives.

⁴²¹Dmitry Malkov, SSHPS kept the last word, Kommersant, Dec. 2, 2014.

according to ultra-liberal conceptions of a free-market economy. So, the managers who were ultimately responsible for the proper operation of the turbines were punished in any case, but without public disclosure of the corruptive tactics of the reformed Russian electro-energetics industry. The prosecutors also neglected to investigate the possible guilt of the top management of RAO UES, who had implemented an apparently misguided reorganization of Russian electro-energetics, damaging the interests of national energy security, with the approval of the Russian government. This omission is all the more glaring in that some RAO UES executives, as well as some former government officials, were mentioned in Rostekhnadzor's report as persons *"who contributed to the occurrence of the accident"*.⁴²² After the disaster, the Russian parliament's investigation commission stated: *"Most of the causes of the disaster are systemic and multifactorial, influenced by indigenous deficiencies of the existing organizational scheme and functioning of domestic electro-energetics... During radical changes of property relations and principles of conduction of the sector [i.e. during the reforms of RAO UES], comprehensive conditions for ensuring technological safety were not formed"*.⁴²³

Sayano-Shushenskaya Hydropower Station Accident: Why Risks Were Concealed

- The Politburo and State Planning Commission **focused on the short-term reduction of safety costs** through the redesign of the station, and **demanding constant rush** during the construction phase, because they wanted to accelerate the introduction of new energy facilities to meet the needs of the national economy.
- There was a general **reluctance** within the Soviet and Russian electro-energetics industry **to investigate in detail the causes of previous accidents/near-miss cases**, or to transmit the results among decision-makers, so that the remedies learned from the experience of previous accidents on other electro-energetical facilities could be implemented across the industry.
- After the collapse of the Soviet Union, the liberal-oriented government **gave priority to short-term financial results** in the operation of electro-energetical facilities, and to indicators of market capitalization, over the long-term reliability of Russian electro-energetics.
- **Habituation/wishful thinking/overconfidence/self-suggestion/self-deception**: engineers and management at the station believed that a severe turbine accident was highly unlikely, because of the station's 30-year history of generally safe operations.

⁴²²The act of technical investigation of the accident at the Sayano-Shushenskaya HPP, Rostekhnadzor, Oct. 3, 2009, pp. 111–113.

⁴²³Victor Kudryavy, *Mister kilowatt*, The Soviet Russia, Nov. 28, 2013.

- SSHPS managers were afraid of **potential criminal charges** for using questionable repair tender schemes, which they felt obliged to implement after the misguided reorganization imposed by RAO UES. They were also afraid to seem incompetent in the eyes of RusHydro's superiors.
- **The Russian government was unwilling to admit its own mistakes in pushing through unreasoned free-market reforms of Russian electro-energetics**, or to admit the evident failure of its reorganization of RAO UES. This led to a situation where only SSHPS staff faced criminal charges after the accident.

2.1.9 Deepwater Horizon Oil Spill (USA, 2010)

From January to April 2010, floating in the Gulf of Mexico 66 km from the coast of Louisiana State, the Deepwater Horizon oil platform was drilling the Macondo exploratory well. The total depth of the well was 6500 m: 1500 m below sea level and 4000 m beneath the seafloor in Block 252 of the Mississippi Canyon. The proven reserves of the field were 110 million barrels⁴²⁴; the potential income from extraction of this amount of oil was approximately US\$10 billion. The platform was owned by Transocean Ltd., the largest offshore drilling operator in the world. BP (formerly known as British Petroleum) leased the rig for exploration of the Macondo field. Halliburton Company, one of the world's largest oilfields services companies, was engaged as the cementing contractor.

On April 20th, 2010 at 9:45 p.m. US Central Time, a blowout of oil, gas and concrete from the well occurred on the Deepwater Horizon platform, causing an explosion and a fire that sunk the platform. There were 126 crewmembers on the rig during the accident; 11 people perished and 17 were injured. The rest of the crew survived unharmed, but the accident led to oil being discharged from the well for 87 days—for a total of 3.19 million barrels.⁴²⁵ This was the third largest oil spill in the history of the oil industry, after the Kuwaiti oil fires in 1991 where the approximate discharge was 10 million barrels and the blowout at Lakeview Gusher Number One oil well in Kern County, California, which was out of control for nine months in 1910–1911 and led to the release of approximately 9 million barrels. BP was forced to cover all expenses incurred in shutting down the deepwater leak and

⁴²⁴Macondo: The Gulf Oil Disaster, Chief Counsel's Report, National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drill, Government Printing Office, 2011, p. 25.

⁴²⁵On January 15, 2015, a US federal judge ruled that BP spilled 3.19 million barrels of oil into the Gulf of Mexico during the 2010 Deepwater Horizon disaster. The US government has argued for 4.2 million and BP for 2.45 million. Six experts testified that as few as 2.4 millions barrels of oil, and as many as 6 million, escaped during the 86 day long accident. BP and the US government agreed that 810,000 barrels were captured. The importance of this ruling lies in the fine facing BP, calculated at US\$4300 per barrel. Source: http://scim.ag/_BPuling and News in brief, Science 347 (6220), p. 356 (2015).

in cleaning up the American part of the Gulf of Mexico coastline—an area where 14 million inhabitants reside—contaminated by spilled oil. In addition, they paid compensation to the fishing and coastal tourism industries in the area and a fine issued by the U.S. government. BP's total losses from the accident were estimated at US\$46 billion (US\$28 billion was spent on the accident and \$18 billion on additional government fines and penalties⁴²⁶) and by June 2010, BP's stock market value had fallen by US\$70 billion.⁴²⁷ Because of the disaster, the U.S. government suspended any deepwater offshore activity in the United States for 6 months. In the middle of June 2010, the President of the United States Barack Obama declared: “this oil spill is the worst environmental disaster America has ever faced”. More than 47,000 people and 7000 vessels⁴²⁸ took part in the response to the spill.

In January 2011, the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (hereafter the National Commission) stated in a report to the President of the United States that “*The explosive loss of the Macondo well could have been prevented. The immediate causes of the Macondo well blowout can be traced to a series of identifiable mistakes made by BP, Halliburton, and Transocean that reveal such systematic failures in risk management that they place in doubt the safety culture of the entire industry. Fundamental reform will be needed in both the structure of those in charge of regulatory oversight and their internal decision-making process to ensure their political autonomy, technical expertise, and their full consideration of environmental protection concerns*”.⁴²⁹



⁴²⁶Bradley Olson, Margaret Cronin Fisk, 'Worst Case' BP Ruling to Force Billions More in Payout, Bloomberg, Sep. 4, 2014.

⁴²⁷Steve Hargreaves, BP's \$70 billion whipping, CNN Money, June 2, 2010.

⁴²⁸Jonathan L. Ramseur, Curry L. Hagerty, Deepwater Horizon Oil Spill: Recent Activities and Ongoing Developments, Congressional Research Service, January 31, 2013, p. 2.

⁴²⁹National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. vii.

2.1.9.1 Risk Concealment Before the Disaster

Geological and Regulatory Contexts

In 1947, in Louisiana State, a first well was drilled by a fixed platform, which was located offshore, out of sight of land.⁴³⁰ After the 1973 oil crisis, which led to a dramatic increase in oil prices, oil companies intensified offshore drilling. In 1978, Shell Oil Company's Cognac production platform launched drilling at a depth of 1000 ft (304 m) underwater. In 2006, Chevron, Devon Energy and Statoil drilled the Jack 2 exploratory well, 7000 ft (2133 m) underwater,⁴³¹ reaching a total depth of 28,125 ft (8572 m). In 2009, BP, working from the Deepwater Horizon platform, discovered the gigantic Tiber Oil Field, with resources between 4 and 6 billion barrels of oil at a total depth of 35,056 ft (10,685 m) and under 4130 ft (1258 m) of water.⁴³² In 2011, 30 % of U.S. crude oil production was extracted from the Gulf of Mexico.⁴³³

In 1982, the Minerals Management Service (MMS) under the U.S. Department of the Interior was established to regulate such intensive offshore drilling. Due to the widespread idea that government oversight of private enterprise should be kept to a minimum, active lobbying from the industry and cuts in public funding, the budget of MMS dropped from US\$250 million in 1984 to less than US\$200 million in 2009 (representing less than \$100 million in 1984 dollar value due to inflation), even though oil companies progressed considerably in the development of deepwater drilling over this period.⁴³⁴ The regulator had no budget for hiring advanced specialists who understood innovations in the field, and MMS came to rely on the expertise of deepwater operators and contractors. Moreover, by 2009, the number of unannounced MMS inspections of offshore oil infrastructure reached a negligibly low level compared with the 1980s.⁴³⁵ The impotence of the US regulator led to a situation where innovations in the safety requirements for offshore drilling, which were widely implemented as compulsory measures in other countries after accidents, were left to the discretion of U.S. offshore drilling operators.⁴³⁶ For example, in Norway and in Brazil, all deepwater blowout preventers have an acoustics trigger for remote emergency shutdown of a well—these triggers cost over US\$0.5 million apiece—but in the USA the use of such devices

⁴³⁰Ibid, p. 23.

⁴³¹Chevron Announces Record Setting Well Test at Jack, Press Release, Chevron, San Ramon, Calif., Sep. 5, 2006.

⁴³²BP Announces Giant Oil Discovery In The Gulf Of Mexico, Press release, BP, Sep. 2, 2009.

⁴³³The U.S. Energy Information Administration, 2011.

⁴³⁴National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 73.

⁴³⁵Ibid, p. 75.

⁴³⁶Ibid, p. 72.

was optional.⁴³⁷ In addition, BP did not have a contingency plan for any emergencies arising while drilling the Macondo well, because such plans were not obligatory under U.S. deepwater drilling legislation.⁴³⁸

When BP filed the plans for the drilling of the Macondo exploratory well to MMS in 2009, the probability of an oil spill in this area was assessed as low (“*[it is] unlikely that an accidental surface or subsurface oil spill would occur from the proposed activities*”).⁴³⁹ This was despite the fact that, since 2001, according to U.S. officials, there had been 948 fires and explosions on offshore oil platforms in the Gulf of Mexico, many of which were associated with the drilling of exploratory wells, where the risk of blowouts was extreme.^{440,441} Moreover, the U.S. Department of the Interior exempted BP from a detailed evaluation of the environmental impact of the Macondo well after concluding that a massive oil spill was unlikely⁴⁴²—in spite of previous MMS study findings that 50 % of tested blowout preventers failed to cut through the pipe and halt the flow of oil during emergencies.^{443,444} In fact anonymous representatives of the Bureau of Ocean Energy Management, Regulation and Enforcement—the federal agency that regulates offshore drilling—had recognized “*that the designs of blowout preventers were not adequate and that new requirements were needed, along with tougher government inspections*”.⁴⁴⁵ After the accident, new BP CEO Robert Dudley said that BP had never anticipated such a tremendous spill: “*we’ve been drilling in the Gulf of Mexico, in the deep water for 20 years now. You just never see an accident like this*”.⁴⁴⁶ However, in 1979, there had been a blowout on the Mexican Ixtoc I oil rig in the south-western part of the Gulf of Mexico, which was unable to shut down for 10 months at a depth of just 50 m, and which resulted in 3 million barrels of oil being discharged.

⁴³⁷Tom Doggett, Timothy Gardner, U.S. mulls requiring remote shutoffs for oil rigs, Reuters, May 3, 2010.

⁴³⁸Vladimir Milov, Oversept the accident, Gazeta.RU, June 16, 2010, <http://www.gazeta.ru/column/milov/3385462.shtml>.

⁴³⁹Cain Burdeau, Holbrook Mohr, BP downplayed possibility of major oil spill, Associated Press, May 1, 2010.

⁴⁴⁰Vladimir Milov, Oversept the accident, Gazeta.RU, June 16, 2010, <http://www.gazeta.ru/column/milov/3385462.shtml>.

⁴⁴¹National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. ix.

⁴⁴²Juliet Eilperin, U.S. exempted BP’s Gulf of Mexico drilling from environmental impact study, Washington Post, May 5, 2010.

⁴⁴³Mini Shear Study, WEST Engineering Services, Study for U.S. Minerals Management Service, Requisition No. 2, 1011–1003, Dec. 2002, p. 13.

⁴⁴⁴Allan Chernoff, Blowout preventers—disasters waiting to happen? CNN, June 10, 2010.

⁴⁴⁵Clifford Krauss, Henry Fountain, Report on Oil Spill Pinpoints Failure of Blowout Preventer, The New York Times, Mar. 23, 2011.

⁴⁴⁶America Speaks to BP, Full Transcript: Bob Dudley Interview, Public Broadcasting Service (PBS), July 1, 2010, http://www.pbs.org/newshour/bb/environment-july-dec10-dudleyfull_07-01.

The Minerals Management Service (MMS) has also been accused of being corrupted by oil companies in return for money, sex favors and drug.⁴⁴⁷ After the disaster, MMS was dismantled and replaced by two separate organizations (Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE)).

Business Pressure and Miscommunications Between BP, Halliburton and Transocean

The platform started to drill the Macondo well in February 2010, aiming to finish the job in 51 days with a budget of US\$96.2 million.⁴⁴⁸ However, with drilling still incomplete following delays and over expenditure, BP managers urged the staff of Transocean and Halliburton to operate faster⁴⁴⁹ because BP expenses on leasing the platform exceeded US\$1 million a day: by the disaster date, the delay added to 43 days and BP were already more than US\$58 million over budget.⁴⁵⁰ Some BP engineers considered that *“this has been [a] nightmare well, which has everyone all over the place”*⁴⁵¹; nevertheless, by the middle of April 2010, the well was successfully drilled.

On the morning of the accident, the cementing engineer of Halliburton sent an e-mail to his colleague in Houston: *“We have completed the job and it went well”*⁴⁵² and a BP engineer informed onshore colleagues: *“just wanted to let everyone know the cement job went well. Pressures stayed low... The Halliburton cement team ... did a great job”*. The reply from BP executives was encouraging: *“Great job guys!”*⁴⁵³ The quality of the cement job is critical for the safe exploitation of deepwater wells: according to an MMS study, cementing was the single most significant factor in 18 of 39 well blowouts in the Gulf of Mexico over a 14-year period.⁴⁵⁴ To save money and time, BP managers had reduced the number of centralizers, which distribute cement evenly in a well, from 21 to 6. Transocean’s rig crew and several BP’s representatives were unaware that

⁴⁴⁷The Friday Podcast: Sex, Drugs and Regulation, NPR, June 11, 2010, <http://www.npr.org/blogs/money/2010/06/11/127772998/the-friday-podcast-sex-drugs-and-regulation>; Investigative Report “OIG Investigations of MMS Employees”, United States Department of the Interior, Office of Inspector General, Sept. 9, 2008, <https://www.doioig.gov/sites/doioig.gov/files/RIKInvestigation.pdf>.

⁴⁴⁸National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 2.

⁴⁴⁹Deepwater Horizon’s Blowout, Part 1, CBS, 60 Minutes, August 22, 2010, <http://www.cbsnews.com/video/watch/?id=6795538n>.

⁴⁵⁰National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 2.

⁴⁵¹Ibid, p. 2.

⁴⁵²Ibid, p. 102.

⁴⁵³Ibid, p. 4.

⁴⁵⁴Christina Ingersoll, Richard M. Locke, Cate Reavis, BP and the Deepwater Horizon Disaster of 2010, MIT Sloan School of Management, Apr. 3, 2012, p. 15.

Halliburton had run three laboratory tests of cement stability for the Macondo well between February and April 2010, all of which had failed.⁴⁵⁵ The BP team was relying on the good quality of Halliburton's cement to compensate for previous BP cost-reduction measures: BP managers even canceled the final acoustic test of the cement job on the morning of the disaster day, thinking that they had saved \$128,000 in doing so.⁴⁵⁶

After the disaster, the National Commission found out that managers of Halliburton *“did not comment on the evidence of the cement slurry’s instability, and there is no evidence that BP examined the foam stability data in the report at all... Documents identified after the blowout reveal that Halliburton personnel had also conducted another foam stability test earlier in February. The earlier test had been conducted under slightly different conditions than the later one and had failed more severely. It appears that Halliburton never reported the results of the earlier February test to BP... Halliburton conducted another round of tests in mid-April, just before pumping the final cement job. By then, the BP team had given Halliburton more accurate information about the temperatures and pressures at the bottom of the Macondo well, and Halliburton had progressed further with its cementing plan. Using this information, the laboratory personnel conducted several tests, including a foam stability test, starting on approximately April 13. The first test Halliburton conducted showed once again that the cement slurry would be unstable. The Commission does not believe that Halliburton ever reported this information to BP... It appears that Halliburton personnel responded instead by modifying the test conditions – specifically, the pre-testing conditioning time – and thereby achieving an arguably successful test result... In fact, it appears that Halliburton did not even have testing results in its possession showing the Macondo slurry was stable until after the job had been pumped. It is difficult to imagine a clearer failure of management or communication... BP’s fundamental mistake was its failure – notwithstanding the inherent uncertainty of cementing and the many specific risk factors surrounding the cement job at Macondo – to exercise special caution before relying on the primary cement as a barrier to hydrocarbon flow... BP, Transocean, and Halliburton failed to communicate adequately. Information appears to have been excessively compartmentalized at Macondo as a result of poor communication. BP did not share important information with its contractors, or sometimes internally even with members of its own team. Contractors did not share important information with BP or each other. As a result, individuals often found themselves making critical decisions without a full appreciation for the context in which they were being made (or even without recognition that the decisions were critical)”*.⁴⁵⁷

A year after the disaster, in April 2011, BP filed a lawsuit against Halliburton accusing it to have intentionally destroyed the evidence related to Halliburton's

⁴⁵⁵National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, pp. 117, 123, 224.

⁴⁵⁶Ibid, p. 4.

⁴⁵⁷National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 123.

non privileged cement testing, in part because it wanted to eliminate any risk that this evidence would be used against it in any trial that would attempt to determine the adequacy of Halliburton's cement job on the Macondo well. In return, Halliburton blame BP for reducing the number of centralisers, a course of action that allowed hydrocarbons to escape through channels that formed in the cement liner.⁴⁵⁸ In 2013, in its coverage of the trial, Dow Jones Newswires published the following statement: "*Halliburton had concealed and failed to disclose evidence 'as part of an effort by upper management to ratify and conceal Halliburton's pre-blowout callous disregard for safety'*".⁴⁵⁹ Moreover, during the trial, former Halliburton lab manager testified "*that a company official asked him not to record the results of a cement stability test related to BP's blown out Macondo well*". This allowed BP to declare: "*Plaintiffs respectfully submit that Halliburton willfully and intentionally concealed and/or otherwise failed to preserve and/or timely produce and disclose material evidence and/or potentially relevant evidence to the parties and to the court in advance of trial... The cumulative effect of Halliburton's pattern of destruction and spoliation of evidence has been to deprive the court and the parties of significant post-incident evidence relevant to the inherent quality and performance of the cement Halliburton provided for the job at the Macondo well, and the role of that Halliburton slurry design as a cause of the events of April 20, 2010*".⁴⁶⁰ Tommy Roth, Halliburton vice president, noticed that "*these tests weren't authorized and he didn't know about them*" and that he was aware "*in April 2011 that a Halliburton employee had conducted unauthorized tests and in 2012 that the results were discarded*".⁴⁶¹

After the cement job on the morning of April 20, 2010, the staff of the platform made several tests of the well's integrity (positive- and negative-pressure tests). The positive-pressure test passed successfully, but the negative-pressure test showed contradictory information. Operators interpreted this data as the "*bladder effect*" and concluded that the negative-pressure test was successful.⁴⁶² "*Many BP and Halliburton employees were aware of the difficulty of the primary cement job. But those issues were for the most part not communicated to the rig crew that conducted the negative-pressure test and monitored the well*".⁴⁶³ So nobody from the rig crew immediately informed decision makers, either on the platform or at onshore headquarters, about the apparently contradictory condition of the well. On being questioned by a Transocean executive "*You got everything under control*

⁴⁵⁸BP accuses Halliburton of hiding evidence, Al Jazeera, Dec. 6, 2011.

⁴⁵⁹Alison Sider, BP Asks Court to Sanction Halliburton in Deepwater Horizon Trial, Dow Jones Newswires, Mar. 22, 2013.

⁴⁶⁰Harry R. Weber, Plaintiffs: Halliburton's reckless behavior marring Gulf spill trial, Fuelfix, Mar. 21, 2013.

⁴⁶¹Allen Johnson Jr., Margaret Cronin Fisk Halliburton, Official 'Surprised' by Unauthorized Tests, Bloomberg News, Mar. 12, 2013.

⁴⁶²Ibid, pp. 6, 107.

⁴⁶³Ibid, p. 123.

here?” the drilling master said “Yes, sir”; to the question “How did your negative test go?” a rig crew member answered “It went good”.⁴⁶⁴ For everybody on the platform, the blowout that followed was unexpected. For a number of technical reasons, the blowout preventer on the Macondo well failed to cut the pipe, and a flow of oil and gas began to surge from the well.

BP managers arrived on the day of the disaster to celebrate the safety award earned by Transocean for the previous year and all staff members were eager to party. The staff did not wait long enough for the cement to dry and they did not see the blowout coming through a series of faults due to the haste to finish the well. They died for it.

The National Commission stated that “each of the mistakes made on the rig and onshore by industry and government increased the risk of a well blowout ... the cumulative risk that resulted from these decisions and actions was both unreasonably large and avoidable”.⁴⁶⁵

Lack of Learning from Earlier Disasters

It is remarkable that, in 1988, two decades before this disaster, the Piper Alpha offshore platform in the North Sea was destroyed because of failure of communication as well as blatant disrespect for safety rules.⁴⁶⁶ In this case, the problem that led to the explosion arose between two repair shifts operating within the existing “permit-to-work system”, when the second team was not informed that the first had removed a pressure safety valve for routine maintenance.⁴⁶⁷ This absence of information about a minor maintenance process had major consequences, when the unwittingly dangerous actions of the second shift caused a leakage of condensate—which exploded, causing a massive fire in which 167 crew members perished. Dr. M. Elisabeth Paté-Cornell, in a discussion of the lessons to be learnt from the Piper Alpha disaster in 1993, wrote: “The culture of any industry that discourages internal disclosure and communication of bad news leads to ignoring small incidents and near-misses as long as they do not result in full-scale accidents. In such an environment, the fact that a severe accident did not occur seems to be sufficient proof that the system works and that ‘an inch is as good as a mile’. The possibility that several minor problems could occur at the same time does not seem to be considered. Consequently, small, isolated incidents are seldom

⁴⁶⁴Ibid, pp. 5–7.

⁴⁶⁵Ibid, p. 115.

⁴⁶⁶Months before the explosion, Jean Laherrère, then assistant to the VP E&P of Total, visited the Piper Alpha platform and discovered that all safety rules were ignored in the production process. But on the day following the explosion, a manager of the UK department of Trade and Industry announced in the media that all safety rules had been respected! (private communication, Dec. 18, 2014).

⁴⁶⁷M. Elisabeth Paté-Cornell, Learning from the Piper Alpha Accident: A Postmortem Analysis of Technical and Organizational Factors, Risk Analysis, 1993, 13(2), 226.

discussed openly since they would constitute a black mark for the personnel involved. Therefore, the same problems are likely to recur elsewhere. In fact, even when an accident does occur, appropriate measures to avoid its recurrence are not necessarily taken. The permit-to-work system, for example, had failed before, in particular on Piper Alpha in 1987, when a worker was killed... The accident was the result of a breakdown of communications in the permit-to-work system and an error in the shift handovers. In spite of memos and warnings to other [offshore installation managers], the lesson was not learned on Piper Alpha itself.⁴⁶⁸ After the explosion, the safety rules were updated, showing that they were previously insufficient and inadequately enforced. In their turn, BP, Transocean and Halliburton also failed to learn the serious lesson of Piper Alpha.

2.1.9.2 Risk Concealment After the Disaster

Over 87 days, the wellhead discharged a total of 4.9 million barrels of oil; on April 22, the daily discharge was 62,200 barrels and on July 14 it was still 52,700 barrels.⁴⁶⁹ However, in the first few days, BP and the U.S. Coast Guard hesitated in concluding that there was an oil leakage: they assumed that the blowout preventer had shut down the well properly and that the oil slick consisted predominantly of 700,000 gallons⁴⁷⁰ of diesel fuel from the sunken platform.⁴⁷¹ Coast Guard Admiral Mary Landry told correspondents “*We are only seeing minor sheening on the water... We do not see a major spill emanating from this incident*”.⁴⁷² After remotely operated submarines dived to the wellhead, could not manually stop the blowout preventer and found oil leaking from the end of the riser, BP declared a leakage of 1000 barrels per day⁴⁷³—2 % of the real discharge. Later, the U.S. Coast Guard and the National Oceanic and Atmospheric Administration estimated the leakage at between 5000 and 8000 barrels per day^{474,475}—still just 10–15 %

⁴⁶⁸Ibid, p. 231.

⁴⁶⁹National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 167.

⁴⁷⁰To put in perspective, a barrel of oil is equivalent to 42 US gallons or 159 liters and a US gallon is 3.79 liters; thus, the 700,000 gallons of diesel fuel amounted to approximately 16700 barrels, a very small quantity compared to the total spill.

⁴⁷¹National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 130.

⁴⁷²Ibid, p. 130.

⁴⁷³Oil rig wreck leaks into Gulf of Mexico, Associated Press, Apr. 24, 2010.

⁴⁷⁴National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 133.

⁴⁷⁵Congressional Republicans seize on oil spill crisis to attack Obama, Michael D. Shear, Washington Post, June 4, 2010.

the actual discharge from the well—and these estimates became official during the following four weeks.⁴⁷⁶ Ultimately, in the first few days—the most important time in any crisis—this underestimation of the seriousness of the spill affected not only public perception, but also the response inside the crisis team, which led to a delay in preventive measures for oil dispersion and collection far away from the coastline. For example, Louisiana State declared a state of emergency only on the ninth day after the accident. Surprisingly, American oil-spill removal organizations were not able to supply enough containment booms for such a large oil spill. After the well was finally capped, the federal government released a report entitled “*BP Deepwater Horizon Oil Budget: What Happened to the Oil?*” in which they assumed that 75 % of the spilled oil was “gone”.⁴⁷⁷ However, the public and the media were skeptical about these estimates: “*From the start of the disaster, the government has badly underestimated the amount of oil spewing from the runaway well. That poor track record makes people understandably skeptical of [the Oil Budget] report*”.⁴⁷⁸

The Center for Public Integrity revealed that, in the hours after the Deepwater Horizon oil rig caught on fire, the US Coast Guard failed to follow its own internal firefighting procedures.⁴⁷⁹ They did not call for an expert to assist them and poured 6000 tons of salt water per hour on the rig to attempt to extinguish the fire, while it is well known that fires involving hydrocarbon fuels should be quenched with foam and not water. As a consequence, the ballasts of the platform were filled with water causing it to sink and, dramatically, the riser pipe to rupture. And the riser pipe did not start leaking until after the rig sank. According to Jean Laherrère, a retired geologist and oil engineer from Total who is known for his work on risk management of the oil industry, the lack of competence and communication concerning fires of hydrocarbon substances led to the wrong decision with horrendous consequences.⁴⁸⁰ From a technical point of view, letting the fires burn (until extinction with the right foam⁴⁸¹) and keeping the platform afloat would have avoided the marine pollution and would have allowed to shut off and secure the riser. Could it have been that some decision makers found more appealing to sink a very visible and inconvenient blaze from the media and public? Moreover, the discussion of the U.S. Coast Guard actions would have been also problematic, given the political and public will to pass on the blame to BP, Transocean, and Halliburton, with good reasons.

⁴⁷⁶Flow Rate Group Provides Preliminary Best Estimate Of Oil Flowing from BP Oil Well, Press Release, U.S. Department of the Interior, May 27, 2010.

⁴⁷⁷National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Report to the President, Jan. 2011, p. 167.

⁴⁷⁸Ibid, p. 169.

⁴⁷⁹Matthew McDermott, Improper Coast Guard Firefighting Responsible For Sinking Deepwater Horizon? Maybe, New York, NY, July 28, 2010 (<http://assirou.net/?p=1905>).

⁴⁸⁰Jean Laherrère, private communication, Dec. 18, 2014.

⁴⁸¹Fire fighting foam, http://en.wikipedia.org/wiki/Fire_fighting_foam.

Deepwater Horizon Oil Spill: Why Risks Were Concealed

- **Habituation/wishful thinking/false reassurance/self-deception** among representatives of the Minerals Management Service, BP, Halliburton Company, and Transocean Ltd. in assuming **that a massive well blowout on American deepwater oil fields was unlikely.**
- The **nationalistic arrogance of American regulators and oil companies:** they ignored international experience of previous disasters on deepwater drilling platforms, and assumed that they could neglect advanced oil drilling requirements because the Americans were pioneers in deepwater oil drilling and had the most skilled staff.
- **Deliberate lobbying by the American oil industry to persuade government to deregulate the sector and massively reduce the budget of the regulators:** unattractive wages, lack of skilled staff, inadequately qualified government officers, and so on. This led to a situation where regulators began to rely on information concerning new technologies from, and on the experience of, oil companies and their contractors, the very entities they were supposed to independently assess and regulate; as a result, **regulators failed to identify systemic failures in risk management, which the industry was trying to hide from regulators and the public.**
- **Fragmentary risk perception (failure to see the whole picture of risks) and lack of communication among representatives of the different organizations** working on the project about the real risks involved.
- **Rush during drilling because of delays in the schedule and cost overrun,** which encouraged those involved to ignore warnings and conceal information from other participants about defects during the cementing job in order to save time and money.

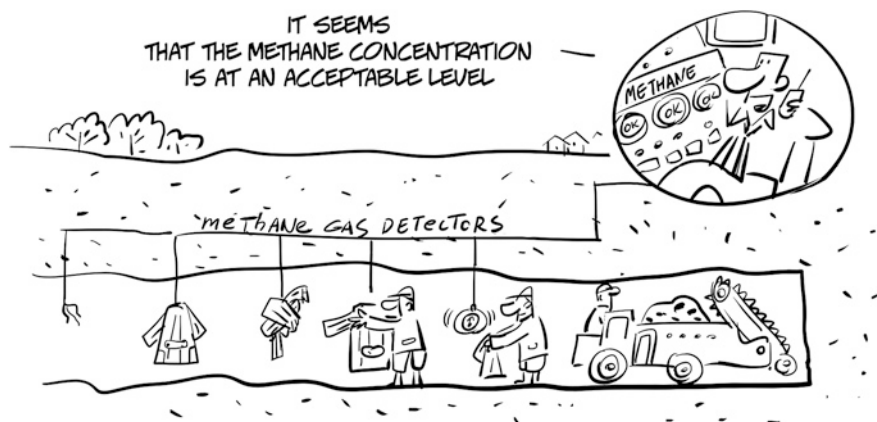
2.1.10 Rospadskaya Coal Mine Burnout (Russia, 2010)

In 2006, the Rospadskaya coal mine together with other mines managed by the open joint stock company (OJS) “Rospadskaya” had 781 million tons of coal reserves, but only 22 million tons were extracted by 2008.⁴⁸² The company still had more than 750 million tons of coal reserves—assets that could lead to substantial profits for their owners for decades to come. The coal company was very profitable: in 2009, its profitability was an incredible 51 %, while Gazprom, the Russian natural gas giant, exhibited a profitability of 36 %, and Lukoil, the largest Russian private oil company, of only around 17 %.⁴⁸³

⁴⁸²“Rospadskaya” is a leader of the coal industry in Russia, Mining Magazine, Mar. 2008, p. 4.

⁴⁸³Natalia Telegina, Victor Dyatlikovich, Why mines explode, Russian Reporter, May 20, 2010, № 19 (147).

The Rospadskaya coal mine itself was the largest underground mine in Russia with reserves of 450 million tons of coking coal: the mine produced up to 20 % of the coking coal in Russia and was among the top ten coking coal producers in the world. It was located in the Kuznetsk coal basin (Kuzbass) in the southern part of Western Siberia. On the night of 8 to 9 May 2010, two blowouts occurred at the mine. As a result, 91 people were killed and 94 injured. The blowouts ignited a huge underground fire, which continued to burn for years, destroying 300 km of coal roadways and making it one of the worst in the history of coal mining worldwide.



2.1.10.1 Risk Concealment Before the Disaster

Flawed Regulation of Coalfield Exploitation with High Concentrations of Methane

Kuzbass produces 56 % of Russia's coal and about 80 % of the coking coal for ferrous metallurgy.⁴⁸⁴ The coal beds of Kuzbass contain high concentrations of methane, which has led to a tremendous number of methane-related blowouts since the Soviet industrialization of Siberia. The privatization of coal mining in Russia in the 1990s deteriorated the situation regarding production safety. Most of the current Russian underground coalmine projects were designed in the 1960s and 1970s, when the productivity of coal-plow machines was modest. During coal plowing in some Kuzbass mines, as much as 15–30 m³ of methane could be released for every ton of coal. Soviet designers calculated the requirements for methane-ventilation equipment in mines according to the capacity of the coal-plow machines at the time.

⁴⁸⁴The economic potential of the Kemerovo region, Administration of Kemerovo region, April 16, 2010, <http://www.ako.ru/Ekonomik/potens.asp?n=1>.

During the collapse of the Soviet Union and the privatization that followed in the 1990s, neither the Russian government nor the new private mine owners had the investment resources to make significant upgrades to the mines overall design; but the productivity of the modern coal-plow machines had dramatically increased since the 1970s. This led to a situation where the productivity of the mines increased manifold and the length of coal roadways expanded to hundreds of kilometers, but the capacity of ventilation systems for the timely elimination of methane and the anti-coal dust equipment in the mines did not keep pace. In addition, private owners did not have the resources to ensure preventive degassing of the methane from the belts prospective coal belts by the process of expensive drilling of special degassing wells to depths of up to 500 m: each well could cost up to \$1 million and hundreds of wells are required for each coalfield. Over a period of up to five years, these wells allow for the concentration of methane within a prospective coal belt to be seriously reduced.^{485,486} Such methods are used in the United States and Australia, where it is strictly prohibited to produce coal if a coal belt releases more than 9 m³ of methane per ton of coal.⁴⁸⁷ However the new Russian private owners, instead of investing in expensive methane venting equipment and a comprehensive system for degassing the coal roadways of prospective coal belts, usually preferred to pay compensations to the families of coal miners killed in methane blowouts—just US\$35,000 per death.⁴⁸⁸ Sergey Slastunov, a professor at the Russian mining university, commented on the situation: *“Nowadays, Russia has 50 mines, in which the concentration of methane has increased, but in our country, no one spends on degassing: this process takes at least three years. Therefore, the owners of the mines cannot wait – they need to quickly make a profit, and for them it is cheaper to bury the miners, rather than to wait a few years until the methane is eliminated”*.⁴⁸⁹

The government’s approach to overseeing the mining industry was based on the assumption that private owners would not violate safety procedures because of their own interest in the long-term productivity of mines, which would bring stable profitability and growing business capitalization value. However, experience showed that this assumption did not uphold in practice. Private owners focused only on short-term profitability instead of long-term benefits, as in many other cases involving various industries reported in this book. At the same time, accusations of extortion and corruption by some representatives of the state regulator in the coal industry led to the deregulation of government control. Any immediate

⁴⁸⁵Press-conference “How to prevent explosions in the mines? The opinions of scientists”, RIA Novosti, Moscow, May 13, 2010, http://ria.ru/press_video/20100513/233925199.html.

⁴⁸⁶The accident at the “Raspadskaya”—12 Weeks Later, Finmarket, July 28, 2010, <http://www.finmarket.ru/main/article/1596882>.

⁴⁸⁷Sergey Slastunov, Methane coal mine safety in Russia—key issues of the coal industry, Mining informational and analytical bulletin, Moscow, 2011, № 12.

⁴⁸⁸Tatiana Zyкова, Coal without the right to live. Rostehnadzor needs to regain the authority to halt unsafe mines without a trial, Rossiyskaya Gazeta, July 7, 2007.

⁴⁸⁹Dmitry Ivanov, Raspadskaya will not launch soon, Trud newspaper, May 26, 2010.

shutdown of mine production following a detected safety violation became quite a complex process for the regulator. As a result, the regulator could issue countless orders to mine managers, who would just ignore them with no serious impact on the profitability and functioning of the mines.⁴⁹⁰

During the decade before the accident, Rospadskaya mine was considered a leader in safe coal production in Russia. For example, in August 2002, the mine was selected for its exemplary safety record as a site for a field meeting of the State Council to discuss the problems of developing Russian coal mining; the meeting was attended by the President of Russia, ministers, and all the top executives of the Russian energy sector.⁴⁹¹ Nevertheless, after the accident, a very different picture of the working conditions at the mine emerged. In the 16 months before the accident, the regulator issued more than 1400 orders to eliminate safety violations at the mine, but the majority of them were ignored because the legislatively approved penalties were not enough of a deterrent. On four occasions, the regulator threatened to disqualify the mine director, but they could not act on their threats because there was no legal framework to back them up after the deregulation of state oversight.⁴⁹²

Deficient Remuneration System of Coalminers Promoting Information Distortion About the Real Level of Methane Concentration in the Mine

After the accident, workers at the mine revealed disgusting safety management practices that were informally introduced by the owners and the top management of the mine, and which could have led to the accident.⁴⁹³ For example, the owners and the management set up a remuneration system based on the coal production performance of each shift, so that there was a direct dependence between the volume of coal produced and the earnings of each miner. A comprehensive system for degassing the coal roadways had been installed in the mine; but the performance-related pay system motivated coalminers to illegally block the methane detectors—which indicated dangerous levels of methane in the air when the new highly productive coal-plow machines were in operation. The methane detectors would have otherwise automatically halted coal production on the whole roadway until

⁴⁹⁰Tatiana Zykova, Coal without the right to live. Rostekhnadzor needs to regain the authority to halt unsafe mines without a trial, *Rossiyskaya Gazeta*, July 7, 2007.

⁴⁹¹Speech of Vladimir Putin at Russian State Council on the development of the coal industry, The Kremlin, Aug. 29, 2002.

⁴⁹²Alexander Terentyeva, Andrei Kotov, Investigators want to prosecute former director of “Raspadskaya” coal mine, *Vedomosti*, May 18, 2010.

⁴⁹³Revelation by miners about the practice of blocking methane detectors reported by journalists of “Week with Marianne Maksimovskaya”, REN TV, May 15, 2010 and “Kvant” local TV channel of Keverovo region (May 10–16, 2010), <http://www.youtube.com/watch?v=0IHCvgnEWc>.

the air had been degasified. The blocking of the methane detectors thus ensured continuous coal production and maintained the coalminers income.⁴⁹⁴

This led to a situation where the degassing system recorded completely inaccurate data about the concentration of methane within the mine. Therefore during any criminal investigation, it would be hard to prove the direct guilt of managers, because they had not directly ordered workers to continue coal production in methane-saturated air. Because the system would not have recorded a high concentration of methane, it would appear that there had been no such high concentration during the hours before any accident, and that the blowout must either have had an unavoidable cause—such as a sudden unpredictable methane emission—or been the fault of the miners who had blocked the methane sensors. Therefore, the miners themselves were unofficially allowed to make decisions about their own productivity and income... as well as safety. Because Kuzbass has a high rate of unemployment, thousands of young, strong but poorly educated workers were glad to get a coalmine job with a salary exceeding the average income in the region; the owner of the Raspadskaya mine, at a meeting with its personnel before the accident, stated that *“if somebody does not like the job, he could leave the company and the management of the coal mine could easily hire cheap Chinese coal miners”*.⁴⁹⁵ As a result, the blocking of methane detectors became a widespread practice in many Kuzbass coalmines.

In 2007, there were two methane blowout accidents on the nearby Ul’yanovskaya and Yubileynaya mines, in which 149 coalminers perished. In both accidents, it was revealed that there had been extensive blocking of the methane detectors, leading to the accumulation of methane to dangerous concentrations. The owners and management of both mines had put in place a payroll scheme that unofficially forced coal miners to violate safety rules in order to increase the profitability of coal production.⁴⁹⁶ In the case of the Ul’yanovskaya mine, prosecutors found out in addition that management had corrupted representatives of the state safety regulator, who developed a strong loyalty to the managers so as to turn a blind eye to safety violations. In return, the coalminers even provided computers and office supplies to the regulator.⁴⁹⁷ After the accident at the Raspadskaya mine, investigators found out that, at the time of the disaster, 40 % of the methane detectors in the mine were inoperative: the seals on 150 out of 400 detectors had been

⁴⁹⁴Revelation by miners about the practice of blocking methane detectors reported by journalists of “Week with Marianne Maksimovskaya”, REN TV, May 15, 2010 and “Kvant” local TV channel of Keverovo region (May 10–16, 2010), <http://www.youtube.com/watch?v=0IIWCvgnEWc>.

⁴⁹⁵Revelation by miners about the practice of blocking methane detectors reported by journalists of “Week with Marianne Maksimovskaya”, REN TV, May 15, 2010 and “Kvant” local TV channel of Keverovo region (May 10–16, 2010), <http://www.youtube.com/watch?v=0IIWCvgnEWc>.

⁴⁹⁶The cause of methane gas explosions in “Ul’yanovskaya” and “Yubileynaya” mines was pursuit of profit, Rossiyskaya Gazeta, June 6, 2007.

⁴⁹⁷Natalia Telegina, Victor Dyatlikovich, Why mines explode, Russian Reporter, May 20, 2010, № 19 (147).

tampered with.⁴⁹⁸ This could also explain the massive fire, which continued for years after the accident burning out 300 km of coal roadways: over the years when methane detectors had been routinely blocked, neither management nor regulators nor coalminers had received any real data about the actual methane concentration in the air throughout the mine. After the accident, the owner of the coalmine admitted that he could not imagine that a disaster of such a tremendous scale could ever take place in reality.⁴⁹⁹

Ironically, the financial results of this economy based on biased incentives were devastating for the mine owners who had unofficially supported such dangerous practices.⁵⁰⁰ After the accident, restoration costs were estimated at US\$280 million, on top of the losses of the burned-out coal.⁵⁰¹ Six months after the accident, the market value of OJS “Raspadsкая”, which had been the most lucrative coal company in Russia, had dropped by 59 % from US\$6 billion to US\$1.88 billion.⁵⁰² Total losses from the accident exceeded hundreds of times the profits resulting from implementing the remuneration system that had motivated miners to violate safety standards. The accident provoked social upheaval in the miners’ hometown, where 3000 participants of a post-accident meeting and hundreds of other workers clashed with the police. This attracted the attention of government executives and the accident site was visited by Prime Minister Vladimir Putin. The accident led to new regulations on coal mining in Russia, bringing, amongst other changes, a new legal framework for the payment of miners.

Criminal charges of responsibility for the accident were brought against the mine’s former director, his deputy, the managers of the coalmine plots and some mechanics at grassroots level. Unfortunately, for the majority of coal miners and residents of the Kuzbass region, the investigators could not find direct evidence that owners of the mine had given orders to miners to violate safety rules; some commentators attribute this to the close relations between Roman Abramovich, the Russian billionaire whose Evraz Holding company partly owns OJS “Raspadsкая”, and high-ranking Russian politicians.⁵⁰³

⁴⁹⁸The former head of “Raspadsкая” was forced to resign four times, ITAR-TASS, May 18, 2010.

⁴⁹⁹Press-conference “How to prevent explosions in the mines? The opinions of scientists”, RIA Novosti, May 13, 2010, http://ria.ru/press_video/20100513/233925199.html.

⁵⁰⁰Revelation by miners about the practice of blocking methane detectors reported by journalists of “Week with Marianne Maksimovskaya”, REN TV, May 15, 2010 and Kvant’ local TV channel of Keverovo region (May 10–16, 2010), <http://www.youtube.com/watch?v=0IIWCvgnEWc>.

⁵⁰¹Anatoly Dzhumaylo, “Raspadsкая” produced losses, Kommersant, Sep. 21, 2012.

⁵⁰²Olga Alekseyeva, “Raspadsкая” is not for sale, Gazeta.RU, Oct. 6, 2010, <http://www.gazeta.ru/business/2011/10/06/3792066.shtml>.

⁵⁰³“Get to the truth. How did tame miners in Mezhdurechensk and who will be responsible for the tragedy at the mine”, “Week with Marianna Maksimovskaya” Ren TV, May 22, 2010, <http://www.youtube.com/watch?v=JnD9HSG3XPM>.

Let us stress the remarkable similarity in all aspects between the Rospadskaya coal mine burnout disaster and the subprime financial crisis described in Sect. 2.2.3—in terms of incentives, the response of employees, the lack of culpability of management for designing an incentive structure that led directly to unethical or irresponsible behavior of employees, the emphasis on short-term profits over long-term benefits... and the fact that the ultimate disaster wiped out all previous gains.

Rospadskaya Coal Mine Burnout: Why Risks Were Concealed

- The owners and management focused on **short-term profitability instead of the long-term resilience of the coal mining business**. They created a sophisticated unofficial payroll scheme, which motivated coalminers to knowingly break safety rules. As a result, miners were potentially implicated in any possible methane blowout. This approach ensured that miners kept quiet about risky working practices.
- **Government oversight over Russian coalmining had been deregulated**, which allowed the management of the coalmine to violate safety rules with impunity.
- **Habituation/wishful thinking/overconfidence/self-suggestion/self-deception**: the owners and management of the mine totally underestimated the impact of a possible blowout of methane/coal-dust/air mixture during the intensive exploration of methane-saturated coal belts by powerful coal-plow machines, in parallel with the systematic desensitization of the methane detectors.

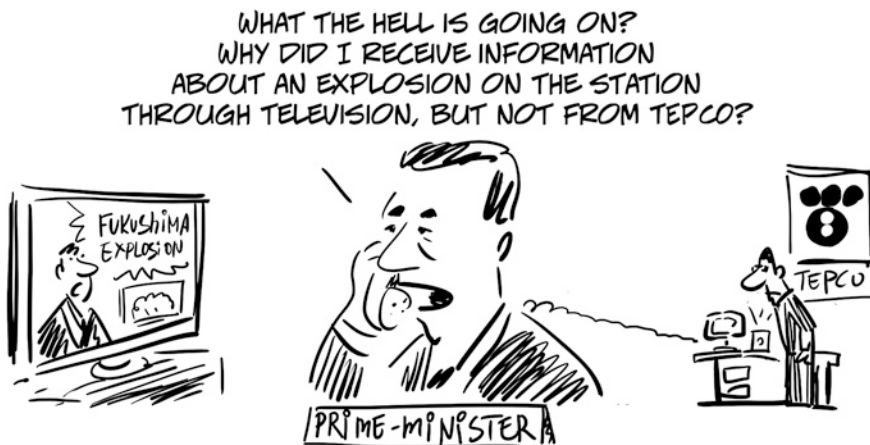
2.1.11 Fukushima-Daiichi Nuclear Disaster (Japan, 2011)

Nancy G. Leveson, Professor at MIT, on the widespread hindsight bias exhibited by experts during the analysis of causes of disasters:

After an incident: easy to see where people went wrong, what they should have done or avoided; easy to judge about missing a piece of information that turned out to be critical; easy to see what people should have seen or avoided [, but] almost impossible to go back and understand how world looked to somebody not having knowledge of outcome.

We need to mobilize “scientific imagination” in the process of decision

Hiroyuki Kameda (Lessons learned from the 2011 Great East Japan Earthquake, 2012)



Twenty-five years after Chernobyl, Japan repeated many of the mistakes of the Soviet nuclear industry during the Fukushima-Daiichi (Fukushima-1) nuclear disaster.

2.1.11.1 Summary of the Disaster

On March 11, 2011 at 2:46 p.m., a seaquake of magnitude 9.0–9.2 on the Richter scale occurred 70 km from the east coast of the Tohoku region in Japan. This was the largest earthquake ever recorded in Japan, and the United States Geological Survey considered that it was the fifth largest recorded worldwide since 1900.⁵⁰⁴ The earthquake generated a large-scale tsunami, which reached the coastlines of Iwate, Miyagi and Fukushima prefectures approximately 50 min after the main shock, destroying hundreds of kilometers of coastline infrastructure and killing more than 18,800 people.⁵⁰⁵

There were five NPPs located in the disaster zone on the east coast of Japan. Several were hit by the tsunami but, at the Fukushima-Daiichi plant owned by Tokyo Electric Power Co. (TEPCO), the largest electric utility in Japan, it led to a severe nuclear disaster—level 7, the highest level on the International Nuclear Event Scale. The plant had 6 reactors (Units 1–6) and large pools with spent nuclear fuel, but only Units 1–3 were operating when the seaquake occurred: Units 5 and 6 were shut down for routine inspection, and Unit 4 was on reconstruction. The emergency shutdown (SCRAM) system on all operating reactors was activated successfully after the main shock. The maximum ground acceleration at the

⁵⁰⁴Christina Nyquist, The March 11 Tohoku Earthquake, One Year Later. What Have We Learned? March 9, 2012, U.S. Geological Survey.

⁵⁰⁵Prof. Dr. Wolfgang Kröger, Fukushima: Need for Reappraisal of Nuclear Risks? ETH Zürich, Keynote SRA-Europe 21st Annual Conference, Zurich, June 18–20, 2012.

Fukushima-Daiichi plant was 550 Gal (550 cm/s),⁵⁰⁶ while the containment vessels were designed to retain functionality up to a seismic ground acceleration of 270 Gal and important buildings, structures, and equipment piping systems were designed to withstand 180 Gal.⁵⁰⁷ Although the ground acceleration of the seaquake was beyond design limits, Unit 1 only had a leakage of coolant.⁵⁰⁸ However, the plant lost all AC power sources because the earthquake had destroyed both external transmission lines and the Shin-Fukushima transformer station. DC power sources (diesel generators and batteries) generated electricity to cool the reactors for the next 51 min—until the tsunami reached the plant.⁵⁰⁹ The maximum designed height of the protective seawall of the NPP was 5.7 m.⁵¹⁰ Vulnerable objects like seawater pumps were located beyond the seawall—4 m above sea level; diesel-generators and batteries were inside the reactor buildings—10 m above sea level.⁵¹¹ But the tsunami waves generated by the Tohoku seaquake had built up to a height of 14–15.5 m by the time they hit the plant.⁵¹² As a result, Fukushima-Daiichi NPP lost all sources of electricity to cool the reactors of Units 1, 2 and the spent fuel pool of Unit 4; Unit 3 had battery power for about 30 h; emergency diesel engines provided emergency power only to Units 5 and 6. Damage to the reactor core – and the resulting meltdown of nuclear fuel—began on Unit 1 3 h and 15 min after the tsunami struck, on Unit 3 after 43 h and on Unit 2 after 76 h.⁵¹³ There were 257 tons of nuclear fuel in the three operational reactors—Units 1 and 2 were fuelled by low-enriched uranium (LEU) and Unit 3 was fuelled by mixed oxide (MOX) fuel that contained plutonium—and 264 tons of spent nuclear fuel in the pool of Unit 4 at time of the disaster.^{514,515}

⁵⁰⁶Prof. Dr. Wolfgang Kröger, Fukushima: Need for Reappraisal of Nuclear Risks? ETH Zürich, Keynote SRA-Europe 21st Annual Conference, Zurich, June 18–20, 2012.

⁵⁰⁷Fukushima Nuclear Accident Analysis Report, Tokyo Electric Power Company, Inc., June 20, 2012, pp. 8, 15.

⁵⁰⁸The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, pp. 17, 30.

⁵⁰⁹Ibid, p. 13.

⁵¹⁰Fact Finding Expert Mission of the Fukushima Dai-Ichi NPP Accident Following the Great East Japan Earthquake and Tsunami, IAEA mission report, 24 May–2 June 2011, p. 11.

⁵¹¹The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 14.

⁵¹²Akira Izumo, Facts, Lessons Learned and Nuclear Power Policy of Japan after the Accident, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan, January 24, 2012.

⁵¹³The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 13.

⁵¹⁴Overview of facility of Fukushima Daiichi Nuclear Power Station, TEPCO, http://www.tepco.co.jp/en/nu/fukushima-np/outline_f1/index-e.html.

⁵¹⁵The Status of Nuclear Fuel Stored at the Fukushima Daiichi and Fukushima Daini Nuclear Power Plants, Citizens' Nuclear Information Center (Japan), Jan. 31, 2013, http://www.cnipc.jp/english/newsletter/nit154/nit154articles/03_nf.html.

The accident resulted in the release of approximately 900–940 PBq of radioactive substances into the atmosphere,^{516,517} compared with the 5200 PBq estimated for the 1986 Chernobyl accident. Thus, the Japanese government reported to the International Atomic Energy Agency (IAEA) that the release was 1/6 of the emissions from the Chernobyl accident when converted to iodine. One hundred and fifty thousand residents were evacuated for a long time⁵¹⁸ because of radioactive contamination: 1800 km² of the Fukushima Prefecture have levels that would give a potential cumulative dose of 5 mSv/year or more.⁵¹⁹

2.1.11.2 Environmental and Economic Consequences of the Disaster

It is expected that more than 40 years will be needed to remove the melted nuclear fuel on the plant and to clean vast areas contaminated by radiation: the Japan Center for Economic Research estimates that the cleanup from the accident may require 20 trillion yen⁵²⁰ which is around US\$200 billion or 4.2 % of the Japanese GDP. Since the disaster, the plant has been contaminating 400 tons of water daily to cool the melted reactors and spent nuclear pools. In the two years since the disaster, 280,000 tons of contaminated water have been stored in tanks at the plant.⁵²¹ In April 2011, TEPCO—in violation of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter but with the approval of the Japanese government—dumped 11,000 tons of low-radioactive water into the Pacific Ocean.⁵²² According to the opinion of Juan Carlos Lentijo, leader of the International Atomic Energy Agency mission team, *“it will be nearly impossible to ensure the time for decommissioning such a complex facility in less than 30–40 years as it is currently established in the roadmap”*.⁵²³

After the accident, the Japanese government dramatically changed its position about the role of nuclear energy in the country’s energy balance, aiming to reduce its input from 35 % in the 2010s to zero by 2035. Before the accident, the country

⁵¹⁶The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 39.

⁵¹⁷Fukushima Accident, World Nuclear Association, updated 13 January 2014.

⁵¹⁸The evacuation map in the following official government site (<http://www.meti.go.jp/english/earthquake/nuclear/roadmap/pdf/141001MapOfAreas.pdf>) shows the most dangerous area called Area3, which is defined as follows: “Area3: Areas where it is expected that the residents have difficulties in returning for a long time”.

⁵¹⁹The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 38.

⁵²⁰The Fukushima Nuclear Accident and Crisis Management—Lessons for Japan-U.S. Alliance Cooperation, The Sasakawa Peace Foundation, Sep. 2012, p. 38.

⁵²¹Mari Yamaguchi, IAEA: Japan nuke cleanup may take more than 40 years, Associated Press, April 22, 2013.

⁵²²Eben Harrell, Fukushima: Dumping into the Sea, Time, April 05, 2011.

⁵²³Mari Yamaguchi, IAEA: Japan nuke cleanup may take more than 40 years, Associated Press, April 22, 2013.

had been planning to get more than 50 % of its energy from nuclear energy by 2030. In 2011–2012, Japan faced a serious shortage of electricity for industrial and domestic needs—by mid-May 2011, only 17 out of the remaining 50 reactors in the country were operating due to intensive safety inspections. From May until July 2012, all Japanese nuclear reactors were suspended. This led to additional spending of US\$40 billion on hydrocarbon fuel imports.⁵²⁴ The shutdown of Japan's entire nuclear fleet has had profound economic consequences for the country due to the US\$134 billion trade deficit in 2013 brought about by increased fossil fuel imports and lower productivity. Higher electricity prices and increased CO₂ emissions are also of concern. Together with on-going dire economic problems of the “two lost decades” following the bursts of the stock market and real-estate bubbles in Japan in 1990, this additional stress is catalyzing a reassessment of these political decisions. In June 2014, the three major business lobbies urged the Industry Minister to expedite restart of the nuclear reactors. “*The top priority in energy policy is a quick return to inexpensive and stable supplies of electricity*”, they said.⁵²⁵ There thus seems to be a rising political will to reinstall the nuclear industry as a major source of energy in Japan. For instance, in July 2014, Kyushu's Sendai nuclear power plant has been given draft approval to restart by Japan's Nuclear Regulation Authority (NRA), having met the greatly upgraded safety requirements published in July 2013. This is a major step towards actually returning to service, after Kyushu committed some US\$3 billion on post-Fukushima upgrades for its nuclear plants. So far, ten more PWRs (pressurized water reactors) are queued for approval by NRA, the reconstituted safety regulator, plus seven BWRs (boiling water reactors), which required more major upgrading and also need formal approval from local government.⁵²⁶

After the accident, the National Diet, Japan's legislative body, established the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) with the legal authority to request—and take action to obtain—any necessary documents or evidence required. During the investigation, the commission performed interviews with 1167 people and organized 900 h of hearings. The commission concluded that the “*accident at the Fukushima Daiichi Nuclear Power Plant cannot be regarded as a natural disaster. It was a profoundly manmade disaster – that could and should have been foreseen and prevented. The accident was clearly ‘manmade’. We believe that the root causes were the organizational and regulatory systems that supported faulty rationales for decisions and actions, rather than issues relating to the competency of any specific individual. We found an organization-driven mindset that prioritized benefits to the organization at the expense of the public*”.⁵²⁷

⁵²⁴Nuclear Power in Japan, World Nuclear Association, updated Feb. 2014.

⁵²⁵World Nuclear Association, weekly digest 11 and 18 July 2014.

⁵²⁶Ibid.

⁵²⁷The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 21.

2.1.11.3 Risk Concealment Before the Disaster

Common Interests of the Japanese Government and Private Corporations Towards the Development of the Civil Nuclear Industry in Japan

Japan began to develop civil nuclear energy in the mid 1960s. Nuclear energy has been a national strategic priority since the oil crisis in 1973 because of Japan's heavy dependence on imported fuel, which provided 84 % of its energy requirements in the 2010s.⁵²⁸ Before the accident, nuclear energy was both promoted and regulated by the Nuclear and Industrial Safety Agency (NISA), working under the authority of the Ministry of Economy, Trade & Industry (METI). There was a deep seated conflict of interests: the primary goal of NISA was to protect society from radiation threat but, at the same time, NISA focused on the energy independence of Japan—which meant supporting large low-cost electricity production from a large number of nuclear plants, and maintaining a stable financial climate for private operators of nuclear plants to enable the further development of nuclear energy. For decades, a cozy relationship developed between operators, regulators and academics, which led to a situation where *“the regulators and the operators prioritized the interests of their organizations over the public's safety, and decided that Japanese nuclear power plant reactor operations ‘will not be stopped’. Because the regulators and operators have consistently and loudly maintained that ‘the safety of nuclear power is guaranteed’, they had a mutual interest in averting the risk of existing reactors being shut down due to safety issues, or of lawsuits filed by anti-nuclear activists. They repeatedly avoided, compromised or postponed any course of action, and any regulation or finding that threatened the continued operation of nuclear reactors”*.⁵²⁹

Unlearned Lessons from Three Mile Island and Chernobyl Accidents

The Chernobyl disaster had little influence on Japanese nuclear safety measures because of the national perception of Japan's unique technical culture, which was assumed to be better able to avoid, or else endure, such catastrophes. In 1986, the country was at the peak of a three-decade long “Economic Miracle” and the Japanese felt *“great pride in its global reputation for excellence in engineering and technology”*.⁵³⁰ As a result, *“the regulators also had a negative attitude toward the importation of new advances in knowledge and technology from overseas... At a time when Japan's self-confidence was soaring, a tightly knit elite with enormous financial resources had diminishing regard for anything ‘not invented*

⁵²⁸Nuclear Power in Japan, World Nuclear Association, updated February 2014.

⁵²⁹The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 43.

⁵³⁰The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 9.

here”.^{531,532} They came to the conclusion that “*Japanese plants are safe, because we are Japanese*”.⁵³³ Leonid Bol’shov, head of the Russian Safety Institute of Atomic Energy Sciences, established after the Chernobyl accident, stated: “*we did not learn the lesson after the Three Mile Island accident and so we were faced with Chernobyl. After Chernobyl, we have learned the lessons, but it seems that the Japanese have not learned them and now they have been faced with Fukushima. In 1992, I went to Japan to various facilities, including nuclear power plants, where we were shown simulators for operators. We asked staff of the station: ‘Do operators simulate severe accidents?’ They replied to him: ‘No, we have a good station’. That is why we need to learn from the mistakes of others. A point of view, that abroad everything is bad and in my country everything is good, is very dangerous*”.⁵³⁴ The Japanese never believed that a beyond-design accident would ever happen, and they never prepared for one. In addition, according to Akihisa Shiozaki, an attorney who was instrumental in putting together the first independent, non-governmental investigation of the Fukushima nuclear disaster, the government and the industry were reluctant to consider worst-case scenarios because of Japan’s unique history: after World War II and the destruction of Nagasaki and Hiroshima by nuclear weapons, the Japanese population vehemently opposed all use of nuclear power in their country. Therefore, at the beginning of civil nuclear development in Japan, the government undertook a campaign to persuade people of “*the absolute safeness*” of nuclear power. “*Absolute safeness meaning that there was no risk that something could go wrong, no risk that a melt-down could happen. Well, that myth of absolute safeness developed over the years into a culture where it almost became a taboo to even talk about this... Discussing a worst-case scenario was feared because it might bring panic to the citizens. And therefore it was omitted from the regulatory discussions*”. Eric Feldman, a law professor at the University of Pennsylvania, considers that there were significant political and economic forces backing nuclear power, and that as a result, “*talking about worst-case scenarios was avoided not simply because it would scare people, but because such fear would mean that local communities would oppose the building of reactors, and without local support the reactors would not be built*”.⁵³⁵

Consequently, the government and the industry thought they did not need to implement serious safety improvements learnt from the experience of foreign nuclear accidents because Japanese stations were already designed for severe disasters like high-magnitude earthquakes. In 1991, this assumption led to a situation in which safety measures applied on Japanese nuclear stations became voluntary

⁵³¹Ibid, p. 16.

⁵³²Ibid, p. 9.

⁵³³Asmolov: Fukushima Disaster was Predictable, The Mainichi Daily News, 26 April 2011.

⁵³⁴“It could have been prevented,” Leonid Bol’shov, head of the Russian Safety Institute of Atomic Energy Sciences, about the differences between Fukushima and Chernobyl, Kommersant, 26 April 2011, № 73 (4614).

⁵³⁵Disasters, Rebuilding and Leadership—Tough Lessons from Japan and the U.S., The Wharton School, University of Pennsylvania, October 2013, p. 3.

and independent from the control of regulators: “*the accident management, including expedient and flexible measures that might be required under actual situations, shall be considered and implemented by the operators based on their ‘technical competency’ and ‘expertise’, but [it] shall not require authority to regulate the specific details of measures*”.⁵³⁶ After the accident, it was revealed that Japanese nuclear operators had ignored and/or delayed implementation of many IAEA recommendations and guidelines about safety measures generated by nuclear accidents elsewhere in the world.^{537,538,539} Moreover, reluctance to reveal the failure of Japanese nuclear plants to conform to international standards, and fears of the possible restructuring of the nuclear community in Japan, led to the decision by the Japanese nuclear regulator to decline overseas scientific assistance to Fukushima-Daiichi NPP.⁵⁴⁰ The NAIIC commission stated: “*this was a disaster ‘Made in Japan’... Its fundamental causes are to be found in the ingrained conventions of Japanese culture: our reflexive obedience; our reluctance to question authority; our devotion to ‘sticking with the program’; our groupism; and our insularity... This conceit [disregard for anything ‘not invented here’] was reinforced by the collective mindset of Japanese bureaucracy, by which the first duty of any individual bureaucrat is to defend the interests of his organization. Carried to an extreme, this led bureaucrats to put organizational interests ahead of their paramount duty to protect public safety. Only by grasping this mindset can one understand how Japan’s nuclear industry managed to avoid absorbing the critical lessons learned from Three Mile Island and Chernobyl; and how it became accepted practice to resist regulatory pressure and cover up small-scale accidents. It was this mindset that led to the disaster at the Fukushima Daiichi Nuclear Plant*”.⁵⁴¹

Concealment of Minor Incidents Was a Decade-Long Practice Within the Nuclear Industry

In 2002, the government of Japan launched an investigation into the widespread practice of falsifying routine safety inspection data at TEPCO NPPs because the

⁵³⁶The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 28.

⁵³⁷The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 75.

⁵³⁸The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 1. Was the accident preventable? July 5, 2012, pp. 53–57.

⁵³⁹James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, March 2012, p. 2.

⁵⁴⁰The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 80.

⁵⁴¹*Ibid.*, p. 80.

true data had been deleted. In the end, TEPCO confirmed 200 cases of data falsification between 1977 and 2002. Tsunehisa Katsumata, appointed as president of TEPCO after the falsification scandal, revealed “*serious cases of inappropriate conduct in which employees should have reported cracks in the shroud to the national government [and] failure to keep records of problems. The engineers involved were afraid that, if they notified the national government of the problem, they would have to shut down the plant for a longer period of time than planned. This fear resulted in a conservative mentality that led them to avoid reporting problems to the national government as long as they believed that safety was secured. Engineers, who were reluctant to report problems, therefore eventually came to believe that they would be allowed not to report faults if the faults did not pose an immediate threat to safety and, as a result, they went as far as to delete factual data and falsify inspection and repair records*”.⁵⁴² The same practice occurred within other nuclear operators—for instance, in 2007, Hokuriku Electric Power confessed to hiding a nuclear incident on Shika NPP in 1999.⁵⁴³ Nevertheless, according to research of James Acton and Mark Hibbs, “*the relationship between NISA and the Japanese government, on the one hand, and that between NISA and industry, on the other, was not fundamentally challenged*” after the falsification scandal.⁵⁴⁴

Tragic Underestimation of the Threat of High-Wave Tsunamis to TEPCO’s Nuclear Power Plants

In 2003, after the restart of nuclear plants that were suspended in the falsification scandal (the suspension and the restart cost TEPCO about US\$1.9 billion⁵⁴⁵), TEPCO “*implemented a company-wide program to reduce cost, including measures to curb maintenance expenditures*”.⁵⁴⁶ NISA helped operators to reduce costs on safety installations by allowing that “*actions should be taken autonomously by the operator*”. Moreover, “*Since 2006, the regulators and TEPCO were aware of the risk that a total outage of electricity at the Fukushima Daiichi plant might occur if a tsunami were to reach the level of the site... NISA knew that TEPCO had not prepared any measures to lessen or eliminate the risk, but failed to provide specific instructions to remedy the situation... NISA informed the operators that they did not need to consider a possible station blackout because the*

⁵⁴²Mr Katsumata Speech BGM 2003, Reconstruction after Misconduct—the Pursuit of Excellence, TEPCO, <http://www.tepco.co.jp/en/news/presen/pdf-1/0310-e.pdf>.

⁵⁴³Steve Stecklow, Nuclear Safety Reports Called Into Question, The Wall Street Journal, Aug. 3, 2007.

⁵⁴⁴James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, March 2012, p. 24.

⁵⁴⁵Nuclear Power in Japan, World Nuclear Association, updated Feb. 2014.

⁵⁴⁶2003 Annual Report, TEPCO, pp. 2, 19, <http://www.tepco.co.jp/en/corpinfo/ir/tool/annual/pdf/ar2003-e.pdf>.

*probability was small and other measures were in place. It then asked the operators to write a report that would give the appropriate rationale for why this consideration was unnecessary.”*⁵⁴⁷

An important reason why the regulators and TEPCO underestimated the risk of a high-wave tsunami was that the Japanese nuclear industry had focused so much on the possibility of earthquakes. They felt confident that they had made comprehensive calculations that guaranteed safety from beyond-design accidents. In the 1960s, when the Fukushima-Daiichi plant was designed by American companies General Electric (who designed the boiling water or BWR reactors) and EBASCO (who designed the plant), its foundations were at a height of 35 m above sea level on a bluff, but civil engineering staff of TEPCO lowered the bluff by 25 m in order to mitigate the threat posed by earthquakes and reduce the cost of running the seawater pumps.⁵⁴⁸ The maximum expected height of a tsunami wave near Fukushima-Daiichi NPP was only 3.1 m above sea level, based on 13 earthquake tsunami statistics dating from 1611. Among them, the 1960 Chilean Earthquake tsunami, at 3.122 m, was the largest tsunami to have hit the Fukushima coastline since 1611.⁵⁴⁹ Nevertheless, since 1498, there had been 12 tsunamis off the coast of Japan and the Russian Kuril Islands with maximum amplitudes of more than 10 m—half of which had maximum amplitudes over 20 m—generated by earthquakes with magnitudes between 7.4 and 9.2.⁵⁵⁰ In particular, the Jogan Jishin earthquake in AD 869 occurred near the Fukushima Daiich Nuclear power plant, and created the largest tsunami in this region until that of 2011. The Active Fault and Earthquake Research Center (AFERC) developed a detailed study the Jogan Jishin earthquake tsunami.⁵⁵¹ Based on the study,⁵⁵² Mr. Okamura, a researcher at AFERC, warned in 2010 the nuclear and industrial safety subcommittee, the seismic and structural design subcommittee, and the working group for “earthquake, tsunami and geological features, the ground”, that there was a possibility for a huge earthquake and tsunami near Fukushima. The meeting was held at the Ministry of Economy, Trade and Industry (METI) in June 24, 2010, and TEPCO officers were included as member of the working group. Mr. Okamura asked the officer of TEPCO (Mr. Nishimura) why the official report of the meeting did not

⁵⁴⁷The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 16.

⁵⁴⁸The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chap. 1. Was the accident preventable? July 5, 2012, p. 23.

⁵⁴⁹Ibid, p. 23.

⁵⁵⁰James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, March 2012, p. 12.

⁵⁵¹https://unit.aist.go.jp/actfault-eq/Tohoku/jogan_tsunami_e.html.

⁵⁵²Namegaya, Y., Satake K., and Yamaki, S. (2010). Numerical simulation of the AD 869 Jogan tsunami in Ishinomaki and Sendai plains and Ukedo river-mouth lowland, Annual Report on Active Fault and Paleoequake Researches, Geological Survey of Japan/AIST, No. 10, 1–21 (2010).

mention the Jogan Jishin earthquake and the associated risk of a huge tsunami. He called for a thorough investigation of the risk of unexpected tsunamis. In spite of Mr. Okamura's warning, TEPCO never prepared for the risk.⁵⁵³

The design of BWR reactors located on the ocean coastline of Japan came from American experience of reactors sited near rivers, which had never been intended to face sudden high-level waves or flash flooding. American engineers placed backup emergency diesel generators and DC batteries in turbine buildings around 4 m above sea level, and TEPCO agreed with this solution because nobody expected a tsunami wave of more than 3.1 m.⁵⁵⁴ NISA never objected to this solution because the regulator had focused for decades on earthquake-resistant solutions rather than dealing with any possible tsunami threat. NISA also preferred to fund academic grants on earthquake safety, thereby marginalizing tsunami safety.⁵⁵⁵ During the construction of the Fukushima-Daiichi NPP, Toshiba engineers wanted to improve on the General Electric design, but TEPCO blocked any major changes: *"TEPCO, conservative by nature, didn't allow the Japanese companies building the plant to make any alterations to GE's basic design... [TEPCO] told the Japanese makers to build the plants exactly in the same way as those of foreign makers... TEPCO was very bureaucratic"*.⁵⁵⁶ And once the Fukushima-Daiichi plant was operating, many engineers there were worried about the placement of the generators: *"If an earthquake hits and destroys some of the pipes above, water could come down and hit the generators. DC batteries were also located too close to the diesel generators. It's not at all good in terms of safety. Many of the middle-ranking engineers at the plant shared the same concern"*.⁵⁵⁷ In 2002, when the Japan Society of Civil Engineers issued a new tsunami assessment method for nuclear power plants, TEPCO raised the estimation of the maximum tsunami to which the Fukushima Daiichi Nuclear Power Plant could be exposed to 5.7 m and notified NISA. However, the company made only minor improvements, which did not affect the position of emergency generators and backup batteries.⁵⁵⁸

⁵⁵³The certified agenda of the METI meeting and extracts of the meeting (in Japanese) were communicated to us and translated by Professor Kaizoji and are available from the authors upon request.

⁵⁵⁴Reiji Yoshida, GE plan followed with inflexibility, The Japan Times, July 14, 2011.

⁵⁵⁵James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, Mar. 2012, p. 29.

⁵⁵⁶Reiji Yoshida, GE plan followed with inflexibility, The Japan Times, Jul 14, 2011.

⁵⁵⁷Ibid.

⁵⁵⁸The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chap. 1. Was the accident preventable? July 5, 2012, pp. 24–25.

Internal Risk Communication Failure

The risk of a potentially severe accident never appeared in TEPCO's list of risks. Any question about operating risks and nuclear safety was under the competence of the on-site plant department and would never have been raised at central risk management meetings.⁵⁵⁹ Masatoshi Toyota, a former senior vice president of TEPCO and one of the executives who oversaw the construction of the Fukushima plant, stated: *"I didn't know until March 11 that the diesel generators were placed in the turbine buildings. If I had known, I would have definitely changed that"*.⁵⁶⁰ The Japanese *"reluctance to question authority"* and their slow bureaucratic system, geared only to passing on good news, led to a situation when executives had little understanding of the real condition of their plants and were fully satisfied with reassuring reports from the stations. Moreover, the TEPCO corporate system *"tolerated or encouraged the practice of covering up problems"*⁵⁶¹ so that *"utilization of risk information was insufficient, and the risk of [a station blackout] was not widely recognized by the management"*.⁵⁶² The regulator required that *"nuclear reactor facilities shall be designed such that safe shutdown and proper cooling of the reactor after shutting down can be ensured in case of a short-term total AC power loss"*.⁵⁶³ However *"short-term"* blackout, for the majority of nuclear plants, meant just 30 min or less, because of the high-performance repair service of transmission lines in Japan after earthquakes. Nuclear executives *"fundamentally believed that, if we lost off-site power, we would be back up on the grid in no more than about half an hour"*.⁵⁶⁴ After the accident at the Fukushima-Daiichi plant, TEPCO Chairman Tsunehisa Katsumata said that the possibility of an unanticipated tsunami—resulting in a blackout lasting days rather than hours—had not been communicated internally to him when he was president of the company in 2008, because *"such [a] tsunami would not happen in reality"*.⁵⁶⁵

This assumption was clearly demonstrated by the complete lack of response from TEPCO management to a chain of great natural disasters and scientific warnings in the preceding few years. Thus, the company's engineers took no account of an incident on the French Blayais NPP in December 1999, when the extratropical storm Martin brought a combination of high tide and strong winds, flooding the

⁵⁵⁹The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 44.

⁵⁶⁰Reiji Yoshida, GE plan followed with inflexibility, The Japan Times, July 14, 2011.

⁵⁶¹James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, Mar. 2012, p. 28.

⁵⁶²Ibid, p. 27.

⁵⁶³Ibid, p. 28.

⁵⁶⁴Ibid, p. 28.

⁵⁶⁵The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 77.

plant and cutting its off-site power supply.⁵⁶⁶ In 2006, a group of junior employees at TEPCO, inspired by one of the consequences of the Indian Ocean tsunami in December 2004—which flooded seawater pumps at the Madras NPP in India⁵⁶⁷—estimated “*that if ... a 10 m tsunami occurred, there was a risk that the emergency seawater pump would cease to function and core damage could occur; and that if ... a 14 m tsunami occurred, there was a risk that electrical equipment would cease functioning as the building flooded, making it impossible to use the emergency diesel generator, external AC power supply, or DC power supply, thereby causing the loss of all power sources*”. The company shared this information with NISA.⁵⁶⁸ The group also asked for 25 million dollars to implement appropriate measures, but TEPCO executives said that the study session had been conducted as training for junior employees, and that the company did not really expect such a large tsunami.⁵⁶⁹

In February 2008, TEPCO engineers, following new simulations taking recent events and the longer historical perspective into account, stated that a tsunami wave between 9.3 and 15.7 m in height could hit Fukushima-Daiichi NPP. However Sakae Muto, Deputy General Manager of TEPCO’s Nuclear Power Plant Division in 2008, and others thought that no urgent action was required because such a tsunami was very unlikely.⁵⁷⁰ Therefore, they did not convey the results of the simulations to the president of TEPCO. During NAIIC commission hearings, Tsunehisa Katsumata, who was president of TEPCO between October 2002 and June 2008, confirmed that he had never received any information about the threat of a tsunami leading to a total blackout at a TEPCO station during his presidency.⁵⁷¹ “*Information [about tsunami risks] was stopped at [TEPCO] headquarters*”⁵⁷² because “*the majority view in the company was that no major tsunami was likely*”.⁵⁷³ In fact, TEPCO bureaucrats reported the results of the simulations to NISA only three years after the simulations, on March 7, 2011, four days before the disaster.⁵⁷⁴ It is remarkable that this risk was not revealed to NISA when the regulator was making the decision to issue a new ten-year license for the

⁵⁶⁶James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, March 2012, pp. 22–23.

⁵⁶⁷Ibid, p. 11.

⁵⁶⁸The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 1. Was the accident preventable? July 5, 2012, p. 26.

⁵⁶⁹Earthquake Report № 443, Japan Atomic Industrial Forum, Inc, Jun 14, 2012.

⁵⁷⁰The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 1. Was the accident preventable? July 5, 2012, p. 29.

⁵⁷¹Stream record of NAIIC/Jikocho 12th Commission Meeting, May 14, 2012 No. 1 <http://www.youtube.com/watch?v=BW4L-InZWg8> (1:25–1:33; 1:47–1:55; 2:00–2:04; 2:14–2:18).

⁵⁷²Ibid.

⁵⁷³TEPCO chairman blames politicians, colleagues for Fukushima response, The Asahi Shimbun, May 15, 2012.

⁵⁷⁴James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, March 2012, pp. 1, 12.

forty-year-old Unit 1 in February 2011, less than a month before the disaster.⁵⁷⁵ Unfortunately, it was only after the accident at the Fukushima-Daiichi plant that NISA ordered operators to reconstruct all seawalls around coastal NPPs with a minimum height of 15 m.⁵⁷⁶

External Risk Communication Failure

Ultimately, before the disaster, nobody from central government, the prefectural governments, or the local community was aware of the operating risks of the Fukushima-Daiichi NPP. Thus, Yuhei Sato, the governor of Fukushima Prefecture at the time of the accident, said that he did not know that the safety systems on the plant did not include anti-tsunami measures.⁵⁷⁷ And Katsutaka Idogawa, mayor of the nearby city of Futaba, said, *“Ever since I was appointed as the mayor, I kept expressing our concern about the nuclear power plant to TEPCO and NISA. They kept telling us there is no need to worry, that the plant is absolutely safe”*.⁵⁷⁸ People from the towns hosting nuclear power plants testified that *“there was no communication about potential issues that are out of human control”*. They always heard *“how safe the plants are”*.⁵⁷⁹

2.1.11.4 Risk Concealment After the Disaster

Repetition of the Mistakes Done During Chernobyl Accident in the Japanese Crisis Response Actions to the Nuclear Disaster

Just as in the aftermath of the Chernobyl accident, the insufficient or falsely reassuring information transmitted from the operators at Fukushima-Daiichi NPP to TEPCO headquarters and the authorities delayed crucial appropriate reactions from officials to the most serious challenge for Japan since the Second World War. Fact is that, at least 8 h after the tsunami, TEPCO headquarters still believed that *“Reactor (Unit 1) was shut down and nuclear steam is [being] cooled by the isolation condenser”* and spread this information to NISA, the government and the public.⁵⁸⁰ This message implied that the situation at the station was not too dangerous in the view of TEPCO executives, NISA and the government. The isolation

⁵⁷⁵Ibid, p. 16.

⁵⁷⁶Ibid, p. 18.

⁵⁷⁷The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 81.

⁵⁷⁸Ibid, p. 73.

⁵⁷⁹Ibid, p. 76.

⁵⁸⁰Plant Status of Fukushima Daiichi Nuclear Power Station (as of 0AM March 12th), TEPCO, Press Release, Mar 12, 2011, <http://www.tepco.co.jp/en/press/corp-com/release/11031203-e.html>.

condenser in Unit 1 was a passive non-electronic backup cooling system, which is located under BWR reactors to cool the stream from the reactor core and restore condensed water to the reactor by gravity. After the earthquake, this system had started up automatically, but the operators of Unit 1 soon recognized that the condenser was cooling the core too quickly and shut it down manually in order to protect the reactor from damage.⁵⁸¹ After the tsunami, when operators lost all information from all gauges, they could no longer evaluate the condition of the condenser. Moreover, communication between the on-site emergency control center and each control room was limited to a single wired telephone line.⁵⁸² In addition, it was impossible to walk anywhere on the site of the plant in the first few hours, because of debris caused by the tsunami.⁵⁸³ According to an investigation by Japanese public broadcasting corporation NHK, involving dozens of interviews with TEPCO staff⁵⁸⁴ over the previous 40 years, the isolation condenser had never been tested during safety checks—so nobody on the plant knew that, during correct functioning of the condenser, it should emit a loud sound and large amounts of redundant steam escape through holes in the wall of the reactor building. Due to the absence of data from instruments, and their own lack of technical knowledge, operators and management of the plant assumed that the isolation condenser was working properly, even though staff at the plant heard no noise and observed little or no steam flowing from holes in the wall of the reactor building.⁵⁸⁵ As a result, they conveyed incorrect information to their superiors. In reality, reactor core damage and the meltdown of nuclear fuel on Unit 1 set in just 3 h and 15 min after the tsunami hit. But it was only 21 h after the tsunami that TEPCO confirmed that the isolation condenser had not yet been used, remarking reassuringly that *“we are implementing a measure to reduce the pressure of the reactor containment vessels in order to fully secure safety. The reactor water level is decreasing, we will continue injecting water step by step”*.⁵⁸⁶ During the investigation, TEPCO officials declared that they had failed to respond promptly to the loss of cooling functions because they mistakenly believed that an emergency core cooling system was still functioning after the tsunami.⁵⁸⁷ They probably believed that the cooling function could be restored within that time frame. So they issued a

⁵⁸¹The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 2. Escalation of the accident, July 5, 2012, p. 8.

⁵⁸²James M. Acton, Mark Hibbs, Why Fukushima Was Preventable, Carnegie Endowment for International Peace, March 2012, p. 16.

⁵⁸³NAIIC/Jikocho 6th Commission Meeting 2012/3/14, <http://www.youtube.com/watch?v=4cEM6cvLm2s> (0:23–0:28).

⁵⁸⁴Meltdown. Oversights in the Reactor Cooling System, NHK Documentary, Yoshihiro Nemoto, Jun 11, 2013.

⁵⁸⁵The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 2. Escalation of the accident, July 5, 2012, pp. 78, 82–89.

⁵⁸⁶Plant Status of Fukushima Daiichi Nuclear Power Station (as of 1PM March 12th), TEPCO, Press Release, Mar 12, 2011, <http://www.tepco.co.jp/en/press/corp-com/release/11031219-e.html>.

⁵⁸⁷TEPCO officials unaware of cooling system shutdown, The Asahi Shimbun, December 19, 2011.

report to the Prime Minister's office (the Kantei) reassuring them: "*There will be no problem for eight hours even if no cooling [of the reactors] occurs*".⁵⁸⁸ Moreover, the Chairman of the Nuclear Safety Commission of Japan visited the Kantei several hours after the disaster and said that "[t]he situation is not one in which radiation is leaking to the outside atmosphere. While there are problems with the power source, the nuclear chain reaction has been completely stopped. The only thing left is to cool the reactors".⁵⁸⁹ In reality, with no cooling taking place, pressure inside the reactors of Unit 1 and Unit 3 reached twice the design limit between 8 and 11 h after the tsunami.⁵⁹⁰ The main threat of high pressure inside BWR reactors is the possibility of the containment vessel exploding, releasing huge quantities of radioactive materials—dozens to hundreds of times more than were emitted at Chernobyl.⁵⁹¹ US protocols on handling accidents at similar reactors call for venting before pressure exceeds the design limit.⁵⁹² According to the NAIIC commission report, "[t]he actual on-site situation of the vent in Unit 1 was not communicated to NISA or the Prime Minister's office [Kantei], which helped create an atmosphere of distrust between TEPCO's on-site management, the regulatory agencies and the Prime Minister's office".⁵⁹³ TEPCO was unwilling to vent, because they knew that venting radioactivity would cast doubt on the safety of the nuclear industry around the nation.⁵⁹⁴ Exposure to radiation is a very sensitive theme for the Japanese after the nuclear destruction of Hiroshima and Nagasaki. In addition, the staff of the plant would not easily be able to vent the reactors: without electricity for the air compressors, the manual opening of vent valves was a very laborious and time-sensitive task, which would require preventive evacuation of nearby residents due to radiation emissions.⁵⁹⁵ In the NAIIC hearing, Sakae Muto—executive vice president of TEPCO and general manager of the nuclear power plant division at the time of the disaster—confirmed that he was aware that TEPCO could not manage such a severe accident independently, but did not inform the Prime Minister of Japan or other authorities about TEPCO's

⁵⁸⁸WHAT WENT WRONG: Fukushima flashback a month after crisis started, The Asahi Shimbun, April 12, 2011.

⁵⁸⁹Ibid.

⁵⁹⁰The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 2. Escalation of the accident, July 5, 2012, pp. 20, 40.

⁵⁹¹NAIIC/Jikocho 16th Commission Mtg. 2012/5/28. www.youtube.com/watch?v=rj12H4zY7DE (0:49–0:50).

⁵⁹²Phred Dvorak, Reactor Team Let Pressure Soar, The Wall Street Journal, April 23, 2011.

⁵⁹³The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 33.

⁵⁹⁴Eric Talmadge, Mari Yamaguchi, How first 24 h shaped Japan's nuclear crisis, Associated Press, July 3, 2011.

⁵⁹⁵The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 2. Escalation of the accident, July 5, 2012, p. 21.

needs.⁵⁹⁶ Consequently, the Japanese government did not take emergency measures such as large-scale military helicopter assistance to transport diesel generators, air compressors, batteries, pumps, and so on to the site on the day of the disaster. Instead, the unhurried TEPCO tried to transport the needed staff by car, on roads disrupted by traffic jams! After the disaster, the Japanese military said that forces did not move in because they were not requested by TEPCO. Japan's Self-Defense Forces had personnel and equipment at the ready 15 miles away, but *"we have to wait for TEPCO to come to us and request help"*.⁵⁹⁷

Absence of Decisiveness in Taking Urgent and Costly Solutions

There was a lack of fresh water sources at the site for emergency reactor cooling. There was plenty of salt water from the ocean—but using salt water would render the reactors permanently inoperable, resulting in billions of dollars of assets being lost. Akira Omoto, a former TEPCO executive and a member of the Japan Atomic Energy Commission, confessed that *"[TEPCO] hesitated because it tried to protect its assets"*.⁵⁹⁸ Operators and management at the plant did not have the credentials to make this decision, and available TEPCO managers were reluctant to take responsibility for it because the President of TEPCO was out of Tokyo on a business trip and the Chairman was in China. According to the NAIIC commission *"The top three management members (the president, chairman, and vice president) were unavailable when the accident broke out. [The chairman] only found out that the president had been away after the accident happened. A lack of a sense of impending crisis was obvious from the fact that [the chairman] made no contact with the president after the president's return from abroad until his return to the head office... At the time of the accident, neither the Chairman nor the President of TEPCO were present or accessible, an inconceivable situation for an operator of nuclear power plants. The Chairman and the President also had different understandings of the emergency response structure, a fact that very likely contributed to the delay in TEPCO's response to the accident"*.⁵⁹⁹ But 24 h after the tsunami, a hydrogen explosion occurred on Unit 1, and the Prime Minister of Japan Naoto Kan intervened. The NAIIC commission described his influence: *"[Because] the situation deteriorated and the planned government accident response systems failed to function, control of the emergency response was taken by the Kantei, with Prime Minister Kan at the center of an ad hoc group of*

⁵⁹⁶Stream record of NAIIC/Jikocho 6th Commission Meeting, March 14, 2012, <http://www.youtube.com/watch?v=4cEM6cvLm2s> (1:18–1:20).

⁵⁹⁷Norihiko Shirouzu, Phred Dvorak, Yuka Hayashi, Andrew Morse, Bid to 'Protect Assets' Slowed Reactor Fight, The Wall Street Journal, March 19, 2011.

⁵⁹⁸Ibid.

⁵⁹⁹The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, pp. 77, 33.

politicians, advisors and the chairman of NISA. This group included people who were neither experts nor had an adequate understanding of the on-site situation".⁶⁰⁰ TEPCO finally began to pump seawater into Unit 1 reactor 29 h after the tsunami; and it was not until the third day after the tsunami that they started to use seawater for the other reactors.⁶⁰¹ At the time, Naoto Kan complained that TEPCO "has almost no sense of urgency whatsoever" and on the sixth day after the disaster, when the situation had reached the worst-case scenario—meltdown of three reactors and a fire in the spent nuclear fuel pool of Unit 4—the government shifted full responsibility for dealing with the situation from NISA and TEPCO to the military.⁶⁰²

Struggle Between Political Camps as a Major Obstacle to the Adequate Risk Information Transmission in Crisis Situation

TEPCO and NISA communicated only the most limited information to the government from the beginning of the disaster. The main reason for this was the complicated political environment inside Japan. Prime Minister Naoto Kan represented the Democratic Party of Japan (DPJ), which in 2009 defeated the Liberal Democratic Party (LDP); center-right conservatives had been in power from 1955 until 2009. The LDP was the main lobbying force for nuclear energy in Japan, had a close relationship with American Republicans and represented the interests of the Japanese elite and bureaucracy. Naoto Kan and the DPJ, on the other hand, had a center-left political position and aimed to "*overthrow the ancient régime locked in old thinking and vested interests, solve the problems at hand, and create a new, flexible, affluent society. We shall build a society governed with transparent, just, and fair rules*".⁶⁰³ DPJ politicians distrusted the United States⁶⁰⁴ and criticized the fact that the Japanese nuclear industry originated from the American nuclear industry. After the disaster, Naoto Kan tried to close down all the nuclear stations in Japan. It was only after elections in December 2012, when the LDP won back a majority, that the nuclear strategy of Japan was turned round again: the new Prime Minister Shinzo Abe declared the restart of existing NPPs and started a program to

⁶⁰⁰Ibid, p. 34.

⁶⁰¹The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Chapter 2. Escalation of the accident, July 5, 2012, pp. 21–22.

⁶⁰²Frustrated with TEPCO, Kan turns to SDF in nuclear crisis, The Mainichi Daily News, March 17, 2011.

⁶⁰³Our Basic Philosophy—Building a Free and Secure Society, The Democratic Party of Japan, April 1998, http://www.dpj.or.jp/english/about_us/philosophy.html.

⁶⁰⁴The Fukushima Nuclear Accident and Crisis Management—Lessons for Japan-U.S. Alliance Cooperation, The Sasakawa Peace Foundation, September 2012, p. 58.

build new ones.⁶⁰⁵ Obviously, in March of 2011, NISA and TEPCO executives—who had had a cozy relationship for decades and shared the old history of falsification and risk information concealment within the industry—represented the camp opposite to that of Naoto Kan. In the crisis, this led to mutual distrust. Thus, the NAIIC commission found out that *“TEPCO had been reporting to NISA, as was the standard protocol, that it was in the process of venting [on Unit 1]. But there is no confirmation that the venting decision was conveyed to senior members of METI, or to the Kantei. This failure of NISA’s function and the scarcity of information at TEPCO headquarters resulted in the Kantei losing faith in TEPCO”*.⁶⁰⁶ METI executive Banri Kaieda described the situation vividly: *“from immediately after the breakout of the accident, communicating and sharing information among the accident site, the Kantei, and TEPCO headquarters was like the telephone game ‘whispering down the lane’”*.⁶⁰⁷ During the NAIIC testimony, Naoto Kan stated that when he questioned them about the reasons for the delay with the venting process on the first day of the disaster, TEPCO answered: *“we do not know”*.⁶⁰⁸ Moreover, he remarked that TEPCO did not have the same technical background as General Electric, which designed the BWR reactors on Fukushima-Daiichi NPP, and questioned whether TEPCO staff fully understood their structure and technical pattern.⁶⁰⁹ Due to the absence of valid information from TEPCO executives and NISA, the Kantei *“participated in discussions of technical matters regarding the nuclear reactors. Prime Minister Kan asked for the mobile phone number of the head of the plant at Fukushima, leaving the top management of TEPCO out of the loop”*.⁶¹⁰ This mistrust reached its peak 15 h after the tsunami when Naoto Kan, dissatisfied with the lack of information about conditions at the plant and the venting process on Unit 1, flew by helicopter to Fukushima-Daiichi NPP in order *“to understand the situation, as he could not obtain any meaningful information from the members of NISA, the NSC, or the technical advisor from TEPCO”*.⁶¹¹ TEPCO also failed to inform him immediately when Unit 1 exploded 24 h after the tsunami—so the leader of Japan was informed about the explosion by TV news! In the ensuing telephone call with TEPCO executives, Prime Minister Kan exclaimed: *“What the hell is going on?”*, because nothing had been said to him for about an hour.⁶¹² Kenichi Shimomura, former deputy director

⁶⁰⁵Hiroko Tabuchi, Japan’s New Leader Endorses Nuclear Plants, The New York Times, December 30, 2012.

⁶⁰⁶The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 18.

⁶⁰⁷Ibid, pp. 78–79.

⁶⁰⁸Stream record of NAIIC/Jikocho 16th Commission Meeting, May 28, 2012, www.youtube.com/watch?v=rjl2H4zY7DE (0:26–0:29).

⁶⁰⁹Ibid (2:23–2:26).

⁶¹⁰The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 74.

⁶¹¹Ibid, p. 80.

⁶¹²Japan PM to nuclear power firm: “What the hell’s going on?”, Reuters, Mar 15, 2011.

general for public relations and chief spokesman of the Kantei, described the impossible situation in which Naoto Kan found himself: “*Being a leader without information... information about the nuclear crisis was a luxury we did not have in the prime minister’s office at the time*”.⁶¹³ Although TEPCO and the regulators “*had agreed on how to deal with the vent and the injection of seawater, the Kantei was unaware of this, and intervened, resulting in further disorder and confusion*”.⁶¹⁴ In its turn, TEPCO and NISA were also unaware of the details of discussions held among Kantei members, since Prime Minister Kan surrounded himself with numerous experts of his own, independent from them.⁶¹⁵ As a result, managerial decisions about the plant and the evacuation were discordant. In addition, both sides held press conferences and briefings separately. Ultimately, the Japanese public and the international community concluded that the authorities and the industry could not communicate, manage and take responsibility for such a challenging event, and this caused panic both inside Japan and worldwide.

Distortion of Information About the Condition of the Plant Led to Inadequate Governmental Crisis Response Measures

The lack of reliable information about the situation on the plant led to a chaotic organization by the Kantei of the evacuation of residents in areas neighboring the plant. There were further examples of risk information concealment. The Associated Press found and reported one case: “*Yukio Edano, the chief Cabinet spokesman, is the face of Japan’s government. At 7:45 p.m. [around four hours after the tsunami], his job was to make an unprecedented statement to the nation – but made it sound routine and reassuring. ‘We have declared a nuclear emergency,’ he said from behind a podium in the press conference room at the prime minister’s office. ‘Let me repeat that there is no radiation leak, nor will there be a leak’. He was wrong. Recently released TEPCO documents revealed that radiation was detected at the plant perimeter at 5:30 p.m. [two hours after the tsunami], but the utility apparently didn’t fax those readings to the government until shortly after 9 p.m.*”.⁶¹⁶

The NAIIC commission revealed that “*regarding the disclosure of an increase of reactor vessel pressure at Unit 2, TEPCO issued a press release about seawater injection at 23:00 on March 14, but made no disclosure about an increase in*

⁶¹³Disasters, Rebuilding and Leadership—Tough Lessons from Japan and the U.S., The Wharton School, University of Pennsylvania, October 2013, p. 4.

⁶¹⁴The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 34.

⁶¹⁵The Fukushima Nuclear Accident and Crisis Management—Lessons for Japan-U.S. Alliance Cooperation, The Sasakawa Peace Foundation, September 2012, p. 100.

⁶¹⁶Eric Talmadge, Mari Yamaguchi, How first 24 h shaped Japan’s nuclear crisis, Associated Press, July 3, 2011.

radiation dosage at the entrance of the plant that occurred between 19:00 and 21:00 on the same day. TEPCO also downplayed the severity of the situation in their disclosure regarding the critical problems in the suppression chamber of Unit 2; moreover, there was a significant delay between the time when TEPCO informed the Kantei and when it disclosed the information publicly. TEPCO noted that they did not inform the public of an increase in reactor vessel pressure at Unit 3, as of 8:00 on March 14, because NISA had banned the release. In fact, the Kantei had merely instructed TEPCO to inform them of the contents of releases when they were made. In obeying NISA's order to halt the release of this crucial information, TEPCO effectively prioritized its own interests and those of NISA over the greater good of the public and their right to be informed".⁶¹⁷ As a result, "the central government was not only slow in informing municipal governments about the nuclear power plant accident, but also failed to convey the severity of the accident. Due to the breakdown in communication from the central government in the post-accident time period, neither the Fukushima prefectural government nor the central government were aware of each other's actions: for example, the Fukushima prefectural government unilaterally ordered that residents within a two-kilometer radius of the plant be evacuated, based on prior emergency prevention training. This was followed 30 minutes later by the central government ordering the evacuation of residents within a three-kilometer radius. Similarly, the speed of information in the evacuation areas varied significantly depending on the distance from the plant. Residents were informed of the accident a few hours after it occurred, but they did not receive any information about the situation or the accident, or information that would be useful for their evacuation. Many residents had to flee with only the barest necessities and were forced to move multiple times or to areas with high radiation levels. There was great confusion over the evacuation, caused by prolonged shelter-in-place orders and voluntary evacuation orders. Some residents were evacuated to high dosage areas because radiation monitoring information was not provided".⁶¹⁸

The government also did not use data from the SPEEDI system (System for Prediction of Environment Emergency Dose Information), which had been designed in the 1980s to make forecasts of radiation dispersal, because "the information was incomplete": the earthquake and tsunami had injured some sensors near the plant. "Without knowing the strength of the releases, there was no way we could take responsibility if evacuations were ordered," said Keiji Miyamoto, who manages SPEEDI.⁶¹⁹ However, some experts consider that "officials there did not want to take responsibility for costly evacuations if their estimates were later called into question".⁶²⁰ On the sixth day after the disaster happened, the U.S.

⁶¹⁷The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 80.

⁶¹⁸Ibid, p. 19.

⁶¹⁹Norimitsu Onishi and Martin Fackler, Japan Held Nuclear Data, Leaving Evacuees in Peril, New York Times, August 8, 2011.

⁶²⁰Ibid.

State Department advised American citizens to evacuate from the area within a 50-mile (80-km) radius of the Fukushima Daiichi NPP,⁶²¹ but, at the same time, the Japanese government started to evacuate citizens from within a 20-km radius. TEPCO officially confirmed the meltdown of all three reactors only after 2 months when all rods inside the reactors were melted: the *“delay in confirming the meltdowns at Fukushima suggested the utility feared touching off a panic by disclosing the severity of the accident earlier”*.⁶²² Taken together, these events have provoked strong public anxiety and distrust of the Japanese nuclear industry and the government. During his testimony, Yuhei Sato (Governor of Fukushima Prefecture at the time of the accident) told the commission that *“the government failed to provide the necessary information at the time of the accident: ‘I still cannot trust the government’”*.⁶²³ This likely contributes to the fact that the majority of Japanese support the phasing out of nuclear power.⁶²⁴

Fukushima-Daiichi Nuclear Disaster: Why Risks Were Concealed

- The distinctive position of the nuclear industry within the Japanese economy and the **misplaced loyalty of regulators concerning shortcomings in the design and operation of Japanese NPPs**, which allowed plant operators to neglect basic safety rules and conceal the occurrence of many safety violations from regulators and the public with impunity.
- The **national arrogance of both executives and regulators in the Japanese nuclear industry**, who refused to learn from the experience of other countries that had faced nuclear accidents, or to implement IAEA’s recommendations and advanced safety requirements. The Japanese preferred to rely on their supposed technical superiority over the rest of the world. They assumed that falsifying data about minor equipment faults would never lead to catastrophic results and that the Japanese attitude toward work would always compensate for minor imperfections in reactor design during natural disasters.
- **Habituation/wishful thinking/overconfidence/self-suggestion/self-deception** among representatives of the Japanese nuclear industry concerning the low probability of a severe nuclear accident caused by a tsunami.

⁶²¹The Fukushima Nuclear Accident and Crisis Management—Lessons for Japan-U.S. Alliance Cooperation, The Sasakawa Peace Foundation, September 2012, p. 48.

⁶²²Shinichi Saoshiro, Tepco confirms meltdowns at 2 more Fukushima reactors, Reuters, May 24, 2011.

⁶²³The official report of The Fukushima Nuclear Accident Independent Investigation Commission, The National Diet of Japan, Executive summary, July 5, 2012, p. 77.

⁶²⁴Martin Adams, Powering ahead. Perspectives on Japan’s energy future, The Economist Intelligence Unit Limited, 2012, p. 4.

- TEPCO's focus on the **short-term profitability of operations and on ongoing cost reduction** provoked reluctance among executives to reveal the risks of NPPs—whether to IAEA specialists, representatives of local authorities or emergency services, investors or local residents—because this would entail additional expenses on advanced safety measures.
- The **specific national risk perception and organizational culture**: Japanese corporate mentality is based on unconditional submission of employees to their supervisors and does not approve of employees asking embarrassing questions. This makes the working environment uncomfortable for whistleblowers.
- The **absence of a prompt risk assessment system**, and the long chain of communication between field staff and senior management, made urgent decision-making difficult during the disaster: field staff had no authority for even minor on-site decisions during the development of the critical situation.
- The **political struggle** between the Democratic Party and the Liberal Democratic Party, which generated massive distortion of information about the real condition of the plant after the disaster. Both parties used the accident in their own political interests.
- Misleading comments from the Kantei, NISA and TEPCO about the accident during the first days after the disaster to the Japanese people and the international community were caused by the following factors: **lack of information and misjudgment about the real scale of the disaster** in the first days; the **absence of objective estimates of possible consequences of the disaster**; **fear of massive panic** in Japan and in nearby countries because nuclear accidents and radiation are the most dangerous threats in public perception; **reluctance to confess that regulation of the Japanese nuclear industry had been defective**, and that concealing the imperfections and risks of Japanese NPPs had been common practice for decades.

2.1.12 Other Cases of Risk Information Concealment

2.1.12.1 Minamata Mercury Poisoning (Japan, 1932–1968)

In 1956, in Minamata city in Japan, a strange epilepsy-like neurological disease was discovered among locals, as well as in their cats and dogs. They called the disease “*dancing cat fever*”. Initially, scientists thought that it was an infectious disease but, when they tested marine creatures on the coast nearby, they discovered extremely high levels of mercury contamination, which was determined as being caused by industrial wastewater discharge from the adjacent Chisso Corporation chemical factory. The factory used mercury sulfate as a catalyst

in the production of acetaldehyde, and had been discharging the compound into Minamata Bay for 25 years. And seafood from the bay had been the main diet of local residents and their domestic animals for decades.

Chisso Corporation knew about the potential damage to the health of locals and to the environment, but was reluctant to construct expensive wastewater treatment facilities. Moreover, the company continued to discharge mercury-contaminated waste after the cause of the disease had been confirmed. It lobbied to cut back pollution control regulation, and obstructed detailed investigation by scientists and the media. Ultimately, 2265 victims have been officially certified—1784 of whom died from the poisoning—and over 10,000 people have received financial compensation from the company, which paid out a total of more than US\$170 million.⁶²⁵

During the Fukushima-Daiichi nuclear disaster described above, many commentators compared the neglectful behavior of TEPCO with the actions of Chisso Corporation during the Minamata crisis. They concluded that, in the intervening 50 years, the Japanese industry had not changed in its willingness to risk the health, and even the lives, of local residents through its activities.^{626,627}

Minamata Mercury Poisoning: Why Risks Were Concealed

- Chisso Corporation prioritized **short-term profitability over the long-term resilience** of the chemical factory, or the protection of public health and the environment.

2.1.12.2 Asbestos Crisis (Worldwide, 1970s)

Asbestos became a very popular construction material at the end of the 19th and the beginning of the 20th centuries because of its resistance to fire, heat, electrical and chemical damage, and its sound absorption, average tensile strength, and affordability. The first evidence that asbestos fibers cause lung cancer and mesothelioma was discovered among asbestos miners, and had been scientifically proven by the 1930s to 1940s. Nowadays, the World Health Organization estimates that about 125 million people around the world are annually exposed to asbestos in the workplace, and about 100,000 workers die each year from an asbestos-related disease.⁶²⁸

⁶²⁵Minamata disease, Wikipedia, http://en.wikipedia.org/wiki/Minamata_disease.

⁶²⁶Christine L. Marran, Contamination: From Minamata to Fukushima, *Asia-Pacific Journal*, May 2011.

⁶²⁷Timothy S. George, Fukushima in Light of Minamata, *Asia-Pacific Journal*, Mar. 12, 2012.

⁶²⁸Mesothelioma & Asbestos Worldwide, <http://www.asbestos.com/mesothelioma/related-issues.php>.

In the United States, it took more than three decades for the government to impose strict regulations concerning the working conditions of employees dealing with asbestos. Regulations were finally developed as the consequence of a lawsuit during which specific documents were provided proving that industry officials knew of the dangers of asbestos and tried to conceal them from workers to avoid the costs of improving the safety conditions of workplaces. During an exemplary lawsuit, it was stated that “[t]he manufacturers put a lethal risk of harm in (the plaintiff’s) work environment, then allowed him unwittingly to confront the risk with tragic results, on a daily basis”.⁶²⁹ The asbestos industry had also been hiding health risks from customers, because of the fear of losing whole markets. After the risks were revealed, dozens of American firms had to file for bankruptcy due to asbestos liabilities—and with 600,000 claims from individuals so far, the total cost of asbestos compensation is estimated to be more than US\$200 billion.⁶³⁰ Nevertheless, China and India still consume large amounts of asbestos imported from Russia, Canada and Kazakhstan.⁶³¹

Asbestos Crisis: Why Risks Were Concealed

- The **priority of short-term profitability**, and the industry’s reluctance to confess the harmfulness of asbestos, thereby destroying the market and generating millions of lawsuits seeking compensation for health damage.

2.1.12.3 Savar Building Collapse (Bangladesh, 2013)

On 24 April 2013, in Savar in the Greater Dhaka Area of Bangladesh, 1127 workers at garment factories died when the Rana Plaza building collapsed on them. There are more than 5000 competing garment factories in Bangladesh, which provide cheap labor for the tailoring of many world-famous brands. The average monthly salary of a sewing machine operator is only US\$38, but the garment industry produces garments for up to US\$20 billion and provides Bangladesh with 77 % of its exports.^{632,633} The Rana Plaza was originally designed as a six-story building for shops and offices, but the owner of the plaza illegally constructed three additional floors using low-quality materials—and sited five garment factories there, deploying heavy machinery, which generated excessive vibrations.

⁶²⁹Bill Burke, Shipyards, a Crucible for Tragedy. Part 1: How the war created a monster, The Virginian-Pilot, May 6, 2001.

⁶³⁰Michelle J. White, Understanding the Asbestos Crisis, University of California, May 2003.

⁶³¹Mesothelioma & Asbestos Worldwide. <http://www.asbestos.com/mesothelioma/related-issues.php>.

⁶³²Victor Luckerson, Bangladesh Factory Collapse: Is There Blood on Your Shirt? TIME, May 2, 2013.

⁶³³Farid Ahmed, Death toll from Bangladesh building collapse climbs above 700. CNN, May 7, 2013.

The day before the collapse, local authorities discovered cracks in the building and issued an order to evacuate the whole building. The personnel on the lower floors with shops and a bank were not permitted to their workplaces until inspectors had confirmed the safety of the building; but managers of the garment factories insisted that their staff should go to work, otherwise they would all lose their monthly salary.⁶³⁴ Moreover, they misled the sewers by telling them that the building had been inspected and declared safe.⁶³⁵ The motives of the managers were simple: if operations were shut down, they would be fined by their customers—world-famous high street clothing brands—for delays with shipping, and could lose contracts in a highly competitive market. Two years earlier in 2011, Walmart and GAP had refused to sign a new industry agreement to pay Bangladeshi factories a higher price, so the garment industry could not afford safety upgrades on their sewing factories.⁶³⁶

Savar Building Collapse: Why Risks Were Concealed

- **Short-term profitability** in a highly competitive market took priority over the safety of personnel.
- The owners of the garment factories were **afraid of losing customers** in case of a prolonged time-out of the factory.

2.2 Financial Sector

Financial genius is a short memory in a rising trend

John Kenneth Galbraith

K Street has replaced the Invisible Hand of perfect competition with the Visible Fist of money and corruption

Dr. Woody Brock in American Gridlock

Over a protracted period of good times, capitalist economies tend to move from a financial structure dominated by hedge finance units to a structure in which there is a large weight to units engaged in speculative and Ponzi finance... The greater the weight of speculative and Ponzi finance, the smaller the overall margins of safety in the economy and the greater the fragility of the financial structure

Hyman Minsky, 1992

⁶³⁴Arun Devnath, Mehul Srivastava, 'Suddenly the Floor Wasn't There,' Factory Survivor Says. Bloomberg, 25 April 2013.

⁶³⁵Syed Zain Al-Mahmood, Rebecca Smithers, Matalan supplier among manufacturers in Bangladesh building collapse. The Guardian, 24 Apr. 2013.

⁶³⁶Arun Devnath, Mehul Srivastava, 'Suddenly the Floor Wasn't There,' Factory Survivor Says. Bloomberg, 25 Apr. 2013.

As Jeremy Grantham said when asked what investors would learn from this crisis:

“In the short term, a lot. In the medium term, a little. In the long term, nothing at all. That is the historical precedent”. Or as John Kenneth Galbraith put it, markets are characterized by “Extreme brevity of financial memory ... There can be few fields of human endeavor in which history counts for so little as in the world of finance”

2.2.1 Barings Bank Collapse (Singapore-UK, 1995)



In February 1995, Barings PLC—the oldest and the most reputable bank in Britain—collapsed from the unauthorized trading of Nick Leeson, a Singapore-based trader at the bank, who single-handedly lost about US\$1.4 billion (£827 million).

2.2.1.1 Risk Concealment Before the Disaster

During its 233-year history, Barings Bank financed the British side of the Napoleonic Wars, the Louisiana Purchase and the Erie Canal and was the personal bank of Queen Elizabeth II. Francis Baring, one of the founders of the bank, described it as “*unquestionably the first merchant in Europe – first in knowledge and talent, and first in character and opulence*”.⁶³⁷ In 1986, Margaret Thatcher’s Conservative government suddenly deregulated the British financial sector and allowed traditional commercial banks to provide investment bank services (for instance, securities brokerage and securities underwriting). They wanted to

⁶³⁷The Annual Register, Or, A View of the History, Politics, and Literature for the Year, London, J. Dodsley, 1825, p. 400.

increase the competitive advantage of British banks on the international markets and ensure the status of London as one of the world's financial centers. Following the deregulation, Barings Bank secured more than 50 % of its total profit from securities.⁶³⁸

In 1989, Nick Leeson came to Barings in London from Morgan Stanley, to take a back-office position focusing on the control of security transactions. Soon, he was sent to Indonesia for another back-office project, working with stock certificates and bearer bonds. In 1992, he was appointed to the position of general manager and head trader at Barings Securities (Singapore) Limited (BSS). There, he had clearance for “*transacting futures and options orders for clients or for other firms within the Barings organization, and riskless arbitraging of price differences between Nikkei futures traded on the SIMEX [Singapore Exchange] and Japan's Osaka exchange*”.⁶³⁹ Given his lack of trading experience, many of his deals were not making profit, and he began to hide his losses via an already existing secret “client” account, number 88888. By February 1995, he had generated losses of over US\$1.4 billion (£827 million) and brought Barings to bankruptcy. Incredibly, neither external auditors, nor supervisors, nor regulators had detected Leeson's true position prior to the collapse.⁶⁴⁰ Leeson admitted that the main reason why he had concealed his own losses and falsified his profits was “*fear of failure*”—because the surrounding environment, both on the Singapore stock exchange and within Barings bank, extolled success and profits and despised failure and losses: if his true losses were revealed, it would highlight his “*incompetence, negligence and failure*”.⁶⁴¹ He also expected that the consequences of his deception would be dramatic, but not catastrophic for the entire Barings business.

From 1992 to 1995, Barings headquarters and internal control did not spot the hidden losses, for several reasons. Firstly, Leeson, as both general manager and head trader of BSS, combined the functions of trader and back-office manager. These roles were usually divided between different people, from different departments of an investment bank and with different professional missions: earning money through deals as a trader, keeping risks within acceptable limits and keeping deals legal as a manager. In this period, BSS “*was operated almost entirely by Leeson alone*”.⁶⁴²

⁶³⁸Documentary “Going Rogue”, Journeyman Pictures, Dec. 2011.

⁶³⁹Glyn A. Holton, Barings Debacle, Risk Encyclopedia, May 2013.

⁶⁴⁰Report to the Board of Banking Supervision Inquiry into the Circumstances of the Collapse of Barings, Bank of England, 18 July 1995, Conclusion chapter, subsection “Outline”.

⁶⁴¹Documentary “Going Rogue”, Journeyman Pictures, Dec. 2011.

⁶⁴²Report to the Board of Banking Supervision Inquiry into the Circumstances of the Collapse of Barings, Bank of England, 18 July 1995, Conclusion chapter, subsection: “Why was the True Position not Noticed Earlier?”.

Secondly, Leeson had more than 5 years' experience as a back-office clerk in Morgan Stanley and Barings Bank; he had a very clear understanding of the shortcomings of the internal control system of a huge financial institution. Thus, his secret "88888" account escaped detection by several external and internal auditors—who accepted a forged guarantee letter, and sent reports to top managers back in London assuring them that Leeson's transactions were credible. Two other major rogue traders—Jerome Kerviel from Société Générale, who lost US\$6.9 billion in unauthorized trading, and Kweku Adoboli from UBS who lost US\$2.3 billion—also worked in back-office departments before their trading careers.⁶⁴³

Thirdly, both the senior management and those responsible for control functions at Barings had a merchant banking background: they knew little about derivatives⁶⁴⁴ and associated them with tremendous risks. Later, Leeson characterized Barings managers as "idiots"⁶⁴⁵ who did not understand the basics of the futures trading business: "*How little did the management of Barings know about what was going on? They had no clue. In 1994 [they] came from London, New York, and Tokyo to receive an award from SIMEX for the 'Highest Customer Volume'.*"⁶⁴⁶ Because they knew so little about derivatives, the management team was blinded by falsified profits from Singapore, which had a direct influence on their annual bonuses; they believed that Leeson was making fully matched trades at no real risk to Barings.⁶⁴⁷ Thus, they continued to send money to Singapore to cover Leeson's losses, comforting themselves that Leeson would bring them millions: "*[Barings was] driven to make profits, profits, and more profits...*"⁶⁴⁸ "*[I]t was their greed that lay at the root of the whole problem. They did not want to know about the internal structure of the firm.*"⁶⁴⁹ For instance, in 1993, Leeson's "transactions" appeared to be making 10 % of all Barings' profits.

Finally, Barings had an exclusive relationship with the Bank of England: according to Lord Hollick, the British central bank had an "*informal regulatory regime*" concerning Barings.⁶⁵⁰ This fact allowed Barings to violate restrictions on

⁶⁴³Documentary "Going Rogue", Journeyman Pictures, Dec. 2011.

⁶⁴⁴A derivative itself is merely a contract between two or more parties. A price derivative is related to the changing price of an underlying asset. Derivatives are synthetic securities—in general, they are not used to purchase the underlying asset, but to hedge from the risks of the changing price of the underlying asset, and generate income from the difference in prices on the underlying asset. The most common underlying assets include stocks, bonds, commodities, currencies, interest rates and market indexes.

⁶⁴⁵Documentary "25 Million Pounds", Director Adam Curtis, 1999.

⁶⁴⁶Gareth Hutchens, Barings wake up call unheeded: Leeson, Sydney Morning Herald, Oct. 20, 2012.

⁶⁴⁷Report to the Board of Banking Supervision Inquiry into the Circumstances of the Collapse of Barings, Bank of England, 18 July 1995, Conclusion chapter, subsection: "Why was the True Position not Noticed Earlier?"

⁶⁴⁸How Leeson broke the bank. BBC, June 22, 1999.

⁶⁴⁹Lords Hansard entry for 21 Jul 1995 (150721-14). <http://www.parliament.the-stationery-office.co.uk/pa/ld199495/ldhansrd/vo950721/text/50721-14.htm>.

⁶⁵⁰Ibid.

regulatory capital or capital adequacy: “[Barings bank’s] capital base was only \$250 million, [but] at the end of 1994 I had \$500 million in Singapore, so twice the capital base of the bank. I think it was 10 times the legal limit that [a bank] could lend to a subsidiary, which the Bank of England had allowed to happen”.⁶⁵¹ In 1993, the bank’s chairman Peter Baring commented to Brian Quinn, Director of the Bank of England: “The recovery in profitability has been amazing following the reorganization, leaving Barings to conclude that it was not actually terribly difficult to make money in the securities markets”.⁶⁵² Obviously, the regulator was pleased that its efforts towards deregulation seemed to be leading to greater profitability in the British banking sector...

After the fraud was revealed, Leeson was sentenced to 6½ years in a Singaporean prison, but was released in 1999 for good conduct and due to colon cancer. Since this time, he has become a risk perception and risk control systems consultant and conference speaker. He also explained his story in the book “*Rogue Trader*”, which has since been adapted as a Hollywood blockbuster.

Barings Bank Collapse: Why Risks Were Concealed

- By authorizing the use of unfamiliar and risky financial instruments, Barings managers gave priority to **short-term profitability over the long-term financial stability of the oldest bank in the UK**.
- The **climate of wishful thinking** at the bank made it uncomfortable for people to spread warnings, or make a sober assessment of suspicious operations or phenomenal earnings.
- **Habituation/false reassurance/self-suggestion/self-deception** among executives at the Bank of England and Barings Bank concerning the low probability of massive losses from **deregulation and innovative financial instruments** (derivatives). The tendency among decision-makers not to see the **whole picture about risks**.
- The widely accepted “**success at any price**” **organizational culture** within the investment banking industry, and the fear of being blamed as incompetent, forced Nick Leeson to start to hide his own losses, leading to a fatal spiral.
- **Ignorance about derivatives and their associated risks** among executives of the bank and representatives of the internal control department, which allowed Leeson to falsify data with impunity for 3 years.

⁶⁵¹Gareth Hutchens, Barings wakeup call unheeded: Leeson, Sydney Morning Herald, Oct. 20, 2012.

⁶⁵²Shelagh Heffernan, Modern Banking, John Wiley & Sons, 2005, p. 381.

2.2.2 *Enron's Bankruptcy (USA, 2001)*

It is difficult to get a man to understand something when his salary depends on his not understanding it

Upton Sinclair

2.2.2.1 Summary

In December 2001, the American company Enron went bankrupt, losing US\$63.4 billion in assets. At the time, this was the largest bankruptcy in US history, though this record was subsequently beaten shortly thereafter by WorldCom in 2002 in a similarly accounting scandal—with lost assets of US\$107 billion—and then again in 2008 by Lehman Brothers, who lost more than US\$600 billion in assets.⁶⁵³

Enron had a predecessor, Metallgesellschaft AG, whose aim it copied. Metallgesellschaft was formerly one of Germany's largest industrial conglomerates based in Frankfurt, with 20,000 employees and revenues in excess of 10 billion US dollars in 1993. It had over 250 subsidiaries specializing in mining, specialty chemicals (Chemetall), commodity trading, financial services, and engineering (Lurgi).⁶⁵⁴ The unsuccessful maturity transformation in Metallgesellschaft's hedging long term contracts with short term futures^{655,656} was echoed by banks and derivative dealers in the financial disasters discussed below. It is interesting to note also that, upon Metallgesellschaft's collapse in 1993, virtually all its staff were hired by Enron in the early days.⁶⁵⁷

Enron focused on wholesale merchant and commodity market businesses, management of retail customer energy services, operation of gas transmission systems, and management of energy-related assets and broadband services through approximately 3500 domestic and foreign subsidiaries and affiliates. For years before the bankruptcy, Enron executives routinely practiced fraud in the firm financial records in order to increase Enron's perceived revenue, so that the company's value in the market—and their own income—would continue to grow in the

⁶⁵³These loss estimations for these three bankruptcies assume that the asset valuations before the bankruptcy were true. Since extraordinary inflation of asset valuations has been one of the causes for the bankruptcies, these considerable loss figures must be taken with a grain of salt.

⁶⁵⁴Metallgesellschaft AG, <http://en.wikipedia.org/wiki/Metallgesellschaft>.

⁶⁵⁵Brennan, M.J. and N.I. Crewe, Hedging long maturity commodity commitments with short dated futures contracts. In: M A H Dempster & S R Pliska, eds. *Mathematics of Derivative Securities*. Cambridge: University Press, pp. 165–189 (1997).

⁶⁵⁶Medova, E.A. and A. Sombos, Price protection strategies for an oil company. In: S W Wallace and W T Ziemba, eds. *Applications of Stochastic Programming*, MPS-SIAM Series in Optimization. Philadelphia: SIAM, pp. 575–608 (2005).

⁶⁵⁷Professor M.A.H. Dempster (University of Cambridge, UK), personal communication (Dec. 22, 2014).

short-term. In 2000, Enron's falsified revenue exceeded US\$101 billion and the company was ranked the seventh largest company in the USA.⁶⁵⁸ Enron's falsified revenue came from trading operations, such as the trading of energy derivatives. As a result of the bankruptcy, 59,000 shareholders—including several pension funds and university endowments—lost a total of more than US\$60 billion, up to 25,000 Enron employees were deprived of a total of US\$2 billion in pension funds and stock options, and 20,000 creditors got back only 14 to 25 cents on every dollar lent to Enron.⁶⁵⁹ In the wake of Enron's collapse, Arthur Andersen accountancy firm failed in 2002 following the irreparable damage to its reputation: Arthur Andersen was Enron's external and internal auditor, and one of the "Big Five" accounting firms in the world along with Price Waterhouse Coopers, Deloitte & Touche, Ernst & Young and KPMG.

Later, accounting frauds were found at WorldCom, Tyco, HealthSouth, and other companies, in investigations triggered by the undermined trust of millions of American and foreign investors in the credibility of financial reporting and audit processes in the United States. Moreover, another accounting scandal at the Italian dairy producer Parmalat revealed a €14.3 billion hole in the company's account sheets in 2003; an investigation found that senior managers at Bank of America, Citigroup, Deloitte & Touche and Grant Thornton were also involved in the fraud.⁶⁶⁰ To restore public confidence, the US Congress hurriedly enacted on July 30, 2002, the Sarbanes-Oxley Act, also known as the 'Public Company Accounting Reform and Investor Protection Act' (in the Senate) and the 'Corporate and Auditing Accountability and Responsibility Act' (in the House), regulating the disclosure of information by U.S. public company boards and management, public accounting firms and investment banks. Under the new legislation, directors or accountants found to have knowingly concealed financial risks from investors and regulators in a firm's accounting would face decades in prison. Unfortunately, these changes could not prevent inflating earnings and routine concealment of debts—through off-balance-sheet partnerships or repo agreements—during the subsequent real estate bubble and the collapse of Lehman Brothers in 2008. Ernst & Young, Lehman Brothers' auditors, knew about debt concealment in the company (repo agreement 105 temporarily removed as much as \$50 billion in bad assets from their balance sheet in 2008), but did not inform the Board of Directors or the regulators.⁶⁶¹ *"So the mere passage of a statute does not appear to*

⁶⁵⁸Report of investigation of Enron Corporation and related entities regarding federal tax and compensation issues, and policy recommendations. Volume I: Report, U.S. Joint Committee on Taxation, Feb. 2003, p. 5.

⁶⁵⁹Dick Carozza, Interview with Sherron Watkins. Constant Warning, Fraud Magazine, January/February 2007.

⁶⁶⁰The Parmalat scandal, Special Report, World Finance, June 24, 2011.

⁶⁶¹Grant McCool, Ernst & Young accused of hiding Lehman troubles, Reuters, Dec. 21, 2010.

serve as a remedy for bad human behavior” as John Nugent observed.⁶⁶² According to some researchers “Enron is too complex a story to avail of one single explanation for its rise and fall”.⁶⁶³



2.2.2.2 Risk Concealment Before the Disaster

Origins and the Rise to Stardom

Enron was created in 1985 by the merger of two natural-gas pipeline companies, Houston Natural Gas and InterNorth Inc., in order to develop the first nationwide natural gas pipeline system. The new company aimed “to become the premier natural gas pipeline company in North America”⁶⁶⁴ after federal deregulation of natural gas transportation in the United States. Ken Lay, chairman and CEO of Enron from 1985 to 2002, was an economics Ph.D. who started his career in Nixon’s Administration as undersecretary of energy, and a supporter of deregulation of the US energy sector.⁶⁶⁵ In the early 1980s, Lay was an executive at Florida Gas Transmission. After the debt-financed merger of Houston Natural Gas and

⁶⁶²Stephen Nzuve, The Impact of the Enactment of the Sarbanes Oxley Act in the United States, 2002 on the Improvement of Corporate Finance and Good Governance Behavior, University of Nairobi, Sep. 5, 2012.

⁶⁶³Dennis Tourish, Naheed Tourish, Charismatic leadership and corporate cultism at Enron: The elimination of dissent, the promotion of conformity and organizational collapse, Leadership, Nov. 2005.

⁶⁶⁴Dick Carozza, Interview with Sherron Watkins. Constant Warning, Fraud Magazine, January/February 2007.

⁶⁶⁵Documentary “Enron: The Smartest Guys in the Room”, Director Alex Gibney, 2005.

InterNorth Inc., Enron was left with a monster debt of US\$4.3 billion. Moreover, because of deregulation, Enron lost exclusive rights on its pipelines in the highly competitive natural gas market, and natural gas prices went down: gas producers were able to sell sources directly to end users, and required pipelines to run their volumes for a simple transport tariff.⁶⁶⁶ Searching for a new strategy, which could generate profits and cash flow in the long-term, was a real challenge for the Enron management team.⁶⁶⁷

In 1987, Lay started to hear about unauthorized—and sometimes fabricated—oil commodities trading at Enron Oil Trading (EOT), one subdivision of the former InterNorth Inc. Traders were running double books and using undisclosed accounts to “[move] excess profits from one [accounting] quarter to the next through entities operating outside the Enron books”^{668,669} Later, internal investigation found out that traders made these actions in Enron’s interests. The unit seemed profitable: in 1985, the company as a whole showed US\$79 million losses, recovering to make US\$557 million profit in 1986, while EOT earned US\$10 million in 1985 and US\$28 million in 1986 without need of capital investments in infrastructure.⁶⁷⁰ This case demonstrated to Enron’s management the possibility of earning money without investment in low-profit real energy infrastructure by using a flexible accounting approach. Ultimately, the management sent a fax to Enron Oil with the following message: “*please keep making us millions...*”⁶⁷¹ In 1987, Enron Oil Trading generated losses of up to US\$1 billion, but ultimately Enron managed to reduce them to US\$142 million; however, an EOT executive was found guilty of fraud and sentenced to 1 year in prison.⁶⁷²

In spite of these losses, Lay realized that commodity derivatives were a new prospective market for Enron, which could gain billions with proper management. When in 1989 Jeffrey Skilling, then a management consultant at the Houston office of McKinsey & Company, offered to establish “Gas Bank” service for Enron, insuring long-term fixed prices on natural gas for buyers and suppliers by means of futures and options, Lay offered Skilling an executive position at Enron Finance Corporation to enable him to implement this “*trading partners*” strategy.⁶⁷³ It was the first step in Enron’s transition from an old-fashioned regional energy company to an innovative nationwide energy-trading corporation. During

⁶⁶⁶Stephen V. Arbogast, *Resisting Corporate Corruption*, M & M Scrivener Press, 2008, p. 10.

⁶⁶⁷C. William Thomas, *The Rise and Fall of Enron*. When a company looks too good to be true, it usually is, *Journal of Accountancy*, Apr. 2002.

⁶⁶⁸Stephen V. Arbogast, *Resisting Corporate Corruption*, M & M Scrivener Press, 2008, p. 43.

⁶⁶⁹Matti Rantanen, *Systems Intelligence in Leadership and Everyday Life Reasons*, Systems Analysis Laboratory, 2007, p. 175.

⁶⁷⁰Stephen V. Arbogast, *Resisting Corporate Corruption*, M & M Scrivener Press, 2008, pp. 12, 19.

⁶⁷¹Bethany McLean, Peter Elkind, *The Smartest Guys in the Room: The Amazing Rise and Scandalous Fall of Enron*, Portfolio Trade, 2003, p. 20.

⁶⁷²Documentary “Enron: The Smartest Guys in the Room”, Director Alex Gibney, 2005.

⁶⁷³Gary M. Cunningham, Jean E. Harris, *Enron And Arthur Andersen: The case of the crooked E and the fallen A*, *Global Perspectives on Accounting Education*, Volume 3, 2006, p. 31.

the following few years, Enron successfully became the largest energy trader in the United States with more than 25 % of the country's gas and electricity transactions, Houston became the Wall Street of energy trading,⁶⁷⁴ and Enron launched significant energy trading on the British deregulated wholesalers market and initiated operations in more than 30 countries. The company even changed its mission statement, announcing its intention *"to become the world's leading energy company"*⁶⁷⁵ and later issued a new one: *"we make markets"*.⁶⁷⁶ As an interesting fact, John LeBoutillier, former Professor of Harvard Business School where Jeffrey Skilling graduated near the top of his class, remembered that Skilling stated at that time: *"I'd keep making and selling the product [in spite of the fact that it was discovered that his fictional company produces a potentially lethal product]. My job as a businessman is to be a profit center and to maximize return to the shareholders. It's the government's job to step in if a product is dangerous"*.⁶⁷⁷

In 1997, Jeffrey Skilling was promoted to President and Chief Operating Officer of Enron, his mission to bring about the full-scale transformation of the company into a global energy-trading corporation. Under his leadership, Enron's annual revenues rose from about US\$9 billion in 1995 to US\$100 billion by 2000.⁶⁷⁸ In 1999, Enron launched Enron Online, an internet trading site for electronic commodities: Enron was counterparty to every transaction conducted on the platform, with credit risk management to ensure a safe trading environment. By the following year, Enron Online had traded a total of US\$335 billion.⁶⁷⁹ By 2000, trading operations produced about 99 % of the company's income, 88 % of income before tax and 80 % of identifiable assets.⁶⁸⁰ In 1996, Fortune named Enron the most innovative company in America, and they continued to award this title to Enron for the next six years until the company went bankrupt.⁶⁸¹ A tribute to Enron from the magazine's April 2000 edition starts in this way: *"Imagine a country-club dinner dance, with a bunch of old fogies and their wives shuffling around halfheartedly to the not-so-stirring sounds of Guy Lombardo and his All-Tuxedo Orchestra. Suddenly, young Elvis comes crashing through the skylight,*

⁶⁷⁴Dick Carozza, Interview with Sherron Watkins. Constant Warning, Fraud Magazine, January/February 2007.

⁶⁷⁵Ibid.

⁶⁷⁶Peter C. Fusaro, Ross M. Miller, What Went Wrong at Enron: Everyone's Guide to the Largest Bankruptcy in U.S. History, John Wiley & Sons, Inc, 2002, p. 70.

⁶⁷⁷Ibid, p. 28.

⁶⁷⁸Yuhao Li, The Case Analysis of the Scandal of Enron, International Journal of Business & Management, Oct. 2010, 5(10), 37.

⁶⁷⁹C. William Thomas, The Rise and Fall of Enron. When a company looks too good to be true, it usually is, Journal of Accountancy, Apr. 2002.

⁶⁸⁰Clinton Free, Mitchell Stein, Norman Macintosh, Management Controls: The Organizational Fraud Triangle of Leadership, Culture and Control in Enron, The Organization, July/August 2007.

⁶⁸¹Dick Carozza, Interview with Sherron Watkins. Constant Warning, Fraud Magazine, January/February 2007.

*complete with gold-lamé suit, shiny guitar, and gyrating hips. Half the waltzers faint; most of the others get angry or pouty. And a very few decide they like what they hear, tap their feet ... start grabbing new partners, and suddenly are rocking to a very different tune. In the staid world of regulated utilities and energy companies, Enron Corp. is that gate-crashing Elvis. Once a medium-sized player in the stupefyingly soporific gas-pipeline business, Enron in the past decade has become far and away the most vigorous agent of change in its industry”.*⁶⁸²

Political Context and Network

Active lobbying for deregulation of the energy and financial sectors played an important role in Enron’s growth. Lay had a cozy relationship with the Bush family as a devoted friend and major contributor to the gubernatorial and presidential election campaigns of George H. W. Bush, George W. Bush and other Republicans.^{683,684,685,686,687,688} This familiarity helped Lay and Enron to benefit from the easing of government control in several spheres.

Firstly, George H. W. Bush was Vice President of the USA during the eight-year presidency of Ronald Reagan, who in his turn was an apologist for deregulation in many spheres, including finance, transport and energy. Reagan declared his position in the following way: “*Government is not the solution to our problem; government is the problem*”⁶⁸⁹; “*We who live in free market societies believe that growth, prosperity and, ultimately, human fulfillment are created from the bottom up, not the government down... [We] believe in the magic of the marketplace*”.⁶⁹⁰ From 1989 to 1993, George H. W. Bush continued Reagan’s deregulation strategy as President of the USA in his own right. In the dozen years of Republican power, new principles were established for the federal deregulation of the American wholesale and retail electricity markets. In the 1990s, this energy deregulation continued on a state level. For example, Pete Wilson, the Republican Governor of California from 1991 to 1999, implemented state electricity deregulation in 1996: the state sold their own power plants and bought electricity from a single

⁶⁸²Brian O'Reilly, *The Power Merchant*, Fortune Magazine, April 17, 2000.

⁶⁸³Documentary “Enron: The Smartest Guys in the Room”, Director Alex Gibney, 2005.

⁶⁸⁴Enron's Kenneth Lay Is a Bush Family Friend, *The Los Angeles Times*, December 02, 2001.

⁶⁸⁵John Nichols, Ken Lay—Guilty. George Bush—Guilty. *The Nation*, May 25, 2006.

⁶⁸⁶Bush-Lay letters suggest close relationship CNN, February 17, 2002.

⁶⁸⁷Josh Gerstein, Enron’s Close Ties to Bush, ABC News, December, 10, 2001.

⁶⁸⁸Arianna Huffington, Ken Lay on Trial: Why are the Media Forgetting the Bush/Cheney Connection? *The Huffington Post*, April 26, 2006.

⁶⁸⁹Inaugural address of Ronald Reagan, January 20, 1981.

⁶⁹⁰Remarks at the Annual Meeting of the Boards of Governors of the World Bank Group and International Monetary Fund, September 29, 1981.

wholesale pool, the California Power Exchange.⁶⁹¹ However in 2000–2001, an electricity crisis erupted in California. Enron energy traders manipulated the supply of electricity—creating an artificial power shortage and causing blackouts by shutting down Californian power plants—to jack up state wholesale prices by 1000 %; the price of natural gas (in Enron’s pipelines) jumped by the same amount.⁶⁹² Enron earned billions on Californian energy contracts and overpriced natural gas. After the 2000 presidential elections, George W. Bush, on Lay’s recommendation, appointed Pat Wood (former chairman of the Public Utility Commission of Texas) as Chairman of the Federal Energy Regulatory Commission, which regulates the transmission and wholesale sale of electricity, natural gas and oil in interstate commerce, and so on. Spencer Abraham, Bush’s Secretary of Energy, had previously received campaign contributions from Enron as Republican senator for Michigan.⁶⁹³ In spring 2001, when Gray Davis, the Governor of California, asked George W. Bush’s Republican administration for a federal response to the state’s electricity crisis, Bush refused any federal government intervention or price controls. He maintained that California legislators had left too many regulatory restrictions in place in the electricity market, and that the federal government had nothing to do with energy companies manipulating the market; and he personally did not see Enron’s role in the California crisis.^{694,695,696} The passive attitude of the Bush administration was likely motivated by the wider political context, in particular, given that California had voted for the Democratic candidate Al Gore in the recent presidential elections, and Democrat Gray Davis had presidential ambitions for the 2004 election cycle.⁶⁹⁷ Moreover, Davis had earlier signed the nation’s first state law requiring car makers to limit auto emissions—damaging the interests of oil companies and car manufacturers, both heavyweight supporters of the Republican Party through campaign contributions. This crisis helped Republicans reverse the gubernatorial election result by the electoral recall of the incumbent, for only the second time in American history: ultimately, Davis was succeeded by Republican Arnold Schwarzenegger in November 2003.⁶⁹⁸ In an analogous political context, in 2005, the federal govern-

⁶⁹¹Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, *Enron and World Finance. A Case Study in Ethics*. p. 26.

⁶⁹²Greg Palast, *California Reamin’*, *The Guardian*, May 22, 2001.

⁶⁹³Robert O’Harrow Jr., Lucy Shackelford, *Enron Case. Political Players*. *Washington Post*. <http://www.washingtonpost.com/wp-srv/business/enron/4a.html>.

⁶⁹⁴Don Van Natta, *Enron’s Many Strands: The Administration; Bush’s California Energy Stance Faulted*, *New York Times*, May 8, 2002.

⁶⁹⁵Jason Leopold, *Lay and Skilling in the Dock. Enron and the Bush Administration*, *Counterpunch*, Feb. 1, 2006.

⁶⁹⁶Frank Pellegrini, *Bush’s Enron Problem*, *Time Magazine*, January 10, 2002.

⁶⁹⁷Clancy Sigal, *Notes From Los Angeles; A Gray Future for California Voters*, *The New York Times*, Oct. 17, 2002.

⁶⁹⁸Wikipedia’s profile of Joseph Graham “Gray” Davis, Jr. http://en.wikipedia.org/wiki/Gray_Davis.

ment responded similarly passively to the Hurricane Katrina crisis, when Democrat Kathleen Blanco was Governor of Louisiana. And in 2008, Republican Bobby Jindal duly won the gubernatorial election in Louisiana.

Secondly, US accounting practice is based on state regulation, and both the Texas-registered Enron and the Houston office of Arthur Andersen were under the jurisdiction of the Texas State Board of Public Accountancy (TSBPA).⁶⁹⁹ Mike Conaway was appointed as TSBPA chairman until 2004 during George W. Bush's term as Governor of Texas (1995–2000). In the 1980s, Conaway was chief financial officer of Arbusto/Bush Exploration.⁷⁰⁰ The worst falsifications of Enron's accounting reports occurred while Conaway was at the TSBPA.

Weak Regulatory Climate

Thirdly, Enron benefited from the weakening regulatory oversight over energy futures trading. In 1989, early in George H.W. Bush's presidency, Enron started trading natural gas commodities and commodity derivative financial contracts. From this time, along with the investment banks, Enron lobbied for the removal of regulatory restriction on over-the-counter (OTC) derivatives—and particularly energy derivatives—from the Commodity Futures Trading Commission. In 1989, the Securities and Exchange Commission (SEC) *“began requiring that managers make specific disclosures of financial contingencies and off-balance-sheet arrangements when a particular ‘trend, demand, commitment, event or uncertainty’ was ‘reasonably likely’.* [However], if management determined that the contingency was not reasonably likely to occur, no disclosure was required”⁷⁰¹. And on January 30, 1992, SEC accepted the mark-to-market accounting method for the energy contracts of Enron Gas Services group, which later allowed Enron to voluntarily calculate its revenue by the market value of derivative trading and to create the illusion of being *“larger”* than General Electric, Citigroup, or IBM.⁷⁰² Active lobbying continued after George H. W. Bush lost his second presidential race in 1992—for which Lay was co-chairman of Bush's re-election committee. Derivative traders also found support from Alan Greenspan, Chairman of the U.S. Federal Reserve during four US presidencies (Reagan, Bush, Clinton and Bush), and from Robert Rubin and Lawrence Summers, Secretaries of the US Treasury during Clinton's terms—who were all ardent apologists for deregulation in the

⁶⁹⁹Gary M. Cunningham, Jean E. Harris, Enron And Arthur Andersen: The case of the crooked E and the fallen A, Global Perspectives on Accounting Education, Volume 3, 2006, p. 33.

⁷⁰⁰Mike Conaway's profile of The Washington Post, 2004. <http://www.washingtonpost.com/wp-srv/elections/2004/candidates/24150/>.

⁷⁰¹Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, Enron and World Finance. A Case Study in Ethics. p. 69.

⁷⁰²B. G. Dharan, W. R. Bufkins, Red Flags in Enron's Reporting of Revenues & Key Financial Measures, July 23, 2008, p. 3.

financial sector.⁷⁰³ This deregulation would ultimately be a significant catalysis in the dynamics ending with the global financial and economic crisis in 2008–2009. In 2001, Harvey who has represented each of the “Big Five” accounting firms,⁷⁰⁴ including Arthur Andersen, was appointed as Chairman of the SEC in George W. Bush’s administration.⁷⁰⁵ Over decades of lobbying, the SEC budget was consciously reduced⁷⁰⁶; meanwhile the complexity of derivatives trading was rising.

Ultimately, the informal relationship between Enron’s senior managers and American political decision makers and regulators resulted in the weakening of government oversight of the energy and financial sectors. This allowed Enron’s management to implement several sophisticated methods of accounting, ensuring the regular growth of Enron’s revenue and allowing debts to be hidden off the balance sheet in special purpose entities—which together resulted in the permanent growth of Enron’s capitalization and multi-million-dollar earnings for executives. Worthy of mention, according to findings of Peter Fusaro and Ross Miller: “*Kenneth Lay, was not only on good terms with George W. Bush, he was a strong supporter of Al Gore’s environmental program. It seemed that Enron would get in bed with any politician who could wield influence on its behalf*”.⁷⁰⁷

Stellar Performance

Thus, the tremendous annual growth of Enron’s revenues, from about US\$13 billion in 1996 to US\$138.7 billion for the first 9 months of 2001, was achieved by the aforementioned mark-to-market accounting method and the “*merchant model*”. These methods were based on reporting, for deals on the Enron Online platform and elsewhere, “*the entire value of each trade on which it was a counterparty as its revenue, rather than reporting as revenues only its trading or brokerage fees*”.⁷⁰⁸ A similar accounting approach was also applied in other companies like Dynegy, Reliant Energy and El Paso, even though investment banks used the more conservative “*agent model*” based on brokerage fees alone.⁷⁰⁹ According to the calculations of Bala Dharan and William Bufkins, Enron’s revenues were “*increased as much as fifty times, compared to what they would have been under*

⁷⁰³Rick Schmitt, Profit and Loss, Stanford Magazine, March/April 2009.

⁷⁰⁴Biography of Harvey L. Pitt, The American Academy in Berlin GmbH, <http://www.americanacademy.de/de/home/person/harvey-l-pitt>.

⁷⁰⁵Robert O’Harrow Jr., Lucy Shackelford, Enron Case. Political Players. Washington Post. <http://www.washingtonpost.com/wp-srv/business/enron/4a.html>.

⁷⁰⁶Arthur Gudikunst, ENRON: A Study of FAILURES, Who, How and Why, Bryant College Working Paper Series, Faculty Newsletter, Sep., 2002, p. 10.

⁷⁰⁷Peter C. Fusaro, Ross M. Miller, What Went Wrong at Enron: Everyone’s Guide to the Largest Bankruptcy in U.S. History, John Wiley & Sons, Inc, 2002, p. xiii.

⁷⁰⁸B. G. Dharan, W. R. Bufkins, Red Flags in Enron’s Reporting of Revenues & Key Financial Measures, July 23, 2008, p. 7.

⁷⁰⁹Ibid, p. 7.

more traditional accounting... We estimate that an adjustment for both MTM [mark-to-market] accounting and merchant accounting would have pushed down Enron's reported revenues to US\$6.3 [billion] in 2000 instead of the reported US\$100.8 [billion]... This allowed Enron to report expected benefits from future transactions into current period income ... An article in the Texas edition of the Wall Street Journal on September 20, 2000... referred to the soaring stock prices of Enron... and continued: 'What many investors may not realize is that much of these companies' recent profits constitute unrealized, non-cash gains. Frequently, these profits depend on assumptions and estimates about future market factors, the details of which the companies do not provide, and which time may prove wrong'... Enron used revenues – not profits [reported profits were microscopic relative to revenues] – as its primary financial objective, performance driver and measure of success. Enron's use of distorted, 'hyper-inflated' revenues was... important to it in creating the impression of innovation, high growth and spectacular business performance".⁷¹⁰

And, with consulting support from the Houston office of Arthur Andersen, Enron financial executives used special purpose entities (or special purpose vehicles or financial vehicle corporations) to hide debts and losses from Enron's balance sheets in order to keep Enron's credit rating on investment grade and keep down the cost of capital borrowing. When Jeffrey Skilling became Enron's chief operating officer in 1997, CFO Andrew Fastow developed a network of 3000 special purpose entities, which were unconsolidated on Enron's balance sheet. He did this "to accomplish favorable financial statement results, not to achieve bona fide economic objectives or to transfer risk. Some transactions were designed so ... Enron could have kept assets and liabilities (especially debt) off its balance sheet... They allowed Enron to conceal from the market [between 1997 to 2001] very large losses resulting from Enron's merchant investments by creating an appearance that those investments were hedged – that is, that a third party [partnership with companies Chewco, LJM1, LJM2, Condor, Raptor I–IV and other] was obligated to pay Enron the amount of those losses – when in fact that third party was simply an entity in which only Enron had a substantial economic stake... These transactions resulted in Enron reporting earnings from the third quarter of 2000 through the third quarter of 2001 that were almost \$1 billion higher than should have been reported... In virtually all of the transactions, Enron's accounting treatment was determined with extensive participation and structuring advice from Andersen, whose management reported to the Board of Enron. Enron's records show that Andersen billed Enron \$5.7 million for advice in connection with the LJM and Chewco transactions alone, above and beyond its regular audit fees".⁷¹¹ In the 1990s, there was the longest bull market in the

⁷¹⁰Ibid, pp. 1, 10, 13.

⁷¹¹W. C. Powers, Jr., R. S. Trough, H. S. Winokur, Jr., Report of investigation by the special investigative committee of the Board of directors of Enron Corp. , Austin, TX, February 1, 2002, pp. 4–5.

history of the USA,⁷¹² but in the early 2000s the market was under the impact of the dot-com bubble burst and the 9/11 attack. *“If the market reversed, mark-to-market accounting required the recognition of losses, possibly enormous losses... Enron hid, delayed or ignored the loss. Andersen apparently did not question any of the values assigned to the contracts or object to tactics to hide, delay or ignore losses. Some of Enron’s most abusive special purpose entities were created to avoid reporting mark-to-market losses”*.⁷¹³ Due to accounting falsifications, from 1996 to 2000, Enron’s declared that its market value grew by more than 4½ times, reaching over US\$60 billion—70 times earnings and six times book value.⁷¹⁴ In this five-year period, Enron paid five executives more than US\$500 million via options, bonus payments and salaries.⁷¹⁵

Because of the cozy relations between Enron executives and American politicians, regulators failed to prevent the worst-case scenario from happening in the Enron case. However, during the five years leading up to the bankruptcy, other audiences failed to recognize—or helped to cover—the concealment of risk by Enron executives: the company’s auditors, its board of directors, other employees, investment banks and the media.

Arthur Andersen

In the 1990s, Arthur Andersen actively developed an accounting consulting practice as a supplement to their main auditing practice. The units within Arthur Andersen competed with each other, failed to communicate about the problems of their clients and sought only permanent growth of revenue regardless of the source of that revenue, the quality of clients or the legality of their recommendations.⁷¹⁶ Enron was Arthur Andersen’s second largest client worldwide—the largest was WorldCom, which filed for bankruptcy in 2002—and the largest client in the accountants’ Houston office.⁷¹⁷ The Houston office of Arthur Andersen provided both auditing and the new consulting service to Enron. Andersen consultants helped to implement aggressive accounting and the use of special purpose entities (more than 70 % of the fees that Andersen received from Enron came from consulting) while at the same time, the Andersen audit unit earned US\$1 million a

⁷¹²C. William Thomas, The Rise and Fall of Enron. When a company looks too good to be true, it usually is, *Journal of Accountancy*, April 2002.

⁷¹³Gary M. Cunningham, Jean E. Harris, Enron And Arthur Andersen: The case of the crooked E and the fallen A, *Global Perspectives on Accounting Education*, Volume 3, 2006, pp. 40–41.

⁷¹⁴Paul M. Healy and Krishna G. Palepu. The Fall of Enron, *Journal of Economic Perspectives*. Spring 2003, 17(2), 3.

⁷¹⁵Dan Ackman, Pay Madness At Enron, *Forbes Magazine*, March 22, 2002.

⁷¹⁶Jennifer Sawayda, Arthur Andersen: An Accounting Confidence Crisis, Daniels Fund Ethics Initiative, University of New Mexico, pp. 2, 6.

⁷¹⁷Gary M. Cunningham, Jean E. Harris, Enron And Arthur Andersen: The case of the crooked E and the fallen A, *Global Perspectives on Accounting Education*, Volume 3, 2006, p. 31.

week for internal and external auditing (less than 30 % of Enron's payments to Andersen).⁷¹⁸ Enron had no fraud examiners and no internal audit department.⁷¹⁹ Enron outsourced their own "internal audit" to Arthur Andersen and many of Enron's internal accountants and controllers were former Andersen executives.⁷²⁰ Joseph Berardino, Andersen's chairman, testified that "*in the previous year (2000), Andersen had received \$52 million in fees from Enron, of which only \$25 million could be directly attributed to the audit. Of those fees, \$13 million were clearly for consulting work and the remaining \$14 million is arguably related to the audit because it is work that can 'only be done by auditors'.*"⁷²¹ The bonuses of staff at the Houston office of Arthur Andersen depended on Enron's stable growth, and many Andersen employees, "*[I]ured by promises of undreamt-of-wealth... aspired to work for Enron and were therefore very reluctant to 'rock the boat' with the company.*"⁷²² Ultimately, this led to a situation where auditors approved falsified accounting reports in order to earn more.

Carl Bass, among other Andersen auditors, expressed concern over Enron's practice of mark-to-market accounting and use of special purpose entities—but immediately after Bass' complaint David Duncan, Andersen senior executive at the Houston office, removed Bass from the Enron account.⁷²³ Obviously, if Bass had revealed his finding to the Texas State Board of Public Accountancy—which as we have noted was under the control of a friend of George W. Bush and Ken Lay—he could have lost his job and put a cross on his carrier as an auditor in Texas state without any assurance that the falsification case would even be properly investigated by the TSBPA. In the end, despite being later recognized as an accounting hero, Bass lost his auditor's license along with other former auditors of Enron.⁷²⁴

Moreover, Andersen headquarters had a weak system of internal control over its regional units, and Andersen executives were delighted by the continuous growth of the Houston office's revenue, so they avoided asking what would be considered awkward questions about the details of consulting and audit practice. After the falsification was revealed, Andersen's Houston office immediately destroyed thousands of e-mails and papers relating to their auditing and consulting for Enron

⁷¹⁸Ibid, p. 43.

⁷¹⁹Dick Carozza, Interview with Sherron Watkins. Constant Warning, Fraud Magazine, January/February 2007.

⁷²⁰C. William Thomas, The Rise and Fall of Enron. When a company looks too good to be true, it usually is, Journal of Accountancy, April 2002.

⁷²¹Peter C. Fusaro, Ross M. Miller, What Went Wrong at Enron: Everyone's Guide to the Largest Bankruptcy in U.S. History, John Wiley & Sons, 2002, p. 127–128.

⁷²²Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, Enron and World Finance. A Case Study in Ethics. pp. 196–197.

⁷²³Jennifer Sawayda, Arthur Andersen: An Accounting Confidence Crisis, Daniels Fund Ethics Initiative, University of New Mexico, p. 6.

⁷²⁴Ibid, p. 8.

from 1997 to 2001⁷²⁵; consequently, Andersen was found guilty only of obstruction of justice for shredding these documents and company files, and they were fined just US\$0.5 million.⁷²⁶ Nevertheless, investors were left in doubt about Andersen's accounting reports for other clients over the previous decade. As a result, the company failed to restart its business after the Enron case, as auditing is based mainly on trust and on the reputation of the auditor.

According to some researchers, *“Enron’s board of directors simply did not understand what was going on; they trusted that Jeffrey Skilling’s and Andrew Fastow’s labyrinthine special purpose entities made sound financial sense; after all, both Skilling and Fastow had graduated from top MBA programs. Thus, neither the auditors nor the Board of Directors performed effectively their function of monitoring the activities of insiders for the benefit of outsiders...”*⁷²⁷ *The Auditing Committee of the Board of Directors continued to rely on its public auditing firm, Arthur Andersen, who continued to write favorable opinion letters that ENRON’s accounting was ‘adequate to provide reasonable assurance as to the reliability of financial statements’”*.⁷²⁸ Others suggest that Enron's board of directors kept silent for financial reasons: *“Each director received nearly \$350,000 per year for serving on Enron’s board. That amount was double the high end of normal large public company director fees. The board routinely bragged about Enron’s management team. One may ask how much of their ‘Enron can do no wrong’ attitude was impacted by the fees they received?”*.⁷²⁹

Enron's Culture

Under the leadership of Jeffrey Skilling, who got the nickname of Darth Vader for his ruthless behavior,⁷³⁰ a “cut-throat” corporate culture, unusual for an energy company, was developed at Enron. This culture would have been more appropriate for an investment bank. Because the mark-to-market accounting approach allowed the recording of profits from long-term deals in the current year, it put enormous pressure on traders to keep providing gigantic new deals, which continued Enron's revenue and market capitalization growth. According to Peter Fusaro and Ross

⁷²⁵Ibid, pp. 5, 8.

⁷²⁶Elizabeth K. Ainslie, *Indicting Corporations Revisited: Lessons of the Arthur Andersen Prosecution*, *American Criminal Law Review*, Vol. 43:107, p. 107.

⁷²⁷Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, *Enron and World Finance. A Case Study in Ethics*. pp. 196–197.

⁷²⁸Arthur Gudikunst, *ENRON: A Study of FAILURES, Who, How and Why*, Bryant College Working Paper Series, Faculty Newsletter, Sep. 2002, p. 3.

⁷²⁹Dick Carozza, *Interview with Sherron Watkins*. *Constant Warning, Fraud Magazine*, January/February 2007.

⁷³⁰Peter C. Fusaro, Ross M. Miller, *What Went Wrong at Enron: Everyone's Guide to the Largest Bankruptcy in U.S. History*, John Wiley & Sons, 2002.

Miller: “Enron’s corporate culture was essentially focused on two things: The first was profits and the second was how to make even greater profits. The firm didn’t strive to create long-lasting business relationships and had little desire to be involved in anything that smacked of the low margins associated with retail-oriented business”.⁷³¹ At Enron, it was not the quality of a deal but the size of the deal and the maintenance of a constant ‘deal flow’⁷³² that mattered: “Good deal versus bad deal? Didn’t matter. If you could give it a positive Net Present Value it got done”.⁷³³ As soon as a deal was done, the trader immediately received compensation and forgot about the future of the deal. Therefore, the entire staff of Enron was focused on short-term output.⁷³⁴ Enron preferred to hire “the best and the brightest” young MBA school graduates, who at first were too inexperienced to understand the real flaws of Enron’s corporate system—but were very smart, aggressive, and hungry to make short-term money. Enron paid extremely large rewards to traders who met their earnings targets: some common traders were able to earn up to US\$15 million a year.⁷³⁵

The corporate message was simple: “If you were smart enough and tough enough to work at Enron, you deserved to live like last year’s Oscar winner”.⁷³⁶ On bonus day, luxury car dealers set up showrooms around the Enron headquarters building. In 2000, the base salary at Enron exceeded the peer group average by 51 %, bonus payments by 382 % and stock options by 484 %.⁷³⁷ Because employees’ pension funds were invested in Enron stock and significant compensation was in the form of stock options, employees were motivated to increase Enron’s capitalization by any means. In exchange for such large compensation, Enron claimed enormous productivity, total loyalty to superiors and faith in Enron’s unique path: the staff were nicknamed “Enronians” and “believers”.⁷³⁸

Moreover, Jeffrey Skilling created the most rigid system of selection and ranking of personnel in corporate America. The system was called the Performance

⁷³¹Peter C. Fusaro, Ross M. Miller, *What Went Wrong at Enron: Everyone’s Guide to the Largest Bankruptcy in U.S. History*, John Wiley & Sons, 2002, p. 47.

⁷³²Clinton Free, Mitchell Stein, Norman Macintosh, *Management Controls: The Organizational Fraud Triangle of Leadership, Culture and Control in Enron*. The Organization, July/Aug. 2007.

⁷³³Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, *Enron and World Finance. A Case Study in Ethics*. p. 196.

⁷³⁴Clinton Free, Mitchell Stein, Norman Macintosh, *Management Controls: The Organizational Fraud Triangle of Leadership, Culture and Control in Enron*. The Organization, July/August 2007.

⁷³⁵Ibid.

⁷³⁶Brian Cruver, *Anatomy of Greed: Telling the Unshredded Truth from Inside Enron*, Basic Books, 2003, p. 191.

⁷³⁷Dan Ackman, *Pay Madness At Enron*, Forbes Magazine, Mar. 22, 2002.

⁷³⁸Dennis Tourish, Naheed Tourish, *Charismatic leadership and corporate cultism at Enron: The elimination of dissent, the promotion of conformity and organizational collapse*, Leadership, Nov. 2005.

Review Committee (PRC), and it focused on assessing the amount, profitability and permanency of the deals an employee had brought into Enron during the previous six months. Every six months, 15 % of staff found themselves on the bottom rank of the PRC rating; if they remained there in the next review, they were fired.^{739,740} Such a system strengthened competition and atomization between traders, which prevented anyone in the company being honest with anyone else about the risks they were taking: *“Clearly, the switch from affirmation to punishment within Enron meant that employees regularly received mixed messages. On the one hand, they were the cleverest and best in the world – a form of positive reinforcement, or love bombing, that it would be hard to better. On the other, they could be branded as ‘losers’, and fired at any time. Consistent with general cultic norms, the overall effect was disorientation, an erosion of one’s confidence in one’s own perceptions and, most crucially, a further compliance with the group’s leaders that strengthened conformist behavior in general... It is clear that Enron management regarded kindness as a show of weakness. The same rigors that Enron faced in the marketplace were brought into the company in a way that destroyed morale and internal cohesion. In the process of trying to quickly and efficiently separate from the company those employees who were not carrying their weight, Enron created an environment where employees were afraid to express their opinions or to question unethical and potentially illegal business practices. Because the rank-and-yank system was both arbitrary and subjective, it was easily used by managers to reward blind loyalty and quash brewing dissent... [There was a] prevailing culture [of] ‘the undiscussability of the undiscussable also undiscussable’... [A] former senior manager’s summary of the internal culture: ‘There was an unwritten rule... a rule of ‘no bad news.’ If I came to them with bad news, it would only hurt my career’”.*⁷⁴¹ *“Paranoia flourished and trading contracts began to contain highly restrictive confidentiality clauses. Secrecy became the order of the day for many of the company’s trading contracts, as well as its disclosures”.*⁷⁴² *“Enron Gas Services was developing a reputation as a predatory place where people would sell each other out to survive”.*⁷⁴³

⁷³⁹Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, *Enron and World Finance. A Case Study in Ethics*. p. 196.

⁷⁴⁰C. William Thomas, *The Rise and Fall of Enron*. When a company looks too good to be true, it usually is. *Journal of Accountancy*, April 2002.

⁷⁴¹Dennis Tourish, Naheed Tourish, *Charismatic leadership and corporate cultism at Enron: The elimination of dissent, the promotion of conformity and organizational collapse*, *Leadership*, November 2005.

⁷⁴²C. William Thomas, *The Rise and Fall of Enron*. When a company looks too good to be true, it usually is, *Journal of Accountancy*, April 2002.

⁷⁴³Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, *Enron and World Finance. A Case Study in Ethics*. p. 28.

This internal climate of concealment about risk soon extended to communication with external audiences: Mark Koenig, Enron's former head of investor relations, testified the following *"I wish I knew why I did it. I did it to keep my job, to keep the value that I had in the company, to keep working for the company. I didn't have a good reason"*.⁷⁴⁴ Sherron Watkins—Enron vice president, subordinate of Andrew Fastow, former auditor at Arthur Andersen and ultimately famous in the USA as an internal whistle-blower—sent an anonymous memo to Lay about the possibility of a wave of accounting scandals after the unexpected resignation of Jeffrey Skilling as CEO in August 2001; later she sent a signed letter to Lay, and visited him personally.⁷⁴⁵ Watkins began her letter with these selfish words: *"Has Enron become a risky place to work? For those of us who didn't get rich over the last few years, can we afford to stay?"*.⁷⁴⁶ She honestly outlined to Lay possible risks from accounting fraud, but the motivation for her whistleblowing attempts was not concern about investors (many of them were pension funds and education organizations; she mentioned them once in the letter), but apparently about the personal wealth of employees—their options and pension funds—and her career prospects: *"I am incredibly nervous that we will implode in a wave of scandals. My eight years of Enron work history will be worth nothing on my resume, the business world will consider the past successes as nothing but an elaborate accounting hoax"*.⁷⁴⁷ Nevertheless, she recommended to cover-up the problems (*"clean up quietly if possible"*).⁷⁴⁸ Her letter was found only during the investigation, when the falsifications were revealed, but she had kept silent about Enron's frauds for years before the bankruptcy. Apparently, it was impossible for a conscientious person to survive unscathed in Enron's *"cut-throat"* environment for 8 long years...

Enron and the Investment Banks

Investment banks made serious money from underwriting merger deals, while broker fees brought insignificant profits in comparison. They got large investment-banking fees from Enron transactions, they were investors in Enron's off-balance-sheet special purpose entities and had credit exposure to Enron.⁷⁴⁹ Therefore,

⁷⁴⁴Clinton Free, Mitchell Stein, Norman Macintosh, Management Controls: The Organizational Fraud Triangle of Leadership, Culture and Control in Enron. The Organization, July/August 2007.

⁷⁴⁵Gary M. Cunningham, Jean E. Harris, Enron And Arthur Andersen: The case of the crooked E and the fallen A, Global Perspectives on Accounting Education, Volume 3, 2006, p. 34.

⁷⁴⁶Text of Watkins' Letter to Lay After Departure of Chief Executive, The New York Times, January 16, 2002.

⁷⁴⁷Ibid.

⁷⁴⁸Peter C. Fusaro, Ross M. Miller, What Went Wrong at Enron: Everyone's Guide to the Largest Bankruptcy in U.S. History, John Wiley & Sons, Inc, 2002, p. 127.

⁷⁴⁹Paul H. Dembinski, Carole Lager, Andrew Cornford and Jean-Michel Bonvin, Enron and World Finance. A Case Study in Ethics. pp. 31–23.

investment bank analysts were urged to publish positive analytic reports about Enron, and sell-side bank traders promoted Enron's stock among their clients—though with an average annual growth of over 65 %, Enron stocks did not require a lot of effort to promote.⁷⁵⁰ If the occasional dissident—like John Olson, an analyst at Merrill Lynch—made a “*sell*” recommendation on Enron stocks or published “*neutral*” reports, he or she would be fired, since all the investment banks had a close relationship with Enron's executives. Later, in gratitude for the dismissal of John Olson, Merrill Lynch received at least US\$45 million in fees from Enron deals.⁷⁵¹ Enron's impressive projections to become “*the world's leading company*” attracted investors from all around the world. The company declared: “*We believe wholesale gas and power in North America, Europe and Japan will grow from a US\$660 billion market to a US\$1.7 trillion market over the next several years. Retail energy services in the United States and Europe have the potential to grow from US\$180 billion to \$765 billion in the not-so-distant future. Broadband's prospective global growth is huge – it should increase from just US\$17 billion today to \$1.4 trillion within five years. Taken together, these markets present [a several] trillion [dollar] opportunity for Enron... Our stock price is going to go to \$120 per share*”.^{752,753} The registered maximum for an Enron share was US\$90 in August 2000; as things turned out, the value of the share in late November 2001 was less than US\$1. A Goldman Sachs analytic report extolled Enron: “*Enron has built unique and, in our view, extraordinary franchises in several business units in very large markets*”.⁷⁵⁴ In early 2001, according to Thomson First Call, 13 of Enron's 18 analysts recommended to buy Enron's stocks.⁷⁵⁵ Moreover, 10 out of 15 analysts who followed Enron were still rating the stock as a “*buy*” or a “*strong buy*” as late as November 8, 2001, when Enron finally confessed to accounting falsifications.⁷⁵⁶

⁷⁵⁰B. G. Dharan, W. R. Bufkins, Red Flags in Enron's Reporting of Revenues & Key Financial Measures, July 23, 2008, pp. 2,4.

⁷⁵¹Richard A. Oppel Jr., Merrill Replaced Research Analyst Who Upset Enron, New York Times, July 30, 2002.

⁷⁵²Dennis Tourish, Naheed Tourish, Charismatic leadership and corporate cultism at Enron: The elimination of dissent, the promotion of conformity and organizational collapse, Leadership, November 2005.

⁷⁵³Text of Sherron Watkins' Testimony at House Hearing on Enron. The New York Times, Feb. 14, 2002.

⁷⁵⁴Bethany McLean, Is Enron Overpriced? Fortune, March 5, 2001.

⁷⁵⁵Ibid.

⁷⁵⁶The Watchdogs didn't Bark: Enron and the Wall Street Analysts, Hearing before the Committee on Governmental Affairs United States Senate, One Hundred Seventh Congress, Second Session, U.S. Government Printing Office, Washington, February 27, 2002.

The Academics Are Impressed

Impressed by the company's fantastic growth in the market, Harvard University prepared a case study about Enron's success for MBA students; Business Week, Forbes, Fortune and other business magazines and newspapers were dazzled by the "Enron Miracle" and published articles portraying the company in a favorable light.⁷⁵⁷ For example, Fortune evaluated Enron stocks among its *"10 stocks to last the decade... that should put your retirement account in good stead and protect you from those recurring nightmares about stocks that got away"*⁷⁵⁸; Skilling was named *"The #1 CEO in the USA"* for embracing innovative theories of business and receiving enormous income from these innovations.⁷⁵⁹ Ultimately, this was a tale of *"individual and collective greed born in an atmosphere of market euphoria and corporate arrogance. Hardly anyone ... wanted to believe the company was too good to be true... Many kept on buying the stock, the corporate mantra and the dream"*.⁷⁶⁰ It was only on March 5, 2001 that Fortune magazine published the first serious investigation into the accounting practices of Enron—an article by Bethany McLean entitled *"Is Enron Overpriced?"*—which provoked great attention from investors to the problems.⁷⁶¹

The Demise

At the peak of Enron's stock price, Ken Lay and Jeffrey Skilling secretly began to sell their stock options. At the same time, they assured the employees that the stock would probably rise.⁷⁶² On October 16, 2001, after Skilling's resignation in August and following the activity of Sherron Watkins, Lay was forced to announce the first quarterly losses for more than four years, of US\$618 million; net assets declined to US\$1.2 billion.⁷⁶³ Sherron Watkins assessed Skilling's resignation as a trigger that would lead to unearth the cover-ups in Enron's "success story": *"I believe that the probability of discovery significantly increased with Skilling's*

⁷⁵⁷Dick Carozza, Interview with Sherron Watkins. Constant Warning, Fraud Magazine, January/February 2007.

⁷⁵⁸David Ryneck, 10 Stocks to Last the Decade, Fortune, August 14, 2000.

⁷⁵⁹Clinton Free, Mitchell Stein, Norman Macintosh, Management Controls: The Organizational Fraud Triangle of Leadership, Culture and Control in Enron. The Organization, July/August 2007.

⁷⁶⁰C. William Thomas, The Rise and Fall of Enron. When a company looks too good to be true, it usually is, Journal of Accountancy, April 2002.

⁷⁶¹Bethany McLean, Is Enron Overpriced? Fortune, Mar. 5, 2001.

⁷⁶²Yuhao Li, The Case Analysis of the Scandal of Enron, International Journal of Business & Management, October 2010, Vol. 5 Issue 10, p. 37.

⁷⁶³Clemens von Frentz, Enron—Chronicle of a record bankruptcy, Manager Magazine, June 25, 2003.

*shocking departure. Too many people are looking for a smoking gun”.*⁷⁶⁴ Soon, Enron revealed that the company had overstated its earnings during the last four years by US\$586 million, and hidden US\$3.1 billion in debts.⁷⁶⁵ After these statements, it became clear to everybody that Enron had been falsifying its accounts for years. From the first investigations of possible accounting fraud, the Enron fall began...

Lay probably counted on the help of George W. Bush, his close friend, but due to tremendous media pressure after the fraud revelations, Bush tried to disown his relationship with Lay, and Enron's massive contributions to his election campaigns. Several Enron executives pleaded guilty, and got decades-long jail sentences with multi-million-dollar fines. Ken Lay died in July 2006 before serving his sentence. Jeffrey Skilling and Andrew Fastow were sentenced to 24 and 10 years in prison respectively.

Enron's Bankruptcy: Why Risks Were Concealed

- **Close and corrupting relationships between Enron executives and representatives of the US political elite led to deregulation changes** that allowed Enron to build a flawed business model. The risks of such a model could be hidden with impunity because of the absence of a strict regulatory framework, and extensive informal relationships between Enron executives, regulators and politicians. Employees of Enron and Arthur Andersen were afraid to reveal risks to the public because they feared they would not find support from regulators, who seemed to have a cozy relationship with Enron's management team.
- The business model was geared to constantly raising the earnings of Enron executives by maintaining the permanent growth of the company's market value. This growth could be achieved by a continual increase of Enron's short-term revenue figures and low debts. Therefore, **Enron's executives corrupted their auditors and several investment banks with lucrative years-long contracts for reaching the required figures.**
- **Wishful thinking of the board of directors, and among investors, employees and the media**—they preferred to believe only in what they wanted to believe, and ignored facts and early warnings. The unwillingness of the majority of investors to go deep into Enron's complex financial operations while the company was steadily expanding in the market.
- **Unfathomable complexity** of the financial engineering through which Enron generated its false financial results was key. This was a precursor to

⁷⁶⁴Peter C. Fusaro, Ross M. Miller, What Went Wrong at Enron: Everyone's Guide to the Largest Bankruptcy in U.S. History, John Wiley & Sons, Inc, 2002, p. 126.

⁷⁶⁵Corporate Fraud: Stop History from Repeating Itself, Kroll investigative service, 2011.

the absolute impossibility of penetrating the CDO-squared structure of the mid-2000s. It was not just an unwillingness, it was an inability.

- The **reluctance of Enron executives to confess any shortcomings of the created business model** in the early stages of Enron's ascent, because doing so could lead to accusations of incompetence and the collapse of capitalization. The **fear of criminal prosecution after the majority of the falsifications** had occurred caused Enron's management to continue distorting information about the real situation within the company until bankruptcy.
- A **"success at any price" and "no bad news" culture**, the **secrecy of deals at Enron**, the **absence of internal control within the company and its frequent labor turnover**: all these processes were consciously implemented by executives to provide a **fragmentary picture of risks among employees**.

2.2.3 Subprime Mortgage Crisis (USA, 2007–2008)

The experience of France in the Belle Époque proves, if proof were needed, that no hypocrisy is too great when economical and financial elites are obliged to defend their interests.

Thomas Piketty

Thirty per cent of OTC derivatives are bought and seventy per cent are sold.

Michael A.H. Dempster



2.2.3.1 The LTCM 1998 Precursor in Addition to the Enron Precursor

The subprime mortgage crisis that started in 2007 in the USA had two notable precursors: (i) as reported earlier, Enron was a precursor with respect to the complexity of its financial engineering constructions; (ii) the hedge fund Long-Term Capital Management (LTCM), which collapsed in 1998,⁷⁶⁶ was a precursor with respect to excess leverage (its positions were quite straightforward and very easy to understand, unlike Enron's structures) and the potential for a single firm to have systemic catastrophic impact on the global financial system.⁷⁶⁷

With 1997 Memorial Nobel prize winners Myron S. Scholes and Robert C. Merton among its principals, LTCM developed arbitrage positions betting on the convergence of what was deemed mispriced spread between bonds and between equity pairs and also traded options. In its first few years, LTCM achieved remarkable returns but had to escalate its leverage to enormous proportions, as its capital base grew and investment opportunities decreased. Thus, at the beginning of 1998, the firm had equity of US\$4.72 billion and had borrowed over US\$ 124.5 billion with assets of around US\$129 billion, for a debt to equity ratio of over 25 to 1.⁷⁶⁸ The debt of LTCM was developed with counterparties being most of the important banks on Wall Street. Starting with the 1997 East Asian financial crisis followed by the 1998 Russian government bond default, the convergence arbitrages that LTCM had bet upon actually diverged, leading to huge losses. As LTCM's capital was composed of funds from the same financial professionals with whom it traded, its difficulties led Wall Street to fear that LTCM liquidation of its securities to cover its debt would further push price down in a positive feedback loop, and could cause a chain reaction with catastrophic losses throughout the financial system. On September 1998, the Federal Reserve supervised a bail out of LTCM involving 14 financial institutions for a US\$3.6 billion recapitalization allowing to avoid further liquidation in order to prevent the vicious cycle that was feared to possibly collapse the entire world financial system.

Unfortunately, the Federal Reserve, the US treasury and regulators did not learn anything or choose to ignore the lessons offered by the LTCM debacle, allowing essentially the same leverage dynamics to develop industry wide with catastrophic consequences that are still echoing.

⁷⁶⁶See Donald Mackenzie, *An Engine, Not a Camera: How Financial Models Shape Markets*, The MIT Press, Aug. 29, 2008 for a detailed account.

⁷⁶⁷It is interesting to note that, in the combined 1200 pages of Rubin and Greenspan biographies, only about 1.5 pages are dedicated to the deepest banking crisis they oversaw while at the Treasury and the Fed. Should we conclude they were too scared still from the near death experience of the banking system in 1998 to discuss it in public? But their behavior in the 2007–8 crisis proved instead they had not even understood the event!

⁷⁶⁸Long-Term Capital Management's profile. http://en.wikipedia.org/wiki/Long-Term_Capital_Management.

2.2.3.2 Brief Summary of the Crisis

During the 2000s, an American real estate bubble was forming,⁷⁶⁹ which burst during 2007–2008. More than eight million American households lost their homes due to foreclosure. More than US\$17 trillion of household wealth was wiped out within 21 months after the burst. The American subprime mortgage crisis triggered a global financial and economic crisis in 2008–2009,⁷⁷⁰ which caused the most severe recession in over 50 years. Total stock market losses exceeded US\$30 trillion worldwide.⁷⁷¹ In order to prevent a total collapse of the world financial system, governments imperiled trillions of taxpayers' money on bailouts of private financial institutions, which were “*too big to fail*”. This global salvage operation disrupted the stability of government finance not only in the USA, but also in many European countries. The US federal deficit (the amount by which federal spending exceeds federal income in a given fiscal year) grew from US\$161 billion in 2007 to \$1.4 trillion in 2009⁷⁷²; and total public debt (the total amount owed by the federal government, including debts from intra-governmental holdings) increased by US\$3.5 trillion, from \$8.8 trillion in the middle of 2007 to \$12.3 trillion at the end of 2009.⁷⁷³

After the crisis, the Financial Crisis Inquiry Commission (FCIC) was created by the United States government to “*examine the causes of the current financial and economic crisis in the United States*”. During hundreds of witness hearings under oath, numerous cases of risk information concealment were revealed, which had led to an inadequate perception of mortgage-related risks among US officials and financial industry executives. The commission stated: “*The crisis was the result of human action and inaction, not of Mother Nature... The captains of finance and the public stewards of our financial system ignored warnings and failed to question, understand, and manage evolving risks within a system essential to the well-being of the American public. Despite the expressed view of many on Wall Street and in Washington that the crisis could not have been foreseen or avoided, there were warning signs. The tragedy was that they were ignored or discounted... Little meaningful action was taken to quell the threats in a timely manner*”.⁷⁷⁴ Ultimately, the deregulation of the financial sector over decades, the highly fragmented state of US financial regulation and the desire of both government and financial institutions to ensure permanent growth of

⁷⁶⁹W.-X. Zhou, D. Sornette, Is There a Real-Estate Bubble in the US? *Physica A: Statistical Mechanics and its Applications*, 2006, 361, pp. 297–308.

⁷⁷⁰Markus K. Brunnermeier, Deciphering the Liquidity and Credit Crunch 2007–2008, *Journal of Economic Perspectives*, 2009, 23(1), 77–100.

⁷⁷¹Justin Yifu Lin, Policy Responses to the Global Economic Crisis, *Development Outreach*, World Bank Institute, Volume 11, Issue 3, December 2009, pp. 29–33.

⁷⁷²Historical Budget Data—August 2013, Revenues, Outlays, Deficits, Surpluses, and Debt Held by the Public since 1973, Congressional Budget Office, August 12, 2013.

⁷⁷³The Daily History of the Debt Results: historical returns from 07/16/2007 through 12/31/2009, U.S. Department of the Treasury, Bureau of the Fiscal Service.

⁷⁷⁴The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, p. xvii.

income and of the economy as a whole, in an illusionary belief in a perpetual money machine⁷⁷⁵—all of these together led to this crisis. There are strong arguments and compelling evidence that the financial meltdown was predictable and thus avoidable, and resulted from an exaggerated implementation of the free-market ideology and shareholder-value capitalism, with strong asymmetric information and misaligned incentives between shareholders and managers (the so-called agency problem), competition of the corporate-elites and, arguably, a shocking failure of leadership.⁷⁷⁶

From a macro-economic view point, the crisis had its roots in non-sustainable global unbalances, in particular in the exploding China trade surplus with respect to the US, and the associated growing US debt bought by the Chinese, Japanese and Germans: *“If foreigners hold the debt, the interest rate stays stable. Mercantilist only works as long as they are willing to take the losses with the inflation that is coming along. Avoids social consequences of supernormal growth rates for them; subsidizes us by buying our debt. Good deal for us: they give us goods and we give them paper. Herb Stein would say: unsustainable trends have to end”*.⁷⁷⁷ Even the New York Fed admitted that, because of this trade, rates were held artificially low and drove the search for yield leading up to the crisis.⁷⁷⁸ This sounds all too familiar regarding the five years of Quantitative Easing (QE) that have followed and created many short lived bubbles and other unsustainable unbalances!⁷⁷⁹ The crisis has forced us to pay closer attention to the deregulated derivatives market, whose notional size amounts for more than US\$600 trillion⁷⁸⁰—10 times more than the annual global world GDP. Nobody really knows what kind of threats derivatives could bring to the world financial system...

2.2.3.3 Risk Concealment Before the Disaster

Decades-Long Destruction of the Legislation that Followed the Great Depression

In 1933, after the Great Depression, the Banking Act, usually referred to as the Glass–Steagall Act, was passed. In four provisions of the Act, securities activity by

⁷⁷⁵D. Sornette and P. Cauwels, 1980–2008: The Illusion of the Perpetual Money Machine and what it bodes for the future, *Risks* 2, 103–131, 2014.

⁷⁷⁶Michael Lounsbury and Paul M. Hirsch, Editors, *Markets on Trial: The Economic Sociology of the U.S. Financial Crisis*, Emerald Group Publishing Limited (July 14, 2010).

⁷⁷⁷Meltzer on the Fed, Money, and Gold, EconTalk Episode with Allan Meltzer hosted by Russ Roberts, Library of Economics and Liberty (May 19, 2008) (http://www.econtalk.org/archives/2008/05/meltzer_on_the.html).

⁷⁷⁸Dempster, M.A.H. (University of Cambridge, UK), personal communication (Dec. 22, 2014).

⁷⁷⁹Sornette, D. and P. Cauwels, Financial bubbles: mechanisms and diagnostics, *Review of Behavioral Economics* (in press 2015) (<http://ssrn.com/abstract=2423790>).

⁷⁸⁰Sources: U.S. National statistics; International Monetary Fund; OECD, Bain Macro Trends Group Analysis, 2012; Top 10 Challenges for Investment Banks 2011, Accenture, 2010, Chapter “Challenge 2: Dealing with OTC Derivatives Reform”.

commercial banks and affiliations between commercial banks and securities firms were restricted to avoid conflicts of interests. The creation of a single financial institution combining an investment bank, a commercial bank and an insurance company was prohibited. In 1934, the United States Securities and Exchange Commission (SEC) was established to regulate secondary trading of securities, by regulating stock exchanges and enforcing sanctions against criminal acts of fraud.⁷⁸¹ In the 1970s, American economists suggested that deregulation of the economy could increase competition within industries, reduce the price of goods and services through the interdependency of supply and demand, and enhance the economic growth of the United States. In 1971, during the Nixon presidency, the first step towards deregulation was made in the transportation industry with the deregulation of rail and truck transport. In 1978, during the Carter administration, the Airline Deregulation Act was passed.

In 1981, U.S. president Reagan promoted a new economic policy based on the reduction of government spending, federal income tax and capital gains tax, and on minimizing government intervention in the economy with the goal to stimulate jobs creation and productivity gains. To implement the “Reaganomics” strategy, Donald Regan—former chairman and CEO of the investment bank Merrill Lynch—was appointed to the position of Secretary of the Treasury, the American equivalent of finance minister. In 1982, the Garn–St. Germain Depository Institutions Act was passed in order to help savings and loan associations compete with mutual funds, which were offering more lucrative interest rates during the high inflation of the 1970s–1980s.⁷⁸² In a short speech describing his motivations for the Garn–St. Germain Depository Institutions Act, Reagan “*told an audience of S & L executives, bankers members of Congress, staffers, and journalists that the bill – which bore the names of Republican Senator Jake Garn of Utah and Democratic Congressman Fernand St Germain of Rhode Island – would cut S & Ls loose from the girdle of old – fashioned regulation. One of Reagan’s campaign platforms was deregulation, to get government off the backs of businesses to help the struggling economy create new jobs. When Reagan took office in 1981, mortgage rates were in nosebleed territory: 14 percent. (And this was for home buyers with good credit.) A year later rates would be even higher – 16 percent. ... Reagan signed the Garn – St Germain bill, he said the legislation would create more housing, more jobs, and growth for the economy. ‘All in all’, ‘he proclaimed’, ‘I think we’ve hit the jackpot’*”.⁷⁸³ The act broadened the range of legally permitted loans

⁷⁸¹Matthew Sherman, A Short History of Financial Deregulation in the United States, Center for Economic and Policy Research, July 2009, pp. 3–4.

⁷⁸²Ibid, p. 7.

⁷⁸³Paul Muolo and Mathew Padilla, Chain of Blame. How Wall Street Caused the Mortgage and Credit Crisis, John Wiley & Sons, Inc., p. 52; But this book does not mention any information about the large contributions of the financial industry to Reagan’s campaign and the appointment of its representatives in key positions in US regulatory bodies.

and investments, allowing banks to provide variable-rate mortgage loans. Mutual funds, established by investment banks, were serious competitors of commercial banks: the assets of mutual funds surged from US\$3 billion in 1977 to more than US\$740 billion in 1995, and US\$1.8 trillion by 2000.⁷⁸⁴ These funds were not regulated: according to the testimony of Paul Volcker, former chairman of the Federal Reserve, “*There was no regulation. It was kind of a free ride*”.⁷⁸⁵ These funds had complete freedom of investment activity and did not participate in the deposit insurance system. Clients’ protection against losses was based only on the investment bank’s reputation for protecting money market funds.⁷⁸⁶ The rise of mutual funds urged the commercial banks to “*put a lot of pressure on [government] institutions to get higher-rate performing assets*”.⁷⁸⁷

The Tax Reform Act of 1986 also promoted the house bubble and mortgage refinancing frenzy: “*And there was yet one more advantage to being a consumer finance company, especially one that was making loans (second liens) secured by a house. Congress passed the Tax Reform Act of 1986 – signed into law by President Reagan – which eliminated the ability of consumers to deduct interest payments on credit cards, auto loans, and all types of personal loans. Worried about a growing budget deficit, the politicians were hoping that by eliminating the tax deduction, this newfound money would feed the federal coffers. Consumers could no longer deduct the interest payments on their cars, credit cards, or personal loans, they might stop spending, which ultimately might hurt the consumer finance industry. Instead, it shifted borrowing – to some degree – away from personal loans to an asset class where Americans could still deduct the interest payments: the home*”.⁷⁸⁸

In 1986–1987, the Federal Reserve allowed American banks to make up to 5 % of gross revenues from investment banking business, and to underwrite commercial paper (unsecured promissory notes issued by banks or corporations), municipal bonds, and mortgage-backed securities.⁷⁸⁹ In August 1986, Alan Greenspan, a leading apologist for deregulation and the free market, was appointed as chairman of the Federal Reserve; he was to remain chairman for the following 18½ years until January 2006. In the same year, commercial banks obtained the right to get up to 10 % of their revenue from debt and equity securities; in 1996, this limit was raised to 25 %.⁷⁹⁰ Banks also got permission to deal with derivatives: debt

⁷⁸⁴The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 30.

⁷⁸⁵Ibid, p. 33.

⁷⁸⁶Ibid, p. 33.

⁷⁸⁷Ibid, p. 34.

⁷⁸⁸Paul Muolo and Mathew Padilla, Chain of Blame. How Wall Street Caused the Mortgage and Credit Crisis, John Wiley & Sons, Inc., pp. 36–37.

⁷⁸⁹Matthew Sherman, A Short History of Financial Deregulation in the United States, Center for Economic and Policy Research, July 2009, p. 9.

⁷⁹⁰Ibid, p. 9.

securities (allowed from 1983), interest and currency exchange rates (from 1988), stock indices (from 1988), precious metals such as gold and silver (from 1991), and equity stocks (from 1994).⁷⁹¹ During the 1980s and early 1990s, commercial banks began providing higher-risk loans with higher interest payments. They offered loans to oil and gas producers, financed leveraged buyouts of corporations, and funded residential and commercial real estate developers for international expansion.⁷⁹² As a result, during the savings and loan crisis in the late 1980s and early 1990s, 1034 savings and loan associations failed with US\$160 billion losses.⁷⁹³ By contrast, 584 banks had failed between 1934 and 1980 when there was a rigid legal framework.⁷⁹⁴

Later, Greenspan described the arguments for deregulation: *“Those of us who support market capitalism in its more competitive forms might argue that unfettered markets create a degree of wealth that fosters a more civilized existence. I have always found that insight compelling.”*⁷⁹⁵ *“The market-stabilizing private regulatory forces should gradually displace many cumbersome, increasingly ineffective government structures.”*⁷⁹⁶ The decline of government involvement in the economy had an ideological and geopolitical basis, coinciding as it did with the collapse of the Soviet Union, a unique example of total government control over political, social and economic activities. In addition, the financial lobby sought theoretical credibility for further deregulation from the academic world, and began to engage prominent professors and researchers to study the possible advantages of deregulated markets. They offered millions of dollars in funding and grants, tens of thousands of dollars in speaking fees and generous salaries for involvement on the boards of financial institutions.⁷⁹⁷ In fact, the academic founders of modern finance theory did not need to be induced into their theoretical positions. They deeply believed in the creative logic of their work.⁷⁹⁸ Unsurprisingly, all these elements combined to ensure the dominance of a free-market theory, supported by apparently solid scientific studies, which argued for the necessity to decrease the role of government in the economy. This research helped financial lobbyists to find

⁷⁹¹The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 35.

⁷⁹²Ibid, p. 35.

⁷⁹³Timothy Curry, Lynn Shibut, The Cost of the Savings and Loan Crisis: Truth and Consequences, FDIC Banking Review, Dec. 2000, pp. 26, 29.

⁷⁹⁴Failures and Assistance Transactions, Number of Institutions US and Other Areas (1934–1980), Federal Deposit Insurance Corporation. <http://www2.fdic.gov/hsob/HSOBSummaryRpt.asp?BegYear=1934&EndYear=1980&State=1&Header=1>.

⁷⁹⁵Remarks by Chairman Alan Greenspan, Before the Council on Foreign Relations, Washington, D.C., Nov. 19, 2002.

⁷⁹⁶The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 28.

⁷⁹⁷Documentary film “Inside Job”, Director Charles Ferguson, 2010.

⁷⁹⁸See Donald Mackenzie, An Engine, Not a Camera: How Financial Models Shape Markets, The MIT Press, Aug. 29, 2008.

a legal justification for deregulation, and convince politicians to disassemble the legal framework that had been in place since the Great Depression: from 1999 to 2008, the financial sector spent US\$2.7 billion on reported federal lobbying. In addition, the sector contributed more than US\$1 billion to political campaigns during this period.⁷⁹⁹

“We Had a 21st-Century Financial System with 19th-Century Safeguards”

In 1998, during the Clinton administration, Citibank announced a merger with Travelers Insurance Group—which owned Salomon Brothers investment bank—to establish the largest financial institution in the world, Citigroup Inc. It is remarkable that the deal was declared in violation of the Glass–Steagall Act of 1933, but the Federal Reserve made an exception for this merge. At the time of the deal, the Secretary of the Treasury was former Goldman Sachs executive Robert Rubin, who worked at Citigroup Inc. after the merger as a board member, chairman of the executive committee and chairman of the board of directors (1999–2009). Citigroup Inc. paid him up to US\$126 million.⁸⁰⁰ In 1999, after lobbying from the financial sector, Congress passed the Gramm–Leach–Bliley Act, which lifted all restrictions against the combination of banking, securities and insurance operations within a single financial institution. This paved the way for further mergers.⁸⁰¹ Ultimately, by 2005, the ten largest US commercial banks held 55 % of the industry’s assets—twice the proportion held by the top ten in 1990.⁸⁰² Lawrence Summers, Rubin’s successor as Secretary of the Treasury and a former academic economist and Harvard professor, said on the passing of the Gramm–Leach–Bliley Act: “*Today, Congress voted to update the rules that have governed financial services since the Great Depression and replace them with a system for the 21st century. This historic legislation will better enable American companies to compete in the new economy*”.⁸⁰³ After the crisis, the FCIC commission stated that, in fact, “*we had a 21st-century financial system with 19th-century safeguards*”.⁸⁰⁴

⁷⁹⁹The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. xviii.

⁸⁰⁰William D. Cohan, Rethinking Bob Rubin From Goldman Sachs Star to Crisis Scapegoat, Bloomberg, Sep. 20, 2012.

⁸⁰¹Matthew Sherman, A Short History of Financial Deregulation in the United States, Center for Economic and Policy Research, July 2009, p. 10.

⁸⁰²The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. xvii.

⁸⁰³Stephen Labaton, Congress Passes Wide-Ranging Bill Easing Bank Laws, The New York Times, Nov. 5, 1999.

⁸⁰⁴The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. xx.

Deregulation led to a situation where the banking, securities and insurance operations of the new merged financial institutions were still overseen by separate regulators: there was no single government regulator looking at all of their commercial activities. So neither government nor the executives of financial institutions had the whole picture of the risks involved in a complex combination of businesses with different interests—especially in the widening distribution of derivatives. For instance, the CEO of Citigroup told the FCIC commission that US\$40 billion invested in highly rated mortgage securities would “*not in any way have excited my attention*”, and the co-head of Citigroup’s investment bank said he spent “*a small fraction of 1 % of his time on those securities*”. The commission declared that “*too big to fail meant too big to manage. We conclude a combination of excessive borrowing, risky investments, and lack of transparency put the financial system on a collision course with crisis*”.⁸⁰⁵

The complexity of understanding the principles of the creation and calculation of derivatives, together with continued lobbying from financial institutions, resulted in the absence of serious government regulation over innovative financial instruments. We should also stress the prevalence of finance theories that rationalized and legitimized both public deregulation and extraordinary private risk-seeking behavior, while generating such complexity in the financial engineering and the underlying cash flows beneath the financial structures that literally no one could have penetrated in the cases of Enron and of the global financial crisis.

When the Commodity Futures Trading Commission expressed their intention to discuss the possible regulation of over-the-counter (OTC) derivatives, their attempts to do so were suspended by Alan Greenspan, Robert Rubin and Lawrence Summers.⁸⁰⁶ Greenspan testified that there was no need for government oversight, because “*regulation of derivatives transactions that are privately negotiated by professionals is unnecessary*”.⁸⁰⁷ In the 20 years from early 1990 to 2009, the unregulated global derivatives market—of which 90 % consisted of OTC derivatives—grew from US\$10 trillion to US\$605 trillion⁸⁰⁸; the world GDP in 2010 was approximately US\$65 trillion.⁸⁰⁹ After the mortgage crisis in autumn 2008, Greenspan admitted that “*Those of us who have looked to the self-interest of lending institutions to protect shareholders’ equity (myself especially) are in a state of shocked disbelief*”.⁸¹⁰ The FCIC commission considered that “*the enactment of legislation in 2000 to ban the regulation by both the federal and state governments*

⁸⁰⁵Ibid, p. xix.

⁸⁰⁶Rick Schmitt, Prophet and Loss, Stanford Magazine, March/April 2009.

⁸⁰⁷Testimony of Chairman Alan Greenspan, The regulation of OTC derivatives, Before the Committee on Banking and Financial Services, U.S. House of Representatives, July 24, 1998.

⁸⁰⁸Top 10 Challenges for Investment Banks 2011, Accenture, 2010, Chapter “Challenge 2: Dealing with OTC Derivatives Reform”.

⁸⁰⁹In search of growth, The Economist online, May 25, 2011.

⁸¹⁰Kara Scannell, Sudeep Reddy, Greenspan Admits Errors to Hostile House Panel, The Wall Street Journal, October 24, 2008.

*of OTC derivatives was a key turning point in the march toward the financial crisis”.*⁸¹¹

Creation of Housing Bubble

In order to stimulate economic growth, the administrations of Bill Clinton and George W. Bush set aggressive goals to increase home ownership, which could generate activity in the construction industry and create millions of new jobs. Deregulated financial products and a Federal Reserve interest rate of 1.75 %, the lowest in the previous 40 years, supplied accessible credit for potential borrowers. From 1999 to 2007, the average house price nationwide increased by 67 %; in 110 metropolitan areas, the price doubled. The floor area of an average new home grew by 15 % in the decade from 1997 to 2007.⁸¹² In 2005, more than 10 % of house sales were made for financial reasons by investors, speculators, or people buying second homes. Houses became a commodity—an asset—and could be mortgaged to get cash for putting children through college, medical bills, or sabbaticals to launch new businesses. As a result, home refinancing rose from US\$460 billion in 2000 to US\$2.8 trillion in 2003, despite stagnant wages.⁸¹³

Before the deregulation of the early 1980s, lenders selected borrowers carefully, because they needed, for their own sake, to ensure that a borrower could pay a 30-year fixed-rate mortgage. The stability of financial institutions depended on the reliability of their debtors. Even in the 1990s, only the highest quality clients who could comply with tough requirements—known as “prime” borrowers—were eligible. For example, one requirement was that first-time home buyers should be able to make a 20 % down payment. However, deregulation and active encouragement from the government allowed lenders to lower the acceptable standard for borrowers, and provide credit for people with no credit history or proof of income—and the “subprime” market was born. It was made possible by the creation of a securitization pipeline: lenders packaged loans into residential mortgage-backed securities, and these securities were repackaged again into collateralized debt obligations (CDOs) by investment banks like Goldman Sachs, Merrill Lynch, Bear Stearns or Lehman Brothers. In their turn, CDOs were promoted among more conservative American investors (retirement systems, hospitals, endowment funds and the like) and global investors (pension funds and sovereign funds) as a “super-senior” and “s`securities from a range of different quality debtors”^{814,815}

⁸¹¹The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, p. xxiv.

⁸¹²Ibid, p. 5.

⁸¹³Ibid, p. 5.

⁸¹⁴Paul Muolo and Mathew Padilla, Chain of Blame. How Wall Street Caused the Mortgage and Credit Crisis, John Wiley & Sons, pp. 185, 219.

⁸¹⁵The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, pp. 117, 119, 170, 278, 339, 393.

Economist James Grant described the “*mysterious alchemical processes [by which] Wall Street transforms BBB-minus-rated mortgages into AAA-rated tranches of mortgage securities*”.⁸¹⁶ Companies like American International Group (AIG)—the largest insurance company in the world—insured the banks against potential default by credit default swaps (CDSs). By 2007, AIG had issued CDSs on \$379 billion of underlying value.⁸¹⁷

A strong positive feedback mechanism developed between the home price dynamics and the loan origination process: “*Why would the defendants overvalue the homes? Answer: because the higher the house value, the larger the loan Ameriquest [it was one of the largest sub-prime mortgage lender in the United States until shut down in 2007] could fund. The larger the loan, the higher the commission the friends could earn. On \$9 million in retail loans that Ameriquest had extended on the 64 homes, the seven friends earned \$172,400, which works out to almost two points (2 percent) per loan. The loan officers, most of whom were in their 20 s, found the borrowers by going through the company’s ‘turn – down files’ where LOs stored the names of customers who had previously been rejected for loans. But the borrowers didn’t receive kickbacks from the LOs – they were just happy to get a mortgage*”.⁸¹⁸ This fed on the absence of information concerning payments of subprime borrowers: “*Mike McMahon, the stock analyst, saw the problem coming. ‘They were way too optimistic on the life of the loans,’ he said. ‘Everyone was guessing with limited historical data.’ Historical data? As far as securitization went, subprime mortgages had no history. ‘Everyone was guessing,’ said McMahon. ‘These weren’t Fannie, Freddie, and FHA loans where there’s 40 years of past data to look at on how they’d perform’*”.⁸¹⁹

Corruptive Assessments of American Rating Agencies

In their book *Chain of Blame*, Paul Muolo and Mathew Padilla summarize the process as follows: “*Almost every mortgage they put into a bond was a loan made to a borrower who either had bad credit or was considered a stated – income risk. Stated – income mortgages worked like this: The borrowers stated their income*

⁸¹⁶The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 194.

⁸¹⁷Matthew Richardson, *Why the Volcker Rule Is a Useful Tool for Managing Systemic Risk*, NYU Stern School of Business, 2012, p. 8.

⁸¹⁸Paul Muolo and Mathew Padilla, *Chain of Blame. How Wall Street Caused the Mortgage and Credit Crisis*, John Wiley & Sons, p. 88.

⁸¹⁹*Ibid.*, p. 44.

*and the lenders believed them. It was a wildly popular product and for obvious reasons: Borrowers got what they wanted even though they had to pay a slightly higher interest rate for it. Wall Street loved any type of loan that was paying a higher rate than the conventional or “A” paper rate of good credit quality mortgages sold to Fannie Mae and Freddie Mac, two congressionally chartered mortgage giants whose mission in life was to buy such loans. A higher – yielding mortgage meant that a Wall Street firm like Bear Stearns could create a higher – yielding bond to sell to an investor. Every time a bond salesman at Bear (or any other firm) sells a bond, he takes a fraction of the deal for himself. On a \$50 million bond, the commission might be an eighth of a point, which works out to \$62,500. Bond commissions are not openly publicized and can vary greatly depending on what type of bond is being sold. But one equation rings true – the higher the yield on the bond, the higher the bond sale commission. Subprime mortgages were the highest – yielding loans around that were backed by something tangible: a house”.*⁸²⁰

The CDOs’ AAA rating was assigned by such respected rating agencies as Moody’s, Standard & Poor’s and Fitch. Investment banks “paid handsome fees to the rating agencies to obtain the desired ratings”⁸²¹ – between US\$0.5 million to 0.85 million for every mortgage-related security. In the 1990s, the quality of the obligations was not in doubt but, with the subsequent growth of lending, it became harder to carefully track the quality of borrowers. The rating agencies knew exactly what they were doing. One S&P employee wrote: “Rating agencies continue to create an even bigger monster – the C.D.O. market. Let’s hope we are all wealthy and retired by the time this house of cards falters”. Another wrote in an instant message: “We rate every deal. It could be structured by cows and we would rate it”.⁸²² After the crisis, Moody’s executives testified: “We had almost no ability to do meaningful research... The threat of losing business to a competitor [Standard & Poor’s or Fitch], even if not realized, absolutely tilted the balance away from an independent arbiter of risk towards a captive facilitator of risk transfer... Bankers were pushing more aggressively, so that it became from a quiet little group to more of a machine... Subprime [residential mortgage-backed securities] and their offshoots offer little transparency around composition and characteristics of the loan collateral... Loan-by-loan data, the highest level of detail, is generally not available to investors”.⁸²³ Moody’s standard disclaimer – stating that “The ratings... are, and must be construed solely as, statements of opinion and not statements of fact or recommendations to purchase, sell, or hold any securities”, gave the rating agency protection against any lawsuits from misled

⁸²⁰Ibid., pp. 7.

⁸²¹The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, p. 44.

⁸²²Jake Zamansky, The Chickens Come Home to Roost for Standard & Poor’s, Forbes Magazine, February 5, 2013.

⁸²³The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, p. 119.

investors. From 2000 to 2007, Moody's rated nearly 45,000 mortgage-related securities as AAA. In 2006 alone, when earnings on mortgage ratings reached US\$887 million or 44 % of overall corporate revenue, Moody's was putting its AAA stamp of approval on 30 mortgage-related securities every working day. In 2007–2008 during the crash, 83 % of the AAA mortgage securities of 2006 were ultimately downgraded.⁸²⁴

Following the onset of the financial crisis in 2008, banks and other financial firms have collectively paid more than \$40 billion as punishment for crisis-era misdeeds to the US government as off January 2015. But rating agencies have been also in the firing line and the US Justice Department has launched a lawsuit against S&P, a unit of McGraw Hill Financial, accusing S&P of giving top ratings to poor quality mortgage-backed securities between 2004 and 2007 and of knowingly misleading investors with inflated ratings of residential mortgage-backed securities and collateralized debt obligations (CDOs). According to the lawsuit, S&P gave the deceptive ratings so it could collect fees from the financial firms that sold the securities. The Justice Department and more than a dozen state attorneys general argue that “*S&P’s relationships with the banks that designed the mortgage deals ‘improperly influenced’ the ratings criteria. It also accused S&P of falsely claiming that its ratings ‘were objective, independent, uninfluenced by any conflicts of interest’*”.⁸²⁵ For fears of the negative impact towards shareholders, reputation damage and to avoid the embarrassment of paying the same or even more after a trial, ratings company Standard & Poor’s has struck a \$1.37 billion settlement with the U.S. Justice Department over mortgage ratings that S&P issued leading up to the 2008 financial crisis, a penalty large enough to wipe out the rating agency’s entire operating profit for a year.^{826,827} According to the CNN announcement of February 3, 2015,⁸²⁸ the settlement also resolves lawsuits with attorneys general in 19 states and the District of Columbia and S&P will pay separately \$125 million to California’s public pension fund to resolve claims that it was misled in three separate transactions. In January 2015, S&P already paid \$58 million to the Securities and Exchange Commission and \$19 million to settle similar charges with the attorneys general in New York and Massachusetts. Again, according to the CNN announcement of February 3,⁸²⁹ “*S&P said the latest settlement ‘contains no findings of violations of law by the company’*. However, federal

⁸²⁴Ibid, p. xxv.

⁸²⁵Ben Protess, S&P nears settlement with Justice Dept. over inflated ratings, The New York Times, January 12, 2015.

⁸²⁶Tom Huddleston, Jr., Fortune, JANUARY 28, 2015, <http://fortune.com/2015/01/28/standard-pooers-doj-settlement/>.

⁸²⁷Evan Perez and Ben Rooney, S&P to pay \$1.4 billion to settle U.S. charges, CNN Money (New York), February 3, 2015 (<http://money.cnn.com/2015/02/03/investing/sp-mortgage-settlement/index.html>).

⁸²⁸Ibid.

⁸²⁹Ibid.

prosecutors said the company has acknowledged the ‘improper conduct that led to this settlement’”.

Development of CDO Monsters

Once a mortgage securities package was sold, the lender had no need to monitor the financial situation of debtors, because all payments from borrowers were transmitted to the owners of mortgage securities. The minimum down payment was soon reduced to 3 % and, after Bush’s “Zero Down Payment Initiative”, it dropped to just US\$500. These lucrative terms attracted millions of subprime (near-prime, non-prime, and second-chance lending) borrowers, who had to pay a higher rate than prime borrowers: in California, the average subprime borrower was paying US\$600 per month more than a prime borrower on their mortgage payments because they had received a subprime loan.⁸³⁰ The share of subprime mortgages in the US mortgage market increased from 7.4 % in 2002 to 23.5 % in 2007.⁸³¹ Subprime mortgages meant greater profitability for financial institutions. Investment banks wanted constant growth in the number of new CDOs (collateralized debt obligations), and encouraged lenders to issue new credit for everyone. In a permanently growing real estate market, such a model worked well: borrowers warmed up the property market by taking the new more accessible credit, and lenders did not have to worry about the creditability of borrowers because they were transferring risks through CDOs and other mortgage securities to investors, who in turn insured risks through CDSs. As this was developing in full force, Greenspan declared that the financial system had achieved unprecedented resilience.⁸³² AAA ratings for mortgage securities maintained the illusion of a high quality of assets, which seemed to be among the safest in the world. One FCIC commission witness compared this financial creativity with “*cheap sangria, when a lot of cheap ingredients [are] repackaged to sell at a premium. It might taste good for a while, but then you get headaches later and you have no idea what’s really inside*”.⁸³³ One of the inventors of securitization testified that “*If you look at how many people are playing, from the real estate agent all the way through to the guy who is issuing the security and the underwriter and the underwriting group and blah, blah, blah, then nobody in this entire chain is responsible to anybody*”.⁸³⁴ As the commission put it, “*They all believed they could off-load their risks on a moment’s notice to the next person in line. They were wrong. When*

⁸³⁰The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, p. 11.

⁸³¹Ibid p. 70.

⁸³²Ibid, p. 83.

⁸³³Ibid, p. 6.

⁸³⁴Ibid, p. 89.

*borrowers stopped making mortgage payments, the losses—amplified by derivatives—rushed through the pipeline”.*⁸³⁵

For the financial sector, the real estate boom became a major source of profit, as a result of the higher interest rates paid by borrowers and the chain of bond placements by Wall Street: *“A consumer (usually subprime) buying a home or refinancing and trying to keep closing costs low would agree to pay a higher interest rate on the mortgage in return for paying no points (or fewer points) at the closing table. The higher yield on the loan made that mortgage more valuable to the wholesaler (Countrywide, Wells Fargo, Washington Mutual), because the wholesaler could sell it to Wall Street at a better price than a lower – yielding loan would garner. In the world of Wall Street, the higher the interest rate on a loan, the more valuable it became. Why? Answer: because the loan would be pooled into a bond, and bond investors loved higher – yielding assets. A higher yield of even just 1 percent more on a billion – dollar bond would translate into millions extra in income for the bondholder”.*⁸³⁶

From 1978 to 2008, the amount of debt held by the financial sector increased from US\$3 trillion to US\$36 trillion; more than 33 % of all corporate income in the United States was generated by financial institutions in 2003, while in 1980 the proportion had been 15 %.⁸³⁷ Before the 1980s, the majority of investment banks were private companies; a loyal employee would receive a bonus on retirement after a successful career lasting decades. After the 1980s, when investment banks became public companies and staff began to trade with shareholders' money, the compensation model completely changed: tremendously high annual bonuses urged executives and managers to focus on short-term financial results, increasing current capitalization and short-term profitability while ignoring the possible consequences of risky practice in the long-term. In 2007, Wall Street paid roughly US\$33 billion in year-end bonuses to New York workers.⁸³⁸ None of the executives wanted to overturn the defective mortgage market by revealing the shortcomings of the business model they had created. After the crisis Jamie Dimon, CEO of JP Morgan, testified that *“I blame the management teams 100 % and ... no one else”.*⁸³⁹ Federal, state and local government also benefited from the real estate boom through permanent economic growth, massive foreign investment in the US stock market, declining unemployment, rising revenues from individual and property taxes, etc. Any problem in the property market could lead to a cascade effect in many American industries, bankrupting millions of Americans, destroying profitability of the financial sector and bringing severe political consequences. So,

⁸³⁵Ibid, p. xxiv.

⁸³⁶Paul Muolo and Mathew Padilla, Chain of Blame. How Wall Street Caused the Mortgage and Credit Crisis, John Wiley & Sons, Inc., p. 68.

⁸³⁷The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, p. xvii.

⁸³⁸Ibid, p. 63.

⁸³⁹Ibid, p. 18.

decision makers in both the financial sector and US government were reluctant to ask questions or embark on a detailed investigation of common business practice within the securitization pipeline. This unwillingness encouraged the institutions involved in the pipeline to conceal information about the real situation within their businesses.

For example, lenders hired thousands of young people, with no mortgage experience, to sell credit products “*to, in some cases, frankly unsophisticated and unsuspecting borrowers*”.⁸⁴⁰ Lenders promoted low monthly payments in the first few months after taking a loan and hid bigger fees in subsequent payments, which were seldom disclosed to borrowers. A study by two Federal Reserve economists confirmed that at least 38 % of borrowers with adjustable-rate mortgages (ARMs) did not understand the calculation of their interest rates.⁸⁴¹ In 2006, during the Federal Reserve’s Home Ownership and Equity Protection Act hearings, consumers testified that ARM loans were sold to people speaking “*primarily non-English languages [migrants from Latin American and Asia], only to be pressured to sign English-only documents with significantly worse terms*”.⁸⁴² The FCIC commission found out that lenders had made loans knowing that borrowers could not afford them, and that the percentage of borrowers who defaulted on their mortgages within the first few months had grown steadily. Lenders had been “*forcing them to pay into—pay loans that they could never pay off. Prevalent among these clients are seniors, people of color, people with disabilities, and limited English speakers and seniors who are African American and Latino*”.⁸⁴³

In 2003, Washington Mutual ordered an internal study “*to explore what Washington Mutual could do to increase sales of Option ARMs, our most profitable mortgage loan*”.⁸⁴⁴ It revealed that Washington Mutual brokers “*felt these loans were ‘bad’ for customers ... a lot of (loan) consultants don’t believe in it ... and don’t think [it’s] good for the customer*”.⁸⁴⁵ Nevertheless, the company motivated brokers to focus precisely on selling ARMs: after 2004, more than 50 % of all Washington Mutual mortgages were adjustable-rate, and the volume of ARMs sold by Washington Mutual rose from US\$30 billion to US\$68 billion in 2004. Unfortunately, other lenders came to the same conclusion—and nationwide ARM sales rose from US\$65 billion in 2003 to US\$255 billion in 2006. During the subsequent crash, it was ARMs that generated the majority of defaults by borrowers as well as the greatest losses for mortgage securities holders.

During the boom, executives of Countrywide—a company that was financing up to 20 % of all mortgages in the United States, around 25 million homebuyers—recognized that many of the loans they were originating could result in

⁸⁴⁰Ibid, p. 8.

⁸⁴¹Ibid, p. 90.

⁸⁴²Ibid, p. 90.

⁸⁴³Ibid, p. 109.

⁸⁴⁴Ibid, p. 107.

⁸⁴⁵Ibid, p. 107.

“catastrophic consequences” and “financial and reputational catastrophe” for the firm. Angelo Mozilo, the co-founder and CEO of Countrywide, wrote in an internal e-mail: “In all my years in the business, I have never seen a more toxic [product]”.⁸⁴⁶ Nonetheless, Countrywide and the investment banks continued to sell these securities to investors, and insurance companies continued to insure them against default (in October 2010, Angelo Mozilo attained an agreement with SEC, in a settlement of the allegations against him that he misled Countrywide’s investors. He was sanctioned to pay a record US\$67.5 million in fines⁸⁴⁷).

The FCIC commission found that critical information was withheld from investors by other lenders too: Countrywide’s portfolio consisted of 59 % non traditional loans, but Wells Fargo had 58 %, Washington Mutual 31 %, CitiFinancial 26.5 %, and Bank of America 18 %.⁸⁴⁸ In some cases, lenders distorted information about the earnings and workplaces of applicants to ensure fast confirmation of loans: some debtors were categorized as “antiques dealers” or “light construction” workers.⁸⁴⁹ After the bankruptcy of New Century Financial Corporation in 2007, it was revealed that 40 % of its mortgages were loans with little or no documentation. Consequently, mortgage fraud grew 20-fold between 1996 and 2005 and doubled again between 2005 and 2009.⁸⁵⁰ More generally, this process can be described as a kind of fraud pandemic: “In 2004 and 2005, home lenders originated \$1.4 trillion in subprime loans – almost all of it winding up in ABSs, with the riskier bonds going into CDOs. Reporters from *National Mortgage News* and the *Orange County Register* began to investigate the outsourcing firms, interviewing not only the executives at those companies but also their rank – and – file workers who were hired – on a contract basis – to sit in hotel conference rooms, armed with a laptop, with orders to review one loan an hour. Mortgages were given a rating of a one, two, or three. One meant pass, two meant so – so, and three meant fail. ‘You weren’t supposed to fail loans unless they were horrendous,’ one contract underwriter told the reporters. He also confessed that they were told by their supervisors at Clayton never to use a certain word – ‘fraud’. Because competition was so stiff those years and because Merrill, Bear, J.P. Morgan, and other Wall Street firms were so hungry for product (which they could put into ABSs and CDOs), the goal, the underwriters said, was to pass as many loans as possible. Loan fraud is a fuzzy term that can mean many things, but in practice it boils down to two basic swindles: Either a borrower is lying about his or her income or the house is not worth what someone says it is. By late 2006, agents from the Federal Bureau of Investigation were describing loan fraud as pandemic in the

⁸⁴⁶Ibid, pp. xxii, 20.

⁸⁴⁷Former Countrywide CEO Angelo Mozilo to Pay SEC’s Largest-Ever Financial Penalty Against a Public Company’s Senior Executive, SEC, Washington, D.C., Oct. 15, 2010, <http://www.sec.gov/news/press/2010/2010-197.htm>.

⁸⁴⁸Ibid, p. 20.

⁸⁴⁹Ibid, p. 12.

⁸⁵⁰Ibid, p. xxii.

United States, singling out stated – income loans (that is, so-called liar loans) being funded through mortgage brokers as a chief problem".⁸⁵¹ In spite of the warnings of the FBI about mortgage fraud, government regulators of the financial sector paid little attention to this inappropriate practice.

During the commission hearing, a criminologist observed that "*Lax or practically non-existent government oversight created what criminologists have labeled 'crime-facilitative environments', where crime could thrive*". "*The FBI did have severe limits*" because they were authorized to tackle the threat of terrorism; nevertheless "*[they] got virtually no assistance from the regulators, the banking regulators and the thrift regulators*".⁸⁵² One former Bear Stearns executive testified that a Federal Reserve representative, on hearing that the housing securitization market was on a shaky foundation, said: "*We don't see what you're talking about because incomes are still growing and jobs are still growing*". Regulators "*relied extensively on banks' own internal risk management systems*" and expected that "*markets will always self-correct*".⁸⁵³

Wall Street CEOs Reject Early Warnings

In June 2006, Richard Bowen, chief business underwriter of Citi, discovered that up to "60 % of the loans that [were bought] and packaged into obligations were defective. If the borrowers were to default on their loans, the investors could force Citi to buy them back. He tried to alert top managers at the firm by 'email, weekly reports, committee presentations, and discussions'; but though they expressed concern, it 'never translated into any action'. He finally took his warnings to the highest level he could reach – Robert Rubin, the chairman of the Executive Committee of the Board of Directors and a former US treasury secretary. He sent Rubin and the others a memo with the words 'URGENT—READ IMMEDIATELY' in the subject line. Sharing his concerns, he stressed to top managers that Citi faced billions of dollars in losses if investors were to demand that Citi repurchase the defective loans. Rubin told the Commission in a public hearing in April 2010 that 'I do recollect this and that either I or somebody else, and I truly do not remember who, but either I or somebody else sent it to the appropriate people, and I do know factually that that was acted on promptly and actions were taken in response to it'. According to Citigroup, the bank undertook an investigation and the system of underwriting reviews was revised... There was no disclosure made to the investors with regard to the quality of the files they were purchasing... Bowen told the Commission that after he alerted management by sending emails, he went from

⁸⁵¹Paul Muolo and Mathew Padilla, Chain of Blame. How Wall Street Caused the Mortgage and Credit Crisis, John Wiley & Sons, Inc., p. 197.

⁸⁵²The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, pp. 161, 164.

⁸⁵³Ibid, pp. 19, 170, 171.

*supervising 220 people to supervising only 2, his bonus was reduced, and he was downgraded in his performance review”.*⁸⁵⁴

However, such practice was common not only in Citi, but also among other players of the securitization pipeline. Thus, Lehman Brothers CEO Richard Fuld was quickly eliminating internal critics who realized early that Lehman was heading for serious trouble. Any warnings from talented researchers and managing directors were ignored. There was a lack of communication and common understanding between the board of directors and senior management.⁸⁵⁵ By December 2006, Goldman Sachs executives recognized “*the major risk in the mortgage business*”, and they secretly decided – despite their own rule that “*clients’ interests always come first*” – to sell all mortgage securities to their own clients. The prevailing attitude is only too clear from these comments: “*Distribute junk that nobody was dumb enough to take first time around*”; “[*They*] structured like mad and traveled the world, and worked their tails off to make some lemonade from some big old lemons”; “*How much of that sh—deal did you sell?*”^{856,857} “... If any other banking agencies in Washington were alarmed by the boom that occurred in subprime lending – \$2.4 trillion in A – to D mortgages originated from the beginning of 2004 to the end of 2007, or 20 percent of all loans funded in the United States (a record) – they hardly voiced much concern, at least publicly. Perhaps because Wall Street was busy securitizing almost all of the loans being originated, they figured: If it’s good enough for the Street it must be okay...”⁸⁵⁸

The commission found out that “*the firm targeted less-sophisticated customers in its efforts to reduce subprime*”.⁸⁵⁹ In July 2007, Goldman Sachs failed to disclose to investors vital information about the low quality of one CDO, known as ABACUS 2007-AC1,⁸⁶⁰ which months later lost investors almost all of their \$150 million investment.⁸⁶¹ In July 2010, the SEC found that “*Goldman also acknowledged that its marketing materials for the subprime product contained incomplete information*” and sued Goldman Sachs for a US\$550 million fine – the largest

⁸⁵⁴Ibid, p. 19.

⁸⁵⁵Robyn Alman, Richard Cudmore, Natalie McVeigh, *Lehman Brothers: An Exercise in Risk Mismanagement*, New England College of Business, 2009.

⁸⁵⁶The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., January 2011, p. 235.

⁸⁵⁷Elizabeth MacDonald, *Goldman Sachs Accused of Misleading Congress, Clients*, FOX Business, April 14, 2011.

⁸⁵⁸Paul Muolo and Mathew Padilla, *Chain of Blame. How Wall Street Caused the Mortgage and Credit Crisis*, John Wiley & Sons, p. 292.

⁸⁵⁹The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 235.

⁸⁶⁰Press Release: Goldman Sachs to Pay Record \$550 Million to Settle SEC Charges Related to Subprime Mortgage CDO, Firm Acknowledges CDO Marketing Materials Were Incomplete and Should Have Revealed Paulson’s Role, U.S. Securities and Exchange Commission, Washington, D.C., July 15, 2010.

⁸⁶¹Dan Wilchins, Karen Brettell, Richard Chang, *Factbox: How Goldman’s ABACUS deal worked*, Reuters, April 16, 2010.

penalty ever paid by a Wall Street firm until that time – for withholding risk information. After the trial, one finance expert declared that this case was “*the most cynical use of credit information that I have ever seen... [It is like] buying fire insurance on someone else’s house and then committing arson*”.⁸⁶² In 2013, JP Morgan Chase was fined US\$13 billion by the US government for overstating the quality of the mortgages the bank had been selling to investors before the sub-prime mortgage crisis.⁸⁶³ And in 2014, the Bank of America also agreed to pay out a very large penalty – US\$16.65 billion – to settle mortgage bond claims (by August 2014, large American banks paid a cumulative penalty of almost on US\$127 billion).⁸⁶⁴ These practices amounted to what John C. Bogle, the founder and previous CEO of Vanguard, has qualified as “*the general loss of the fiduciary principle*”.⁸⁶⁵

Nobody Understood the Whole Picture of Risks

The FCIC commission declared: “*The mortgage pipeline also introduced leverage at every step. High leverage, inadequate capital, and short-term funding made many financial institutions extraordinarily vulnerable to the downturn in the market in 2007*”.⁸⁶⁶ Over-the-counter derivatives enabled derivatives traders at five major investment banks (Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley) to operate with leverage ratios on their capital as high as 40 to 1. In other words, for every US\$40 in assets, there was only US\$1 in capital to cover losses; less than a 3 % drop in asset values could bankrupt any major investment bank.⁸⁶⁷ Brokers at investment banks traded for and against the housing boom through credit default swaps. They often used clients’ assets to raise cash for their own activities without informing clients. Warren Buffett, the chairman and CEO of Berkshire Hathaway Inc., testified that derivatives were “*very dangerous stuff*”, difficult to understand for market participants, regulators, auditors and investors. He added that he didn’t think he could manage a complex derivatives book.⁸⁶⁸ However, it was revealed in November 5, 2011, that Buffett had sold equity derivatives (put options) to undisclosed buyers for \$4.9 billion.

⁸⁶²The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 236.

⁸⁶³Aruna Viswanatha, David Henry, Karen Freifeld, JPMorgan says ‘mea culpa’ in \$13 billion settlement with U.S., Reuters, Nov. 19, 2013.

⁸⁶⁴Christina Rexrode, Andrew Grossman, Record Bank of America Settlement Latest in Government Crusade, The Wall Street Journal, Aug. 21, 2014.

⁸⁶⁵Bogle, J.C. The Fiduciary Principle (No Man Can Serve Two Masters). Journal of Portfolio Management 36, 15–25, 2009.

⁸⁶⁶The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 134.

⁸⁶⁷Ibid, p. xix.

⁸⁶⁸Ibid, p. 49.

Liabilities on the so-called equity-index puts widened when four stock indexes fell from the levels they were at when Buffett made the contracts near the market peaks in 2006 and 2007. If the indexes are at zero when the agreements expire, the losses would be about \$34 billion. Bloomberg communicated that Buffett's foray in equity derivatives had put pressure on Berkshire, with profits dropping 24 %.⁸⁶⁹

The leverage level was often hidden in derivatives positions, in off-balance-sheet entities or REPO transactions to prevent rumors about the real financial situation of investment banks on the market.⁸⁷⁰ Serious doubts about the financial state of any firm could restrict access to the interbank lending market and bankrupt the firm. So it was not only external observers, but also investment bank executives, who failed to understand the real influence of OTC derivatives on their business. Even senior managers at the financial institutions lacked a sense of "the whole picture" of the risks of derivatives; and yet they continued to reassure investors, competitors, partners and the authorities of the financial stability of their organizations. For instance in April 2008 – just after the failure of Bear Stearns – Richard Fuld, CEO of Lehman Brothers, assured shareholders at a meeting that "*the worst ... [is] ... behind us*".⁸⁷¹ Some sources asserted that Fuld's personal experience was mainly as a bond trader, and that he had little technical understanding of such new financial instruments as CDOs and CDSs. Moreover, the majority of Lehman's board of directors had no specialized financial expertise: nine of them were retired, four of them over 75 years old, one was a theater producer, another a former Navy admiral... in fact only two had direct experience in the financial services industry.⁸⁷² Even after the bankruptcy of Lehman Brothers—for which he voted—Fuld insisted that "*There was no capital hole at Lehman Brothers. At the end of Lehman's third quarter [of 2008], we had US\$28.4 billion of equity capital*".⁸⁷³ There was a similar situation in AIG: executives at the insurance firm told the FCIC commission that "*they did not even know about these terms of the [credit default] swaps until the collateral calls started rolling*" in July 2007.⁸⁷⁴ Not even the office of Thrift Supervision, the regulators who supervised AIG on a consolidated basis, knew the true level of risk the company was underwriting.⁸⁷⁵ By the fall of 2007, AIG management certainly knew where things

⁸⁶⁹<http://www.bloomberg.com/news/2011-11-04/berkshire-earnings-decline-24-on-derivatives.html>.

⁸⁷⁰The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. xx.

⁸⁷¹Lorraine Woellert, Yalman Onaran, Fuld Targeted by Lawmakers as Surrogate for Wall Street Excess, Bloomberg, Oct. 6, 2008.

⁸⁷²Larry McDonald, Patrick Robinson, A Colossal Failure of Common Sense: The Incredible Inside Story of the Collapse of Lehman, Random House, Nov. 24, 2009, p. 91, 226, 234–236.

⁸⁷³The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 235.

⁸⁷⁴Ibid, p. 243.

⁸⁷⁵The Financial Crisis Inquiry Report, The Financial Crisis Inquiry Commission, Washington, D.C., Jan. 2011, p. 243.

were heading—and despite this, they too continued to convince investors that “*the risk we have taken in the U.S. residential housing sector is supported by sound analysis and a risk management structure ... we believe the probability that it will sustain an economic loss is close to zero ... We are confident in our marks and the reasonableness of our valuation methods ... [AIG has] active and strong risk management*”.⁸⁷⁶ In September 2008, the US government took over AIG in a US\$85 billion bailout, because of AIG’s liquidity shortage on credit default swap positions.

In addition, there was no unified regulator gathering information to build up a holistic picture of the risks involved in the housing bubble and the securitization pipeline. John Snow, US Secretary of the Treasury from 2003 to 2006, testified that regulators tended not to see a problem at their own institutions: “*Nobody had a full 360-degree view. The basic reaction from financial regulators was, ‘Well, there may be a problem. But it’s not in my field of view’*”.⁸⁷⁷ One member of the FCIC commission observed that “*it appears that market participants were unprepared for the destructiveness of this bubble’s collapse because of a chronic lack of information about the composition of the mortgage market. Information about the composition of the mortgage market was simply not known when the bubble began to deflate*”.⁸⁷⁸ After the crash, Federal Reserve Chairman Ben Bernanke admitted that he had missed the systemic risks: “*Prospective subprime losses were clearly not large enough on their own to account for the magnitude of the crisis*”.⁸⁷⁹ In 2006, property prices peaked and Bear Stearns investment bank was found problematic during the following year, but regulators stated that it was a “*relatively unique*” case. They continued to convince the financial community that there was “*comfort about the capital cushions*” at the big investment banks until the collapse of Bear Stearns in March 2008.⁸⁸⁰ Henry Paulson, US Secretary of the Treasury during the crisis, had been CEO of Goldman Sachs—one of the key players of the securitization pipeline—from 1999 until 2006. He warned in October 2007 that the burst of the housing bubble was “*the most significant risk to our economy*”.⁸⁸¹ Despite his warning, and the occurrence of US\$100 billion mortgage-related losses in 2007, the government did not act decisively to assess the real situation of the financial institutions, or to mitigate the consequences of a possible crisis, until the autumn of 2008. Because nobody could really see the whole picture, few could guess the real magnitude of the approaching calamity—even in the last few months before the government takeover of “Fannie Mae” (the Federal National

⁸⁷⁶Ibid, p. 272.

⁸⁷⁷Ibid, p. 172.

⁸⁷⁸Ibid, p. 465.

⁸⁷⁹Ibid, p. 27.

⁸⁸⁰Ibid, p. 288.

⁸⁸¹Edmund L. Andrews, Housing Slump ‘Unfolding,’ Treasury Chief Says, The New York Times, Oct. 16, 2007.

Mortgage Association) and “Freddie Mac” (the Federal Home Loan Mortgage Corporation) in August 2008.

“Why Are There no Jail Sentences for Wall Street CEOs?”

When the crisis occurred, a great number of Americans asked each other: “*Why are there no jail sentences for Wall Street CEOs?*” There was plenty of evidence of fraud, conspiracy and lies, but no criminal prosecutions of the executives of investment banks and auditors as there had been when the cases of Enron, WorldCom or Madoff’s ‘Ponzi’ scheme came to light. The answer is likely to be quite simple: this crisis was in significant part created as an unintended consequence of a close cooperation between the US government and private financial institutions—which were giving billions of dollars in contributions to the campaign coffers of both the Republican and Democratic parties. Nobody wanted to dig into the dirty laundry. The situation could be summarized by the following aphorism, which summarizes the generic problem underlying sound risk management: “*No one sees any pressing need to ask hard questions about the sources of profits when things are doing well*”.

Subprime Mortgage Crisis: Why Risks Were Concealed

- **Deregulation** was implemented in the (mistaken) pursuit of long-term improvement in the efficient allocation of resources. In this respect, the transient triumph of the Efficient Market and Rational Expectations Hypotheses created an intellectual environment that rationalized and legitimized policy initiatives that created the opportunity for massive, unregulated pursuit of short-term profits by all the intermediaries in the financial supply chain. So, **the captains of finance got carte blanche from the government to take further risks with derivatives**—and to conceal the risks they were taking—with near impunity.
- **Government representatives, and the executives and board members of financial institutions, did not fully understand the complexity of innovative financial instruments** and the potential consequences of deregulating the financial sector. **Government control over these complex systems was too weak** in the absence of a “mega-regulator”, and there was only **fragmentary perception of the whole picture of risks** among representatives of the government and the top managers of companies in the mortgage pipeline.
- **Wishful thinking among borrowers, investors and the media**—they preferred to believe only what they wanted to believe and in particular in the illusion of a “perpetual money machine” promising endless wealth

and prosperity for everyone based on the sure thing, the never ending growth of real-estate prices, and ignored known facts and early warnings about the real estate bubble and the low quality of CDOs.

- **Government executives were reluctant to admit mistakes in previous deregulation efforts**, which, together with the policy of low interest rates in 2002–2003, had help create the real estate bubble. Any admission of oversight would massively reduce the value of assets and lower US economic figures. So, government decision-makers preferred not to respond to clear evidence of risk before the collapse of Bear Stearns and Lehman Brothers.

2.3 Military, Social and Natural Disasters

2.3.1 *Unreadiness of the Soviet Red Army for the Nazi Invasion (1941)*



On June 22, 1941 at 3:30 a.m., the Nazi German armed forces (the Wehrmacht) together with Italian, Romanian, Finnish, Hungarian, and Slovakian forces invaded the Soviet Union. It was the most powerful invasion in world history in terms of the number of soldiers: more than 5.5 million fighters were amassed in 192 divisions for the Eastern campaign. The forces had more than 4300 tanks, 5000 military airplanes and 47,200 artillery guns and mortars.⁸⁸² The Soviet Red Army actually had numerical superiority over the Wehrmacht, but could not make use of

⁸⁸²“The Great Patriotic War of the Soviet Union, 1941–45” article, Great Soviet Encyclopedia, Moscow, 3rd edn., Vol. 4, 1971.

it because of its unreadiness for the sudden attack. During the first day, the Wehrmacht penetrated between 25 and 50 km into Soviet territory. By the end of the first week, Minsk, the capital of the Soviet Republic of Belarus, was taken. By the third week, the depth of the invasion exceeded 600 km and the Wehrmacht was close to Leningrad (the former St. Petersburg) and Kiev (the capital of the Soviet Republic of the Ukraine). After 3½ months of fierce battles, the Nazis had advanced up to 1000 km and reached the suburbs of Moscow, the capital of the Soviet Union.

The first months of the war on the Eastern Front—a major part of the Second World War—turned out to be a military catastrophe for the Red Army: more than 850,000 soldiers died, more than 1 million soldiers were captured, and nearly 3500 military airplanes and 6000 tanks were lost. The Wehrmacht seized territory that normally produced up to 40 % of Soviet GDP.⁸⁸³ In doing so, they lost 100,000 soldiers, 950 airplanes and 1700 tanks.

From December 1941 until May 1945, the Red Army successfully counterattacked the Wehrmacht near Moscow, destroyed Nazi divisions near Stalingrad and Kursk, liberated Eastern Europe from the Nazis and reached Berlin.

Nevertheless, the military failure experienced by the Red Army in those first few months was unprecedented. It remains one of the most tragic examples of mismanagement in world history. As we will document below, the widespread concealment of risks—at all levels of the Soviet military and political hierarchy—led to the failure of Soviet political and military executives to assess the reality adequately right before the invasion.

2.3.1.1 Risk Concealment Before the (Red Army) Disaster

Confrontation Between Soviet Politicians and Red Army Executives

There was a covert struggle extending over decades between the political and military executives of the Soviet Union. The fact is that Joseph Stalin rose to become the almighty leader of the Soviet Union and successor to Vladimir Lenin, the leader of the Communist Revolution of 1917, by systematic political struggle within the Communist Party and by his constant presence in Moscow, where all political decisions were made. He had huge political influence but did not have a military background and, during the Russian Civil War of 1918–1920, his military achievements were modest.⁸⁸⁴ By contrast, there was a small group of outstanding generals, who had won the Russian Civil war for the Bolsheviks. These officers

⁸⁸³Shamil Munchayev, Viktor Ustinov, *History of Russia*. Textbook for high schools, Moscow, 3rd edn., 2003, p. 194.

⁸⁸⁴Reference of the Commission of the Presidium of the Central Committee of Communist Party “Inspection of charges brought against Tukhachevsky, Yakir, Uborevich and other military leaders for treason, terrorism and military conspiracy by the judicial and the Party organs in 1937”. Russian Military Archives. 1993. #1. pp. 4–113, Military Historical Archive. 1998. #12. pp. 3–81.

had started to develop the Red Army from an initial small force of a few thousand soldiers in St. Petersburg and Moscow to end up creating a force that won control of the largest country in the world, and that defeated the well-equipped anti-communist forces of 14 countries, all trying to seize territory from a Russia weakened by the revolution. As the heroes of the Russian Civil War, they became the most prominent and popular people in the Soviet Union. To reduce their political influence and mitigate the possibility of possible military coups, Stalin appointed Kliment Voroshilov, his most loyal supporter, as People's Commissar for Defense (defense minister) of the Soviet Union in 1925, a position he retained until 1940. Like Stalin, Voroshilov did not have a military background and had little knowledge of modern military strategy, but he was able to control the ambitious, well-educated and self-determined generals.

Georgy Zhukov, one of the notable generals of World War II and Head of General Staff of the Red Army in 1941, remembered an episode which demonstrated the relationship between Voroshilov and the generals: *"I must say that Voroshilov, later People's Commissar for Defense, was incompetent in his position. To the end of his days, he remained a dilettante in military matters and never knew them deeply and seriously ... Responsibility for military questions fell to [Mikhail] Tukhachevsky, who was really a military expert [and was Voroshilov's First Deputy]. He had permanent struggles with Voroshilov and there were hostile relations between them. Voroshilov did not like Tukhachevsky... During the development of the [Red Army's] articles of war, there was an episode... Tukhachevsky, as Chairman of the articles of war commission, reported to Voroshilov. I was present at that moment. Voroshilov focused on some of the articles and began to express dissatisfaction and suggested changing something. Tukhachevsky, after listening to him, said: 'Comrade Commissar, the Commission can not accept your amendments'. Voroshilov asked 'Why?'. Tukhachevsky: 'Because your amendments are incompetent, Comrade Commissar'"*.⁸⁸⁵ Tukhachevsky was perceived as the informal leader and innovator among the officers of the Red Army. He realized that further war with Germany was unavoidable, and proposed fundamental changes in the Red Army, turning it from an equestrian armed force to a mechanized one through massive production of tanks, aircrafts, missiles, and so on, and through the complete re-training of soldiers to use this new equipment.⁸⁸⁶ Obviously, he wanted to remove Voroshilov from the top military position because of the latter's inability to implement the required changes. However, Stalin saw in Tukhachevsky's opposition a threat, not only to his loyal ally Voroshilov, but also to his own political position.

Ultimately, a severe purge of senior and middle-ranking officers of the Red Army began in 1937, with the intention of eliminating any opposition from the military to the politicians and giving the Politburo total control over the Red Army.

⁸⁸⁵Konstantin Simonov, *The point of view of the person of my generation. Reflections on Joseph Stalin*, Novosti Press Agency Publishing House, Moscow 1989, p. 338.

⁸⁸⁶M.N. Tukhachevsky *Selected Works* in 2 volumes, Moscow, Military Publishing House, 1964, Volume 1, pp. 24, 162, 180.

Between 1936 and 1938, the NKVD—the Soviet secret police and ancestors of the KGB—eliminated more than 44,000 officers, 7 % of the total number of commanders in the Red Army.⁸⁸⁷ Voroshilov personally signed orders for the executions of opposing officers.⁸⁸⁸ The majority of these officers, including Tukhachevsky, were executed on pro-German espionage charges. The question of whether any senior officers of the Red Army were actually involved in pro-German espionage remains open to this day. Nevertheless, by this severe purge, Stalin dealt with two problems: he eliminated any opposition to the central government among the Red Army command and put an end to any espionage activity within the Red Army ahead of the Second World War. One NKVD officer, arrested in 1939, testified in a statement that was eventually published in the late 1980s: “*The mass repression of decision makers could be explained by Stalin’s dictatorial methods of running the country, he makes all decisions in the country by himself, he does not tolerate objections and ignores the opinion of others and organizes massive operations [repressions] against those individuals who contradict (criticize) him*”.⁸⁸⁹ Stalin personally controlled the investigation process, received interrogation reports of the arrested officers and participated in deciding what to charge them with.⁸⁹⁰ Over several years, the entire regional command of the army—all commanders of regional army divisions, and of military training and administrative establishments—along with 90 % of the deputies and chiefs of arms, 80 % of the leadership at division level, and 91 % of regimental commanders and their deputies, were replaced.⁸⁹¹ Many witnesses confirmed cases after the repressions where junior commanders (captains) became colonels, and were appointed to command whole regiments, because there were no superior officers left. From 1937 to 1942, a military commissariat in the Red Army was created to ensure political oversight of the military command and to re-educate or indoctrinate personnel with pro-Communist ideology. Ultimately, Stalin obtained a new executive officer corps, who were devoted to him and the Communist Party.

⁸⁸⁷N.M. Ramanichev, People paid a high price for the victory, Military History Magazine, Moscow, 1991, № 12, pp. 2–9.

⁸⁸⁸Reference of the Commission of the Presidium of the Central Committee of Communist Party “Inspection of charges brought against Tukhachevsky, Yakir, Uborevich and other military leaders for treason, terrorism and military conspiracy by the judicial and the Party organs in 1937”. Russian Military Archives. 1993. #1. pp. 4–113, Military Historical Archive. 1998. #12. pp. 3–81.

⁸⁸⁹Reference of the Commission of the Presidium of the Central Committee of Communist Party “Inspection of charges brought against Tukhachevsky, Yakir, Uborevich and other military leaders for treason, terrorism and military conspiracy by the judicial and the Party organs in 1937”. Russian Military Archives. 1993. #1. pp. 4–113, Military Historical Archive. 1998. #12. pp. 3–81.

⁸⁹⁰Reference of the Commission of the Presidium of the Central Committee of Communist Party “Inspection of charges brought against Tukhachevsky, Yakir, Uborevich and other military leaders for treason, terrorism and military conspiracy by the judicial and the Party organs in 1937”. Russian Military Archives. 1993. #1. pp. 4–113, Military Historical Archive. 1998. #12. pp. 3–81.

⁸⁹¹N.M. Ramanichev, People paid a high price for the victory, Military History Magazine, Moscow, 1991, № 12, pp. 2–9.

Distorted Red Army Casualties of the Finish Campaign

In spite of the repressions, the modernization plans of the former military command were being implemented intensively. At the end of the 1920s, the Red Army had only 89 tanks and 1394 military aircraft imported from Europe but, by 1941, the army already had 20,000 tanks and 22,000 military aircraft, designed and manufactured in the Soviet Union.⁸⁹² In order to test the modernized Red Army in a real war, between November 1939 and March 1940, the Soviet Union tried to bring Finland back under Russian control. Finland had been part of the Russian Empire from 1809 to 1917, but was lost during the Russian Civil War. Stalin and the renewed military executive were counting on the power of mechanized armed forces, confident that the huge amount of modern military equipment would ensure victory. Voroshilov reported to Stalin before the Finnish campaign that *“everything is good, everything is fine, everything is ready [for a successful military operation]”*.⁸⁹³

However, the Red Army made modest military progress, gaining back for Russia only 11 % of Finnish territory; originally Stalin had hoped for total reunification with Finland. Against the Red Army's military operation, Finnish generals—the majority of whom were former officers of the Russian Empire, just like the Soviet senior officers executed in 1937–1938—mounted a sophisticated defense strategy, adapting well to the terrain and carefully coordinating units of well-trained soldiers. As a result, the Red Army formally defeated Finland, but in reality failed to achieve its ambitious goal, and the two countries signed a peace treaty. During and after that war, Red Army commanders at all levels began to embellish the real situation in their reports to superiors, because of the fear of further repression from Stalin after such a poor performance from what was—despite its tremendous wealth of military equipment—an under-trained army with young and inexperienced commanders.

This embellishment manifested itself especially in the falsification of figures for war casualties. Red Army officers tried to underplay their own losses, and exaggerate those of the enemy, in their reports to Stalin and the General Headquarters of the Red Army. Thus—according to the report received by the Politburo and the Supreme Council of the USSR—48,475 Soviet soldiers were killed and 158,863 were injured during the Finnish campaign, but the Finnish Defense Forces lost more than 70,000 soldiers and 250,000 were injured. Decades later, historians found out that the Red Army had actually lost 95,200 soldiers, and the Finnish Defense Forces had lost 23,500.⁸⁹⁴ In other words, Red Army officers halved their own losses and exaggerated the losses of the enemy by a factor of three.

⁸⁹²Ibid.

⁸⁹³Konstantin Simonov, *The point of view of the person of my generation. Reflections on Joseph Stalin*, Novosti Press Agency Publishing House, Moscow 1989, p. 307.

⁸⁹⁴Alexander Pravdin, *Casualties in ground battles of the Winter War*, <http://www.proza.ru/2011/08/05/1121>.

After the war, the Finns declared that the main defect of the Red Army was the weakness of its command. At debriefs, this statement was eventually admitted by the Red Army generals. They accepted that the troops did not suffer from a lack of equipment, but from an abundance of equipment and the inability of commanders of the infantry, tank divisions, the air force and the navy to interact effectively with each other: *"The war... showed that the weakest link in the chain was the level of training of commanders, who could not make the full use of... the personnel subordinated to them"*.⁸⁹⁵ Nevertheless, nobody had the courage to inform Stalin and the politicians, and to state openly that the main cause of the low level of training of Red Army commanders was the previous purges of senior and middle military management. Everybody was afraid of further repression. As a result, Stalin began to receive the information he wanted to hear and not an honest appraisal of the condition of the Red Army. In 1937, Hitler had also eliminated opposition among generals of the Wehrmacht, who objected to his plans for further conquests. However, only 60 generals were replaced and these were retired. Hitler also surrounded himself with generals who did not criticize his maniacal desire to expand the Third Reich.

The poor level of training of the Red Army commanders was one of the key factors in Hitler's decision to open an Eastern Front. In January 1941 at an executive military meeting with the commanders of his armies, he stated that *"The Russian Armed Forces are like a headless colossus with feet of clay but we cannot with certainty foresee what they might become in the future. The Russians must not be underestimated. All available resources must therefore be used in the German attack"*.⁸⁹⁶ In May 1941, Colonel-General Halder noted in his diary: *"The Russian officer corps is exceptionally bad. It produces a worse impression than [the officer corps] in 1933. It will take about 20 years until it reaches the same level [as 1933]"*.⁸⁹⁷ After the Second World War and Stalin's death, Alexander Vasilevsky, Marshall of the Soviet Union and Head of the General Staff of the Red Army (1942–1945), declared that *"without [the repressions of] the thirty-seventh year, there might not have been any war in the forty-first year. [When] Hitler decided to start the war in the forty-first year, the assessment about the degree of destruction of the military command [that had] occurred in the USSR played a significant role"*.⁸⁹⁸

After the Finnish campaign, the General Staff of the Red Army ordered their subordinates to improve the quality of military training of personnel. The subordinates began to send assuaging reports to Moscow about the supposed serious progress in training. In turn, the military command tried to reassure Stalin that the

⁸⁹⁵Boris Sokolov, *Secrets of the Finnish War*, Veche Publishing House, Moscow, 2000, p. 384.

⁸⁹⁶R. H. S. Stolfi, *Hitler's Panzers East: World War II Reinterpreted*, University of Oklahoma Press, 1993, p. 20.

⁸⁹⁷Shamil Munchayev, Viktor Ustinov, *History of Russia*. Textbook for high schools, Moscow, 3rd edn., 2003, p. 194.

⁸⁹⁸Konstantin Simonov, *The point of view of the person of my generation. Reflections on Joseph Stalin*, Novosti Press Agency Publishing House, Moscow 1989, p. 338.

Red Army had already overcome the shortcomings identified during the Finnish war and that it was ready for any war. In May 1941, inspired by the apparent progress, Stalin declared that fundamental restructuring of the army was over, that they now had 300 divisions with 10,000–13,000 soldiers in each, and that one third of the divisions were mechanized.

Stalin's Self-deception

Stalin did not believe that Hitler would attack the Soviet Union. There were several reasons for this view.

Firstly, Germany had a history of military failures caused by trying to wage a war simultaneously on two battlefronts, and Stalin expected that Hitler would not be keen to repeat this experience, but would wait for the total fall of Great Britain—especially since he had completely defeated France in only 1½ months in the summer of 1940.

Secondly, Stalin was relying on the Ribbentrop–Molotov Pact or Nazi–Soviet Pact, a mutual non-aggression pact signed in 1939, which determined agreed spheres of interests for both parties in Eastern Europe and declared the absence of aggressive motives.

Thirdly, if Hitler intended to attack the Soviet Union, the Wehrmacht would have to prepare for a period of winter warfare. Napoleon's "unbeatable" army was catastrophically defeated in Russia in the late autumn months of 1812 because they had not prepared for the long Russian winter. During 1940–1941, there was no intelligence evidence that the Wehrmacht was prepared for a winter campaign. Stalin always believed in taking a logical approach, and did not expect reckless actions from Hitler like launching an Eastern Front campaign with only summer equipment.

Fourthly, Russian military production output had risen sharply and this created the illusion that, as the Red Army had numerical superiority over any army in Europe, it would be in a favorable position to protect the Soviet Union from any external attack.

Fifthly, when the Red Army military intelligence service began to register serious movement of the Wehrmacht in Poland close to the western borders of the Soviet Union, Stalin suggested that it was a provocation from Hitler, and ordered the Red Army to give no reaction—to abstain from returning fire, or from shooting down German spy planes, and so on—in order to minimize the probability of any accusation of starting a war between the Soviet Union and Germany by mobilization of the Red Army. A quarter of a century earlier, on July 31, 1914, the Russian Empire had ordered the full mobilization of its troops in response to the attack by Austria-Hungary against Serbia, a close Russian ally; the next day, August 1, 1914, Germany had declared war on the Russian Empire and the First World War had started. With this dreadful precedent in mind, Stalin preferred not to mobilize the Red Army in order to avoid any blame for starting another war.

Sixthly, Stalin emphasized that all the foreign intelligence reports that had been warning him of Hitler's imminent invasion since late 1940 were merely provocations fabricated by Great Britain in its great distress, in order to draw the Soviet Union into the war with Germany. There was a meeting in the Kremlin on May 14, 1941, when the Soviet military command informed the Politburo about the concentration of German troops near the border of the Soviet Union, but Stalin categorically rejected the conclusions of the Soviet military: "*Germany is stuck up to its ears in the war on the West, and I believe that Hitler would not dare to create for himself a second front by attacking the Soviet Union. Hitler is not such fool as not to realize that the Soviet Union – is not Poland, it is not France, and it is not even England and all of them put together... Do you [generals] propose to mobilize the whole country, raise troops and move them to the western borders? This is war! Do you [military] understand it? ... Comrade Zhukov, tell us, why is your information about deployment of German army correct? – Comrade Stalin, all conclusions were refined by aerial reconnaissance and confirmed through a network of agents. – A network of agents? Whose? Ours or English? Our agents send me every week a new date for the commencement of hostilities, but nothing happens... Have you come to frighten us by war or do you want war? Do you have shortage of awards or titles? Stop generating nonsense!*"⁸⁹⁹ Stalin was finally convinced that he was right a week later, when Nazi Germany launched an invasion on Crete on May 20, 1941, which was a base for the Allies (the United Kingdom, New Zealand, Australia and Greece). Moreover, Hitler assured Stalin in personal correspondence that he had only ordered the concentration of the Wehrmacht's forces in Poland to reduce their losses from air raids by British bombers, which were occurring in France and Germany.⁹⁰⁰

Subordinates Provide Calming Reports to Stalin

In their turn, the Red Army command did not want to be seen by Stalin as British or German spies, so they did not try to transmit fully objective information from the western border. They preferred to change the "facts" to please Stalin. For example, Dmitry Pavlov, commander of the key Soviet Western Front in 1941, received extensive reports from subordinates about the Wehrmacht's prewar frontier activity, but in a call with Stalin, he said: "*No, Comrade Stalin, that's not true! I just came back from defensive positions. There is no concentration of German troops on the border, and my intelligence works well. I checked again, but I think it's just a provocation*". After the call, he commented to a colleague: "*Some bastards are trying to convince him [Stalin] that the Germans are concentrating*

⁸⁹⁹Georgy Zhukov, *Memories and Reflections*, OLMA Media Group, Moscow, Vol. 1, pp. 258–259.

⁹⁰⁰Sergey Smirnov, *Marshal Zhukov*, Moscow, Politizdat, 1988, p. 100.

troops on our border".⁹⁰¹ Moscow also tried to interpret German preparations as a provocation and "*assured [subordinates] that everything is in order, and [they have to] be quiet and not panic*".⁹⁰² As a result, the order to bring troops to full combat readiness was sent from Moscow only a few hours before the invasion started.

Pavlov and several other generals were accused of "*failure to perform their duties*" and executed one month after the invasion. Nobody among the Politburo and the Red Army command blamed Stalin for mismanaging the situation, refusing to listen to warnings and, above all, for having set up a system of absolute fear, which prevented reasonable criticism and the communication of objective information about risks. Stalin received the usual servile replies from his subordinates to anything he said: "*Yes, Comrade Stalin*", "*Of course, Comrade Stalin*", "*Quite right, Comrade Stalin*", "*You have made a wise decision, Comrade Stalin...*".⁹⁰³ After the war and Stalin's death, Georgy Zhukov stated that "... *it was the responsibility of the Red Army military executives that we did persistently demand to bring the army to full combat readiness [before the war] and urge early implementation of the necessary measures in case of war... Of course, we should be realistic about the possible consequences of any objections to Stalin about his assessment of the general political situation. Everyone remembers recent years during which, if anybody would speak aloud that Stalin was not right, it meant that this person immediately had to meet with the NKVD repression system*".⁹⁰⁴ Only once Stalin confessed his own mistakes—several days after the invasion, when he said angrily to his close subordinates: "*Lenin founded our state, and we've pissed it away*".⁹⁰⁵

2.3.1.2 Risk Concealment After the Disaster

During the first days of the invasion, Stalin and the General Staff of the Red Army had little information about the real situation on the battlefronts. In the midst of such a disaster, few officers at any level of the Red Army would have dared to

⁹⁰¹Contents of the call published after the war in memoirs of Alexander Golovanov, chief of long-range aviation of the Red Army (1942–1944). Alexander Golovanov, Long-distance bomber aviation, Moscow, Centrpoligraf publishing house, 2007, p. 56.

⁹⁰²Protocol of the closed hearing of the Military Collegium of the USSR Supreme Court concerning cases of Pavlov D.G., Klimovskikh V.E., Grigoriev A.T. and Korobkov A.A., Moscow, 22 July 1941. V.Pakhomov, The Great Patriotic War in the documents and testimonies of contemporaries, Samara, 1995, p. 145.

⁹⁰³Konstantin Simonov, The point of view of the person of my generation. Reflections on Joseph Stalin, Novosti Press Agency Publishing House, Moscow 1989, p. 360.

⁹⁰⁴Konstantin Simonov, The point of view of the person of my generation. Reflections on Joseph Stalin, Novosti Press Agency Publishing House, Moscow 1989, p. 357.

⁹⁰⁵Nikita Khrushchev, Time. People. Power, Moscow, Moscow News, Book I, 1999, p. 695.

admit their own inability to resist the Wehrmacht because of fears of repression. Therefore, they distorted all figures about actual casualties, and tried to convince superiors that a counterattack was possible in the near future. Moreover, because communication channels had been destroyed, the General Staff lost contact with many army units. According to the memoirs of senior army officers and members of the Politburo, in the first weeks after the invasion, Stalin thought the enemy could be defeated in a very short time, because of reports from the front claiming minimal losses for the Red Army and serious damage to the Wehrmacht: “[*The battlefield reports*] instilled confidence in him that [*the enemy could not continue for long to sustain such losses*] and soon the enemy would be defeated”.⁹⁰⁶ The General Staff of the Red Army were misinforming Stalin from the very first weeks: they consistently reduced casualty figures and concealed deplorable facts. For example, they informed Stalin that 700 aircraft had been lost in the first day because the order for full combat readiness came too late, but the real number of damaged aircraft exceeded 1200.

Later, Stalin began to understand that information had been withheld or distorted and shouted furiously: “*You [the military] are just afraid to tell us [the Politburo] the truth*”.⁹⁰⁷ On the 12th day after the invasion, Stalin called Alexander Golovanov, long range aviation chief for the Red Army, and ordered the use of high-altitude bombers to collect information about the German forces and their own army: “*We are not well informed about the situation at the front. We do not even know exactly where our military units and their staff are located and do not know where the enemy is. You have the most experienced flight crews. We need credible data... It will be your main concern. All gathered information must be immediately transmitted to us*”.⁹⁰⁸

Concentration of Political and Military Power in Stalin’s Hands for Effective Decision-Making

Stalin soon recognized that only direct and simultaneous leadership of the Soviet economy and the Red Army, and deep immersion in the military decision-making process, could guarantee an effective response to the most challenging crisis in Russian history. Therefore, six weeks after the invasion, Stalin became Supreme Commander of the Armed Forces of the USSR, and combined political and military power in his hands. Georgy Zhukov remembered: “*Stalin had his own method of conducting a military operation... Before preparing the operation, he was calling the officers of the General Staff – majors, lieutenant colonels, who oversaw the relevant operational areas. He called them for one-to-one meetings, worked with*

⁹⁰⁶Yuri Emelianov, *Stalin: Generalissimus of the Great Victory*, Yauza Publishing House, Moscow, 2008, p. 233.

⁹⁰⁷Ivan Stadnyuk, *The war*, Moscow, Military Publishing, 1987.

⁹⁰⁸Alexander Golovanov, *Long-distance bomber aviation*, Moscow, Centrpoligraf publishing house, 2007, p. 67.

them for 1½–2 hours in each specified situation. He was so prepared that he sometimes surprised the commanders of the battlefronts by his detailed knowledge... It was impossible to visit Stalin with a report with maps that had some “white spots” and reveal incomplete or exaggerated data. Stalin could not tolerate random answers, demanded exhaustive completeness and clarity. He had a special flair for weaknesses in the reports and documents. He immediately showed them and demanded exact clarification of the fuzzy information... Therefore, we tried to prepare reports very carefully”.⁹⁰⁹ This allowed Stalin to understand the reality of the situation at the battlefronts, competently discuss the planning of military operations with senior officers and increase the speed of the decision-making process. According to Georgy Zhukov: “At the beginning of the war, Stalin understood poorly the matters of operational art. ... He could conduct operational issues well... in the last period of the Battle of Stalingrad [winter of 1943] and the Battle of Kursk [summer 1943]... He began to rely on objective reality. [His previous] viewpoint summarized by ‘I decided about something and it must be done in any case’ evolved into a sober attitude based on a more objective assessment of reality... [More importantly] his mind and talent enabled him [to conduct military operations] not worse, and sometimes even better than his subordinates [professional battlefront commanders]”.⁹¹⁰

Ultimately, the war of the Soviet Union with the Nazis continued for 1418 days and resulted in the deaths of up to 27 million Soviet people. The Red Army made a major contribution to the defeat of Nazi Germany and to the victory of Allied forces in the Second World War.

Comments from a Modern Russian Historian About an Alternative Account of the Nazi German Invasion of the Soviet Union

After the preparation of this case, we sent it for comment to experts in the field. We received a very interesting assessment from Russian historian Sergey Nefedov, Senior Fellow in History at the Ural Federal University, about alternative views on the history of the Nazi German invasion of the Soviet Union—in particular addressing the question “*What if Stalin had ordered the Red Army to prepare for defense months before the actual time of the invasion?*” The following is Nefedov’s conclusion: even if Stalin had not conducted repressions and the highest officer corps had been saved; even if Stalin had received reliable information about the state of the Red Army during 1940 and 1941; even if Stalin had trusted the intelligence data clearly warning him about a huge concentration of German forces in Poland in the summer of 1941, and about the high likelihood of an attack on the Soviet Union in June 1941; even if Stalin had declared a total mobilization

⁹⁰⁹Konstantin Simonov, *The point of view of the person of my generation. Reflections on Joseph Stalin*, Novosti Press Agency Publishing House, Moscow 1989, p. 328.

⁹¹⁰*Ibid.*

of the USSR and ordered preparations for defense in the spring of 1941; even then the USSR would have suffered huge losses, and German troops would have been deep into Soviet territory in the late autumn of 1941.

The main problem was not that the USSR did not have fully mobilized forces and was not ready for defense, but the fact that the Soviet General Staff was preparing for the previous war (WWI)—much like the French military in 1940. They could not imagine that the Germans had developed far superior military strategy and tactics with their active use of “Blitzkrieg”: fast mixed attacks by hundreds of tanks, attack planes and motorized infantry, deep into enemy territory through the weakest points in its defense lines. Such blitzkrieg attacks could not be stopped by defensive lines like the famous Maginot Line: in 1940 the Germans bypassed it through Dutch and Belgian territory, advancing suddenly with 1250 armored vehicles and outflanking the French troops to attack them from the rear. This operation was the main cause of their remarkable swift defeat of France in WWII. On the Eastern front too, the Wehrmacht found weaknesses in the thousand-kilometer defensive line of the Red Army; General Guderian’s tank divisions slipped into the rear of the Red Army through these weak points, surrounding Red Army divisions and destroying them. Thus they advanced, gradually but inexorably, towards Moscow...

What stopped the Wehrmacht from continuing its unique military strategy into the late autumn of 1941, and caused its eventual defeat in the battle for Moscow, was the notorious Russian winter—nicknamed “General Frost”—which had also helped the Red Army’s ancestors to destroy the “unbeatable” army of Napoleon in 1812. Even during November 1941, the temperature near Moscow was around -10°C (-14°F), well below freezing—but on December 4, the temperature dropped to -35°C (-31°F). The German tanks and motorized troops were completely frozen: with no adequate winter clothing or equipment, the Wehrmacht soldiers lost any motivation for further military breakthroughs in their desperate search for sources of heat. On 6 December, fresh Red Army units arrived, transferred from Siberia, and began a successful counterattack on Wehrmacht troops near Moscow. This turned the tide, and laid the foundation for their ultimate victory over Nazism three and half years later. In these later years, the German forces used blitzkrieg attacks less frequently, because the Red Army had learned how to anticipate such attacks and prevent them from developing. Dr. Nefedov published an article about his findings in a Russian history periodical.⁹¹¹

Thus, according to Dr. Nefedov’s assessment, Stalin and the Soviet Union had only one chance to avoid the tragic defeat that befell them in the first months of 1941, and save the lives of millions of its citizens: by a preventive attack on the Nazis in Poland. But in this case, the Soviet Union would have been recognized as the aggressor, violating the Ribbentrop-Molotov pact. Consequently, Great Britain and the United States would have been obliged to help Germany in a war against the Communist Russia. Harry S. Truman—later to be president of the

⁹¹¹Nefedov S.A., 1941: The road to Moscow, Questions of History, 2012, № 7, <http://book.uraic.ru/elib/Authors/NEFEDOV/Science/Russia/Guderian.htm>.

US—made the cynical position of the American establishment very clear on June 24, 1941, just three days after the Nazi invasion of Communist Russia: “*If we see that Germany is winning, we ought to help Russia and if Russia is winning we ought to help Germany, and that way let them kill as many as possible, although I don’t want to see Hitler victorious under any circumstances*”.⁹¹²

Unreadiness of the Soviet Army for the Nazi Invasion: Why Risks Were Concealed

- **The wishful thinking/overconfidence/self-suggestion/self-deception** of Stalin, who convinced himself in 1941 that an attack on the Soviet Union by Nazi Germany was impossible.
- **A prevailing culture of “success at any price” and “no bad news”**: the fear among Soviet army officers of being punished (dismissed, criminally prosecuted or executed) for communicating any information about the situation on the battlefronts that did not match Stalin’s perception and expectations.

2.3.2 Worldwide Spanish Flu and SARS Outbreaks (1918–1919, 2003)

Sunlight is the best disinfectant

William O. Douglas

Severe acute respiratory syndrome (SARS) originated in Guangdong Province in China in November 2002. The Chinese authorities suppressed news of the outbreak of an unknown disease, concealing it both from residents of the province and specialists of the World Health Organization (WHO). As a result, large-scale preventive measures were delayed for four months. The WHO issued a global warning only in mid-March 2003. A unique collaboration of governmental organizations and research centers throughout the world made it possible to halt the last human chain of the transmission of SARS on 5 July 2003. But, by that time, the international spread of SARS had resulted in 8098 cases in 26 countries, with 774 deaths.⁹¹³ Early preventive action could have reduced these numbers many times.

⁹¹²Harry S. Truman’s statement in The New York Times, June 24, 1941.

⁹¹³WHO guidelines for the global surveillance of severe acute respiratory syndrome (SARS), WHO (Department of Communicable Disease Surveillance and Response) Updated recommendations, October 2004, p. 6.



2.3.2.1 Risk Concealment Before and After the Disaster

“Spanish Flu” Global Pandemic

To understand what motivated the Chinese authorities to attempt to hide information about the disease, we will start by looking at the actions of the American and European governments during the global pandemic of 1918–1919 (also known as the “Spanish flu”), when around 500–600 million people—a third of the world’s population at that time—were infected, and nearly 50 million lost their lives (some estimates put the figure at nearer 100 million casualties).⁹¹⁴ The pandemic took five times more lives than the First World War. The H1N1 influenza virus originally came from birds, but then appeared in pigs before crossing the species barrier again to ignite the pandemic among humans. The first cases of the unknown disease were registered in Kansas, America, in January 1918. By March 1918, more than 100 soldiers fell ill at the US army camp in Funston, Haskell County, where more than 5000 recruits were training for further military operations on the European battlefronts of the First World War. Most of the recruits were farmers, had regular contact with domestic animals and were less resistant to viruses than recruits from cities. The high concentration of personnel in the camp simplified human-to-human transmission. At that time, viruses were not known to medicine, and some doctors had not even accepted the idea that microorganisms could cause disease.⁹¹⁵ Later, the personnel of Funston camp were transferred to Europe by ship, and during the long transatlantic crossing the virus spread among soldiers coming from other parts of the USA. Upon arriving in Europe, American soldiers

⁹¹⁴Jeffery Taubenberger, David Morens, 1918 Influenza: the Mother of All Pandemics, *Emerging Infectious Diseases*, 2006, Vol. 12, No. 1, p. 15.

⁹¹⁵John M. Barry, *The Great Influenza: The Epic Story of the Deadliest Plague in History*, New York, Penguin, 2004, p. 51.

infected British and French forces, which in their turn infected German forces in hand-to-hand combat. When Woodrow Wilson, President of the United States from 1913 to 1921, began to receive reports about a severe epidemic among American forces, he made no public acknowledgement of the disease.⁹¹⁶ Moreover, other governments involved in the war made similar decisions—censorship, lies, and even active propaganda—to keep up morale, allowing the disease to continue to spread without any preventive measures. The pandemic was named “Spanish flu” because Spain was a neutral country during the First World War and did not suppress the media, so it was only Spanish newspapers that published honest articles about the severity of the disease—despite the fact that it had originated in the USA and spread initially among American soldiers in the absence of a proper response by the US government. This lack of response was probably due to the US strategic goal of developing a strong political influence in the post-WWI peace process that was to shape international politics in the following decades.

In the USA alone, the disease claimed more than 650,000 lives during 1918–1919. One remarkable incident occurred in September 1918 in Philadelphia, during preparations for the Liberty Loan Parade. City officials received warnings about the flu threat from soldiers participating in the parade, but did not cancel it because the parade was expected to be the largest in the city’s history and help sell millions of dollars in bonds to finance the war.⁹¹⁷

SARS Outbreak

According to some virologists, the “Spanish flu” was “*the mother of all pandemics in the 20th century*”.⁹¹⁸ The H2N2 virus, which caused the Asian influenza pandemic in 1957, and the H3N2, which caused Hong Kong influenza in 1968, were both closely related to H1N1.⁹¹⁹ In 1997 in Hong Kong—which was by then a Special Administrative Region of China—a highly pathogenic avian influenza A (H5N1) virus appeared, which crossed the species barrier between birds and humans in a local live poultry market. During the outbreak, 18 people fell ill and 6 perished; more than 1.5 million chickens were slaughtered to stop the spread of the virus. The consequences of the outbreak were severe for Hong Kong’s economy and for its reputation as a center of international tourism in South East Asia, because of negative reports about Hong Kong in the world media.⁹²⁰ The

⁹¹⁶Ibid, p. 302.

⁹¹⁷John M. Barry, *The Great Influenza: The Epic Story of the Deadliest Plague in History*, New York, Penguin, 2004, p. 203.

⁹¹⁸Jeffery Taubenberger, David Morens, 1918 Influenza: the Mother of All Pandemics, *Emerging Infectious Diseases*, 2006, Vol. 12, No. 1, p. 15.

⁹¹⁹Edwin D. Kilbourne, Influenza Pandemics of the 20th Century, *Emerging Infectious Diseases*, 2006, Vol. 12, No. 1, p. 11.

⁹²⁰Gilbert Wong, Nina Hansen, Vanessa N. Clark, *Crisis Communication: The Asian Bird Flu*, Centre for Asian Business Cases, School of Business, University of Hong Kong, 1998.

frequency of aerial flu outbreaks originating in South East Asia led to a widespread opinion among the world virology community that the next high-mortality flu pandemic would start in South China, because of the high concentration of people who permanently live close to domestic animals.⁹²¹ Obviously, based on these historical facts, the Chinese government understands the possible consequences of a third of the population of China becoming infected: based on the mortality statistics for “Spanish flu”, such an epidemic would mean the possible death of at least 40 million people, with inevitable catastrophic political and economic consequences.

In the middle of November 2002, the first case of SARS was registered in Foshan hospital, in Guangdong province, South East China, 130 km from Hong Kong. Staff of the hospital informed a local anti-epidemic station about a “*strange disease*” by mid-December. Representatives of Chinese Ministry of Health landed in Guangdong province for a detailed investigation in mid-January 2003. On January 27, they issued a “*top secret*” report, which was distributed to executives of the provincial health bureau and to the Ministry of Health in Beijing. By the beginning of February, hospitals across Guangdong province were alerted, but the majority of staff did not receive any warnings because of the Chinese New Year holiday, which began on February 1 and continued for 15 days. No public warnings were issued.⁹²²

The unauthorized transmission of health-related information is prohibited in China until there has been an announcement by “*the Ministry of Health or organs authorized by the Ministry*”, in order to “*avoid confusion and panic*”. Before such official acknowledgement, all data about infectious diseases is classified as a state secret: any doctor or journalist who reveals information about the development of a disease will be prosecuted for leaking state secrets.⁹²³ So, the provincial authorities were not allowed to discuss the SARS problem openly until the national authorities had authorized it.⁹²⁴ In the absence of any government statement, the growing number of apparently infected people led to rumors that were widely spreading among the Chinese concerning a “*deadly flu*”. The rumors were carried by word-of-mouth, texting and conversing on social networks.⁹²⁵ By mid-February, nearly 50 % of people interviewed in Guangzhou City confirmed that they had heard about the disease from friends, relatives or the overseas media. The Great

⁹²¹Documentary “SARS: the True Story”, BBC, 2003 and documentary “The Silent killer: SARS”, Eurovision Science with support of European Commission, Films Media Group, 2009.

⁹²²Yanzhong Huang, The SARS epidemic and its aftermath in China: a political perspective, Institute of Medicine (US) Forum on Microbial Threats, Washington, D.C., National Academies Press, 2004, pp. 116–136.

⁹²³Ibid.

⁹²⁴China’s Chernobyl? A health minister fired. A cover-up admitted to. Is China headed in a new direction? The Economist, April 24, 2003.

⁹²⁵Yanzhong Huang, The SARS epidemic and its aftermath in China: a political perspective, Institute of Medicine (US) Forum on Microbial Threats, Washington, D.C., National Academies Press, 2004, pp. 116–136.

Chinese Firewall—a countrywide surveillance system—began to block the sending of SMS and Skype messages about SARS.⁹²⁶ Later, 93 people were arrested for spreading rumors.⁹²⁷

On February 10, 2003, Guangdong health officials reported atypical pneumonia cases in the province—emphasizing that the disease was controllable and treatable. The government played down the risk of the illness.⁹²⁸ The WHO was first officially informed of the outbreak on February 11, 2003, when the Chinese Ministry of Health reported 305 cases of an unknown disease with five deaths in Guangdong Province. Transmission of the disease was largely confined to health care workers—105 doctors, nurses, and other medical workers were infected—and the friends or families of patients.⁹²⁹ The Chinese health authorities did not impose strict anti-epidemic measures (respiratory precautions to protect medical staff, taking people’s temperature on entry to the hospital, and so on). In spite of clear evidence that hospital staff were the main source of transmission of the virus, Liu Jianlun, a Chinese doctor who had treated cases in Guangdong and had symptoms of SARS already from February 15, was allowed to travel to Hong Kong to attend a wedding ceremony. On February 21, he stayed in the Metropole Hotel and infected several people, who transmitted the virus to Canada, Vietnam, Singapore over the following few days, initiating a global SARS outbreak. By the end of February, 806 people were ill in China and 34 had died.⁹³⁰

On March 12, 2003, the WHO issued a global health alert about the mysterious pneumonia and recommended that people avoid traveling to Hong Kong and Vietnam. After the WHO warning, Hong Kong airport lost 18 percent of flights.⁹³¹ From February 11 to April 25, the Hang Seng Index—the market index in Hong Kong—lost 8.55 %, while the Dow Jones and NASDAQ Composite rose by 7–10 %.⁹³²

Meanwhile, on March 1, SARS had been recorded in Beijing. Nevertheless, the Beijing municipal authorities hid this fact from the national authorities because they wanted to convince superiors that Beijing was implementing all necessary anti-epidemic measures, and there was no reason for canceling the upcoming National People’s Congress meeting, which was planned for March 5–18 and to

⁹²⁶Tim Richardson, China snoops on text messages Stamping out ‘false political rumours’, *The Register*, July 2, 2004.

⁹²⁷Pete Sweeney, Michael Martina, China detains 10 for bird flu rumors, death toll at 9, *Reuters*, April 10, 2003.

⁹²⁸Yanzhong Huang, The SARS epidemic and its aftermath in China: a political perspective, *Institute of Medicine (US) Forum on Microbial Threats*, Washington, D.C., National Academies Press, 2004, pp. 116–136.

⁹²⁹Severe Acute Respiratory Syndrome (SARS) multi-country outbreak—Update 6, WHO, 21 March 2003.

⁹³⁰David Cyranoski, China joins investigation of mystery pneumonia, *Nature*, April 3, 2003.

⁹³¹WHO targets SARS “super spreaders”, *CNN*, April 6, 2003.

⁹³²Comparing of trade results between Hang Seng Index, Dow Jones and NASDAQ Composite for period February 11 to April 25, 2003.

which up to 3000 representatives from every province of China were invited. Beijing's municipal government also convinced superiors that it had all the resources to deal with the situation, and refused any assistance from the central government. Many other local and municipal authorities demonstrated the same behavior: "*officials at all levels tended to distort the information they passed up to their political masters in order to place themselves in a good light*".⁹³³ Moreover, military hospitals, which were not obliged to reveal information about their activity to the civilian authorities, also tried to deny the existence of infected soldiers. As a result, the national authorities received encouraging statistics on SARS development and were convinced there was no need for urgent nationwide preventive measures. During March, they reassured themselves that the SARS outbreak was limited to Guangdong Province and Hong Kong. It was only on March 25 that the central government confirmed the spread of SARS outside of Guangdong Province. Moreover, when the Chinese authorities invited WHO experts to China, they would only allow them access to Guangdong Province until April 2. The decision to allow them wider access was only made under tremendous international pressure on China, when it became obvious that the Chinese authorities were covering up what was actually a national SARS outbreak. On April 5, Chinese Vice Premier Wu Yi announced "*the immediate establishment of a national medical emergency mechanism, with emphasis placed on public health information and an early warning reporting mechanism*".⁹³⁴ On April 6, China apologized for its slow reporting on the outbreak⁹³⁵ and the Chinese Health Ministry reported 19 cases and four deaths in Beijing.⁹³⁶ However, Dr. Jiang Yanyong, retired chief of surgery for a Beijing military hospital, had previously stated on TV channels that he was aware of a hundred cases and six deaths in his hospital—more than five times the number of cases announced by the authorities.⁹³⁷ So on April 9, WHO experts gained permission to inspect military hospitals in Beijing as well. After clear evidence that the real size of the outbreak was being hushed up, Chinese Communist Party executives launched their own investigation into the matter. On April 20, Health Minister Zhang Wenkang and Beijing mayor Meng Xuenong were fired for their mismanagement of the crisis.⁹³⁸ During May, more than 120 health execu-

⁹³³Yanzhong Huang, The SARS epidemic and its aftermath in China: a political perspective, Institute of Medicine (US) Forum on Microbial Threats, Washington, D.C., National Academies Press, 2004, pp. 116–136.

⁹³⁴WHO targets SARS "super spreaders", CNN, April 6, 2003.

⁹³⁵Ibid.

⁹³⁶Howard Kunreuther, Michael Useem, Learning from Catastrophes: Strategies for Reaction and Response, Pearson Prentice Hall, 2009, p. 196.

⁹³⁷Andrew Scobell, Larry M. Wortzel, Chinese National Security Decision-making Under Stress, Diane Publishing, 2005, pp. 108–115.

⁹³⁸China's Chernobyl? A health minister fired. A cover-up admitted to. Is China headed in a new direction? The Economist, April 24, 2003.

tives were sacked and nearly 1000 government officials were reprimanded for their “*slack*” response to the outbreak.⁹³⁹

On April 16, an international network of 11 leading laboratories under the leadership of the WHO discovered the etiological agent of SARS and suggested potential treatments. The cause of the Severe Acute Respiratory Syndrome was determined as a coronavirus (subsequently named the SARS coronavirus, or SARSCoV) originating from bats. Virologists breathed a sigh of relief, as coronaviruses are less dangerous than flu viruses. Had SARS been a kind of influenza, the consequences for the world population could have likely been devastating.⁹⁴⁰ In such a scenario, the mismanagement and risk concealment demonstrated by the Chinese health system at the early stages of the epidemic could have cost millions of lives throughout the world—as it did in the case of the “Spanish flu” pandemic because of the inadequate response of the US government.

Worldwide Spanish Flu: Why Risks Were Concealed

- The military requirement to keep up the morale of the US nation caused deliberate suppression of any information about the disease. Such **secrecy on the grounds of “national security” was common during the war period.**
- **The absence of scientific knowledge about viruses, the principles of their transmission and the associated risks meant** that decision-makers underestimated the need for urgent and decisive action.
- American (and other allied countries) politicians apparently gave **priority to their political interests over the lives of hundreds of thousands of their own citizens, and millions of people around the World.**

SARS Outbreak: Why Risks Were Concealed

- National security concerns: the Chinese authorities were **afraid of massive panic, and were worried about the threat to social stability and continued economic growth** if SARS caused a similar death rate as the Spanish flu pandemic.
- **The Chinese provincial authorities wanted to be seen in a good light by the central government,** which in turn tacitly approved of the “**no bad news**” culture that existed within the Chinese communist party.

⁹³⁹Yanzhong Huang, The SARS epidemic and its aftermath in China: a political perspective, Institute of Medicine (US) Forum on Microbial Threats, Washington, D.C., National Academies Press, 2004, pp. 116–136.

⁹⁴⁰Documentary “SARS: the True Story”, BBC, 2003 and documentary “The Silent killer: SARS”, Eurovision Science with support of European Commission, Films Media Group, 2009.

2.3.3 Great Wildfires in the European Part of Russia (Russia, 2010)



In July 2010, gigantic wildfires and a drought occurred in the western part of Russia caused by a record-breaking heat wave. Fifty-four people perished and 458 were injured in the wildfires themselves and, according to Munich Re estimates, around 56,000 people died from the effects of the smog and heat wave caused by the fires.⁹⁴¹ More than 2000 buildings were destroyed and more than 9 million hectares of crops were lost. Total damages from the wildfires and drought were estimated at between US\$15 billion and \$50 billion.⁹⁴² In June 2010, temperatures exceeded the previous Russian maximum 36 times, and in July 124 times.⁹⁴³ In July, maximum temperatures were recorded in all regions of the European part of Russia for the first time since records began.

After the wildfires were extinguished, the Russian Minister of Emergency Situations described the causes of the severe wildfires. Firstly, there had been no warnings of a wildfire threat from Russian regional authorities. Regional bureaucrats had simply repeated the same message to the federal authorities: “*We have enough forces and ability to deal with any situation*”. For example, the government of the Nizhny Novgorod region refused federal help.⁹⁴⁴ Less than three days afterwards, fire coming out of the forest destroyed a whole village of 341 dwellings. Secondly, intervention by the federal forces should have been organized

⁹⁴¹Natural catastrophes 2010. Analyses, assessments, positions, Munich Re, Feb. 2011, p. 27.

⁹⁴²A. Shapovalov, D. Butrin, \$15 billion lost in Russian fires, Kommersant, Aug. 10, 2010.

⁹⁴³Anomalous phenomena don’t exempt from responsibility, Parliamentary newspaper, Sep. 14, 2010.

⁹⁴⁴Russian Prime Minister Vladimir Putin chaired a conference on measures to reduce the number of wildfires, July 27, 2010, Website of the Government of the Russian Federation, <http://archive.government.ru/docs/11511>.

much earlier, despite the absence of requests from the regions and the misinformation about the real situation from local and regional authorities. Thirdly, federal authorities should have ignored the existing regional framework for granting legal permission to fight the fires, and unilaterally declared a state of emergency in the regions. Fourthly, aerial support should have been provided earlier in the development of the wildfires. Fifthly, local authorities should have taken the necessary firefighting measures in advance, and extinguished peat fields preventively. Sixthly, regional leaders were not paying attention to pessimistic weather forecasts or taking the necessary action over a whole month of heat waves, which later caused the wildfires.

This disaster confirms again that the distortion of information occurring on one level of the managerial hierarchy of an organization or a country leads to a situation where senior management receive information about risks too late to allow them to deploy serious force in time to respond adequately to foreseeable risks, resulting in a much larger-scale disaster.

2.3.3.1 Risk Concealment Before and During the Disaster

Russia accounts for around 20 % of all the forested area on the planet. In the Soviet Union, a centralized system of forest protection allowed firefighting forces from one region to be redeployed to another. The last giant wildfire disaster occurred in the European part of Russia in 1972, when tens of thousands of Red Army soldiers with military engineering equipment helped federal forest firefighters to extinguish the fires. However, by the 2000s, this event had been forgotten, and the Federal Forest Service had been eliminated as part of a wider deregulation movement and to reduce public expenditure. In 2007, a new Forest Code was passed that provided no federal forest protection whatsoever. State control was transferred to regional authorities who were expected to work with private logging operators to manage forest fires and fight wildfires. However, the regional authorities did not have the budget to do what was required: for example, Mordovia, a region the size of the state of Massachusetts and with 800,000 residents, had just 50 forest firefighters and 2 specialized fire trucks. In their turn, private logging operators were only concerned with the short-term profitability of business and were reluctant to invest in fire protection activity. The overall financing of Russian forest management dropped to US\$0.55 per hectare per year, although nearby Kazakhstan spent US\$1.05, the USA \$4 and Belarus—with forests contaminated by radionuclides from Chernobyl—\$7.45.⁹⁴⁵ In addition, the new provisions of the Forest Code did not regulate clearly the separate jurisdiction of federal, regional and local authorities during interregional wildfires, and the responsibility of the different authorities during fires moving from forests to settlements and conversely. Ultimately, after these legal changes, the area of forest destroyed by fire

⁹⁴⁵Wildfires 2010: The miser pays twice, Greenpeace (Russia), press release, August 6, 2010.

doubled. The public did not see the consequences of the absence of federal control over forests, until an unprecedented natural phenomenon occurred, perhaps associated with the phenomenon of global change due to anthropogenic causes: a two-month long anticyclone hovered over the European part of Russia and caused heat waves with temperatures up to +40 °C, hot wind storms with speeds of up to 30 m/s and a total absence of rainfall.

The heat and drought of summer 2010 were predicted by NASA analysts in December 2009 and confirmed by Russian scientists. On March 23, 2010, the Russian meteorological service Roshydromet issued a weather forecast for the coming summer season. It predicted an increased wildfire hazard in the European part of the Russian and Ural regions. Despite this warning, large-scale preventive actions were carried out neither by federal authorities (because there was no legal framework for intervention) nor by regional and local authorities, (because of the lack of money and resources). Moreover, none of the officials could imagine the possible consequences of two months of extreme heat and the resulting wildfires, because since 1972 there had been no similar disaster. In June 2010, when the wildfires started, regional agencies began to pass the responsibility for fire prevention and fighting to each other because it was not defined clearly enough in the existing legislative base. As a result, they just spent precious time playing bureaucratic games and lost the initiative in preventive action. In addition, the failure to manage forest firefighting was aggravated by the Russian political system. In December 2004, Vladimir Putin, President of Russia, had changed the rules for appointing regional leaders: instead of being elected by popular vote, all heads of Russian regions were appointed by the President. This led to a situation where their performance was evaluated in Moscow, rather than in their regions by the citizens they were supposed to be serving. Eager to make a favorable impression on Putin and ensure their continuation in power, regional leaders preferred to send only reassuring reports to the central government. They always tried to convince the federal authorities that they could handle any situation but, in reality, they did not have the power or the resources to deal with a crisis of this scale. Some of governors were continuing to send soothing reports to Moscow and reassure the residents of their regions that “*everything is under control*”. Some, having delegated authority to their deputies, flew out from the regions for 2–3 weeks on planned vacations: such distasteful cases occurred in the Moscow, Vladimir and Voronezh regions. Without proper management, the situation was thus getting worse.

When the fires started to reach settlements in many of the regions, which were supposedly “*under control*”, and Russian newspapers and social networks were filled with horrific details of deaths from fire and burned houses, the federal authorities realized the true scale of the disaster. Moreover, when smog from the giant wildfires covered Moscow—the information and control center of Russia—and all nearby regions, questions about the adequacy of the crisis response became the main agenda of both the Russian media and foreign correspondents. From this point, the swift extinction of the fires was seen as a test of the ability of Vladimir Putin and the federal government to manage emergency situations. This was perhaps ironic in that the crisis was created in the first place by the federal

government's shortsightedness in deregulating forest management. The Russian political culture, which motivated subordinates to conceal risks, only aggravated the magnitude of the disaster.

In the end, the inaction of the regional authorities was balanced by the vigorous intervention of the federal authorities. Vladimir Putin and the Minister of Emergency Situations were presiding over the response forces directly from the Government Emergency Center, and were present in person in the most damaged places. Putin set a record in terms of the number of visits to disaster-stricken areas: at no other time in his political career has he attended affected regions six times to make decisions about comprehensive state assistance to the victims. Some remarkable facts include the following: Dmitry Medvedev, the President of Russia from 2008 to 2012, visited the ambulance control center in Moscow in place of the mayor, who had left the city on vacation during the worst of the smog, and would duly be dismissed after the disaster; and Vladimir Putin (who was President of Russia from 2000 to 2008, Prime Minister at the time of the disaster, and President again from 2012 till the time of writing [summer 2014]), personally flew a multi-purpose amphibious firefighting aircraft to demonstrate his direct involvement and control over the situation to the public. Such actions gave these politicians additional credits to their ratings and drew the attention of Russian and world media, but also revealed the weakness of the state management hierarchy, which could not adequately and promptly react to risks without the intervention of federal government officials.

After the disaster, the Minister of Emergency Situations described the behavior of the regional authorities as follows: *"Half of the governors sat and waited until the fires died out themselves. Another half continued to relax, waiting for the Minister of Emergency Situations and the Prime Minister to come, who like the magicians on the blue helicopter could extinguish the fires"*.⁹⁴⁶ The governors refused to admit that they could not cope with the fires, and that they needed external help, until the bitter end.

Massive Wildfires in the European Part of Russia: Why Risks Were Concealed

- **This propensity for hiding bad news** resulted in part from the change of the rules for appointing regional leaders: instead of being elected by popular vote, all heads of Russian regions were appointed by the President. This led to a situation where their performance was evaluated in Moscow, rather than in their regions by the citizens they were supposed to be serving. **Eager to make a favorable impression on Putin and ensure their**

⁹⁴⁶Anomalous phenomena don't exempt from responsibility, Parliamentary newspaper, September 14, 2010.

continuation in power, regional leaders preferred to send only reassuring reports to the central government. They always tried to convince the federal authorities that they could handle any situation. This led to massive distortion of information about the real situation concerning wildfires in several Russian regions and, as a result, delayed the reaction of Russian federal government to the threat. There is a prevalent Russian political culture, which motivated subordinates to conceal risks.

- This was further reinforced by the federal government's **shortsightedness in deregulating forest management**, leading to confusing and badly designed attribution of responsibilities among involved parties from local government to the private sector.

2.3.4 Krymsk Flooding (Russia, 2012)



On July 7, 2012 from 2 until 4 a.m., a powerful flash flood with a 6.8-m water surge occurred in the Krymsk district of Southwestern Russia. Krymsk is in the Krasnodar region, just 30 km from the coast of the Black Sea and 200 km from Sochi, where the Winter Olympic Games took place in 2014. For two days before the disaster, the volume of rainfall exceeded the monthly average by three to five times. The torrential rain caused a sharp rise in the water level of rivers flowing from the nearby Caucasus Mountains, which led to the flooding of several districts and cities. However, it was only in the Krymsk district that the consequences of the flooding were dreadful. The disaster affected 34,650 people, 171 people died—153 in the Krymsk district—and 2225 people (including 496 children) were

injured. More than 7200 residential and public buildings in the district were destroyed or damaged by the flood.⁹⁴⁷

The magnitude of the disaster—a large number of deaths and injuries—was caused by the absence of emergency information about the coming flood from local authorities, despite the fact that local officials received information about a dangerous rise in river levels more than 36 h before the flooding. Moreover, 12 h after the disaster, Vasily Krut'ko, the head of Krymsk district, reported directly to Vladimir Putin—who had immediately come to the affected district from the nearby presidential residence with a group of journalists—that local officials had declared a state of emergency in good time and taken action to inform the population 5 h before the peak of the flash floods. He claimed that the crisis information campaign had included personal visits to private houses in potential flooding areas, continuous coverage on local television and emergency SMS messages. However, investigations that following revealed that Krut'ko had lied about the decision by local officials to declare a state of emergency—it was actually issued 2 h after the gigantic flash flood occurred—and that the majority of the above actions were never implemented in reality. As a result, only 52 out of the 60,000 residents of Krymsk confirmed that they received warnings about the coming flood.⁹⁴⁸ The majority of the dead were elderly people who drowned while sleeping, or when it was too late to escape from their houses. Krut'ko was arrested after the investigation, on charges of negligence resulting in the death of two or more people. On March 2013, during the trial, he partially admitted his guilt. In August 2013, he and other former local officials were sentenced to between 3¹/₂ and 6 years in prison.

As in many other cases, this bottom line manager tried to convince his superiors that he had responded adequately, in spite of the presence of thousands of witnesses and a dozen journalists with TV cameras, and the likelihood of criminal prosecution for document forgery and bluffing. The Russian investigation committee declared: *“In this situation, the [local] officials worried more how they could justify their inaction by any means rather than how to minimize the consequences [magnitude] of disaster. [Local executives] instructed their subordinates to retroactively make official documents containing false information about the meeting of the Emergency Commission, declaration of state of emergency and warnings of the residents”*.⁹⁴⁹

Facts and documents published after the disaster clearly demonstrated that the actual scale of the flooding was unpredictable in advance by any meteorological or engineering service—let alone by local officials who had no specialist training or experience of hydrology—until the floods came. If only they had been honest and straightforward about their activities before and during the disaster, the local

⁹⁴⁷2012: the year the disaster, Interfax, Dec. 24, 2012.

⁹⁴⁸Falsification of emergency, Interfax, July 25, 2012.

⁹⁴⁹The criminal case hearings concerning flooding in July 2012 in Krymsk city, Krasnodar region, The Investigative Committee of the Russian Federation, May 15, 2013.

managers would probably never have become the main defendants following the disaster. Instead, their undeniable distortion of the facts about what they had done in the attempt to prove their competence by any means led them to prison...

2.3.4.1 Risk Concealment Before and After the Disaster

From the 1970s onwards, private houses began to be constructed without the permission of the authorities in flood zones on the banks of the River Adagum in Krymsk district. Local officials did not consistently oppose this activity: they ruled out the possibility of a disaster for the simple reason that, in the Soviet Union, the beds of rivers flowing from the Caucasus Mountains had been cleaned up on a regular basis. Flood-protection measures had been effective enough. But in post-Soviet times, the funding for cleaning riverbeds and limiting the deforestation of mountain areas was terminated,⁹⁵⁰ due to lack of financial resources and the dismantling of the integrated system of state control over the political and economic matters in 1991. Almost every year after 1995, Krymsk district faced minor floods of the River Adagum, with water surges of up to 1.5 m. In August 2002, after heavy rains in the Krasnodar region and the collapse of a dam reservoir, 7000 homes and commercial buildings were flooded, 4968 homes damaged and 447 destroyed. Two villages in Krymsk district were completely washed away, killing 62 people. An investigation initiated by the Parliament after these floods found that they were caused by the widespread unauthorized construction of private houses and the silting of riverbeds. In both cases, local authorities were found to have been negligent. The investigation commission stated: “[Local and regional] officials ... were not recognizing their mistakes and are still trying to reduce the degree of [their] own guilt and amount of damage by misinforming federal authorities about the actual size [of the disaster]... The residents and tourists were not informed about the coming disaster... Responsible services did not take the necessary steps to prepare for a disaster: [there was no] drainage clearing, riverbeds were not maintained in a good state”.⁹⁵¹ After the investigation, two local officials were sentenced to 3½ years on probation. According to one witness who survived the flood, “those who were in the flood zone got from [local and regional] authorities significant compensations and everyone has forgotten about the incident”.⁹⁵² After the flood, the Krasnodar regional authorities ordered hydrological studies of the affected districts, but did not subsequently implement the recommendations of scientists. None of the regional and local officials worried about complex anti-flooding measures because their had been no serious floods since 2002. Therefore, only 12 % of the budget intended for flood prevention measures—up to

⁹⁵⁰Y. Vorobev, V. Akimov, Y. Sokolov, Catastrophic floods of beginning of XXI century. Lessons and conclusions, Moscow, DAX-Press, 2003, p. 72.

⁹⁵¹C. Baimukhametov, The country of unlearned lessons. Why is there no hydraulic security in Russia? Moscow Pravda, July 12, 2012.

⁹⁵²Ibid.

US\$40 million had been funded by federal government—was actually spent for this purpose.⁹⁵³

Another problem was the high frequency of warnings about dangerous weather events issued by the Russian metrological service (Roshydromet). In 2010, Roshydromet released 2700 storm warnings throughout Russia; the average accuracy was 92 %.⁹⁵⁴ In 2011, the service released 1800 storm warnings throughout the country (average accuracy was 91 %) and 700 warnings about dangerous weather events (average accuracy was 88 %). More than 100 storm warnings were registered in Krasnodar region alone in 2011 (roughly one warning every three days). In the five days before the disaster, Roshydromet issued 18 weather forecasts⁹⁵⁵ and two storm warnings. Local authorities in Krymsk district received the first warning 36 h before the flash flood: “*in the next 3–6 hours [and during the whole of the next day], heavy thunderstorms, severe hailstorms and strong winds up to 20 m/s are expected*”.⁹⁵⁶ Six hours before the flash flood, they got a storm warning about possible natural hazards referring to the serious threat of flooding, severe rise of water levels and so on. During the investigation, it was revealed that, after receiving the second warning, local executives under the leadership of Vasily Krut’ko began to collect information about the current water level in the River Adagum by personal observation of the banks of the river. At 11:30 p.m. on 6 July 2012, about 2½ h before the flash flood, the level of the Adagum in the city of Krymsk had only risen by 24 cm (later investigators declared that the flash flood raised the water level in the river by up to 6.8 m!).⁹⁵⁷ Local officials were communicating regularly with each other by cell phones. Vasily Krut’ko, who had been the head of Krymsk district for the previous seven years, was reassuring subordinates: he emphasized that Roshydromet’s storm warnings were always similar, such warnings came to him weekly and they had never been followed by serious flooding.⁹⁵⁸ After the disaster, Russian meteorologists calculated that the volume of rainfalls on the day of the flood was three times the average daily maximum, and the river discharge exceeded the previous maximum recorded flow rate by a factor of 2.5; the last record was during the 2002 flooding. The likelihood of such anomalous levels of precipitation has been estimated to correspond to one such event every

⁹⁵³Ibid.

⁹⁵⁴S. Shilova, Little rainfall and heat are expected in summer in most parts of the country, Russian newspaper, March 23, 2011.

⁹⁵⁵Boris Pasternak, Caucasian Prisoners. Chief Meteorologist spoke about the causes of floods in Kuban, Moscow News newspaper, July 13, 2012.

⁹⁵⁶Transcript of the crisis response meeting under leadership of Vladimir Putin in Gelendzhik, The Kremlin, July 25, 2012.

⁹⁵⁷Open letter of Vladimir Ulanovsky, former mayor of Krymsk city, Site of Krymsk radio station Electron FM, 2013, <http://www.electron-fm.com/%D0%BE%D1%82%D0%BA%D1%80%D1%8B%D1%82%D0%BE%D0%B5-%D0%BF%D0%B8%D1%81%D1%8C%D0%BC%D0%BE>.

⁹⁵⁸Ibid.

200–300 years.⁹⁵⁹ Despite this, Roshydromet’s storm warnings did not point out that this was an exceptional event, unprecedented by any previous dangerous weather events in the Krasnodar region. Ultimately, local officials did not declare a state of emergency and did not wake up this district of 60,000 residents before the flash flood. All 52 witnesses who confirmed that they had heard an emergency signal had received it from three loudspeakers during the second hour after the flash flood reached Krymsk city.⁹⁶⁰ by this time, the abnormal level of water was obvious to local officials, and they turned on the emergency loudspeakers. Later, scientists found the cause of the sudden 4-m wave of water described by many witnesses: a huge amount of debris from previous flooding (wood, silt, stones, and so on) had accumulated on the uncleaned bed and banks of the River Adagum over the previous ten years, which blocked the river flow under railway and road bridges located near the city, forming in this way temporary “dams”. When a critical amount of water had built up, the bridges were destroyed and a wave-like flash flood rushed down to Krymsk city.⁹⁶¹ This explains why local officials did not record an unusual water surge within the city a couple of hours before the disaster.

Detailed investigations later proved the innocence of local executives, but their criminal activity after the disaster—forging documents and misleading residents and federal executives—guaranteed them prison terms and strong rebuke from the majority of Russians.

Even after the disaster, regional and some federal officials continued the practice of sending falsely reassuring reports to Vladimir Putin and the public. For example, in Krymsk district, the flood killed about 40,000 animals. When the temperature exceeded 30 °C, there was a high risk of the spread of disease if the carcasses were not eliminated immediately. Regional officials continued to assure the federal authorities that they had all the resources they needed to clean up Krymsk city. However, clearing the city of dead animals began only after the deployment of army units on the 8th day after the disaster. During the week after the flooding, the regional authorities were still sending messages to Moscow that “*everything is fine, we have everything [we need] to control the situation*”.⁹⁶² The Federal Minister of Health and Social Development assured Vladimir Putin immediately after the flood that all necessary vaccinations (tetanus, hepatitis and dysentery) would be made promptly. Nevertheless, a week later, the President said after his visit to affected areas: “*For me, it is strange now to hear that people were not vaccinated*”. Victims complained to the President about difficulties in the state

⁹⁵⁹Ibid.

⁹⁶⁰Transcript of the crisis response meeting under leadership of Vladimir Putin in Gelendzhik, The Kremlin, July 25, 2012.

⁹⁶¹A catastrophic flood in the river basin of Adagum 6–7 July 2012 and its causes, State Hydrological Institute, Krasnodar Regional Center for Hydrometeorology and Environmental Monitoring Department and RosHydromet’s departments in South Federal District and North Caucasus Federal District, 2012, pp. 13–16.

⁹⁶²Transcript of the crisis response meeting under leadership of Vladimir Putin in Krymsk, The Kremlin, July 15, 2012.

compensation process and the slow work of regional officials. Putin was furious about that: *“People complain that it is hard to reach the sources of state financial assistance. The queues are large. These queues crush. They say that ‘We have already suffered. We need to deal with housing and children, but [clerks] force us to stand in queues’. It is necessary to change the situation radically. Next time [on the president’s next visit to Krymsk city], I will come and stand myself in the queue. Is it so difficult to deploy mobile assistance offices throughout the city for comfortable handling?”*⁹⁶³ The phrase of Vladimir Putin—*“I will come and stand myself in a queue”*—is reminiscent of his piloting of a firefighting aircraft during the wildfires of 2010, when the then Prime Minister tried to sway his subordinates in order to ensure that crisis response actions were provided well.

The conclusion is simple: whenever a senior executive hears reports from subordinates in a crisis situation that everything is under control, generally the situation is much worse than reports state and the executive should personally go to the place of the disaster to check the actual conditions there. During the Krymsk tragedy, the Russian leader made three emergency visits in 18 days for crisis response meetings that he held personally, and two additional trips in the year after the flood to check on the reconstruction of the city. Obviously, such frequent visits and ongoing control of subordinates originated from previous leadership mistakes. For instance, during the Kursk submarine accident, Russian naval officials gave distorted information to Putin and the public, reassuring them that the Northern Fleet of Russia could mount a successful rescue operation, when Vladimir Putin was on vacation. And when hurricane Katrina struck the coast off Louisiana, George Bush was on vacation at his Texas ranch. In the midst of an uncoordinated response from the Federal Emergency Management Agency, Louisiana state and local government, the National Guards and the US Army Corps of Engineers, Bush visited the Gulf Coast only on the fifth day after the disaster.

Krymsk Flooding: Why Risks Were Concealed

- **Habituation/false reassurance/overconfidence/self-deception** among representatives of the local authorities about the low probability of a catastrophic flash flood in Krymsk district.
- **Regional authorities were unwilling to investigate the causes of previous flash floods in detail**, since this would inevitably lead to the lengthy and embarrassing process of passing on the lessons learnt and making recommendations to subordinates.
- **The high frequency of flood and severe weather warnings** previously received by local authorities, which were often not realized, **leading to a “crying wolf” psychological response and growing complacency.**

⁹⁶³Transcript of the crisis response meeting under leadership of Vladimir Putin in Krymsk, The Kremlin, July 15, 2012.

- **Russian regional bureaucrats and federal ministers wanted to appear in a good light in the eyes of the Russian president.** This led to massive distortion of information about the timeliness of the state of emergency during the disaster and the adequacy of crisis response measures after the disaster.

2.4 Retail Production Industry

Maybe it's shameful ... [but w]e live in a capitalist world

Jean-Claude Mas

2.4.1 Nature of the Industry

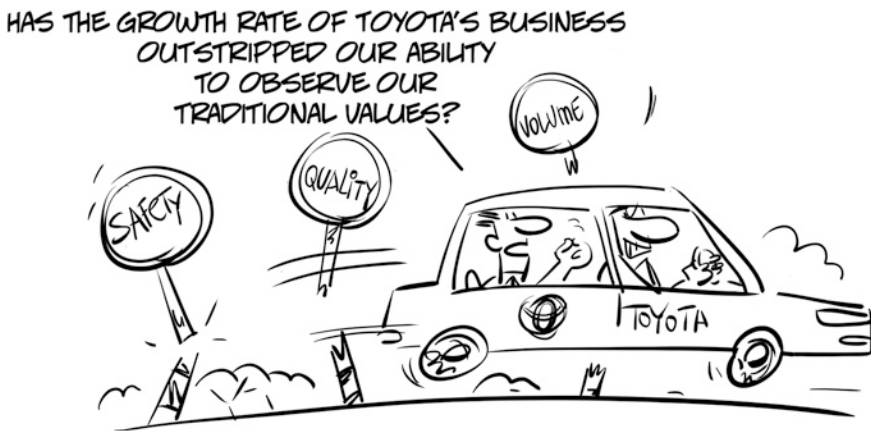
This sector produces consumer goods: foods and drinks, drugs, cosmetics, electronic gadgets, cars and so on. The majority of risk concealment cases in the sector are similar because of its specific business practice. Mutually competing manufacturers tend to produce similar goods in every product segment because each manufacturer is continually watching competitors for any innovations, which will be implemented as fast as possible in the products of all manufacturers. Prof. Leveson assessed the problem very clearly: *“At the same time that the development of new technology has sprinted forward, the time to market for new products has greatly decreased, and strong pressures exist to decrease this time even further. The average time to translate a basic technical discovery into a commercial product in the early part of this century was thirty years. Today our technologies get to market in two to three years and may be obsolete in five. We no longer have the luxury of carefully testing systems and designs to understand all the potential behaviors and risks before commercial or scientific use. [This leads to] reduced ability to learn from experience”*.⁹⁶⁴ Therefore, manufacturers try to launch new products as swiftly as possible to gain a competitive advantage during the first few months, and sometimes ignore defects in the design of innovative production.

Such problems have occurred in many cases with complex innovative products. The retail sector has seen the Ford-Firestone tire controversy (1990), the Intel Pentium FDIV Bug Crisis (1994), and problems with the antenna of the Apple iPhone 4 (2010) and with the brakes of the Toyota Prius (2010–2013). In the industrial sector, notorious cases include the lithium ion batteries on the Boeing

⁹⁶⁴Nancy G. Leveson, *Engineering a Safer World: Systems Thinking Applied to Safety*, MIT Press, 2011, p. 3.

787 Dreamliner (2012–2013)⁹⁶⁵ and the chassis of the Sukhoi SuperJet (2013).⁹⁶⁶ To take just one of these examples: the management of Apple was aware of problems with the quality of signal reception of the iPhone 4 long before it was released, but Apple's co-founder Steve Jobs liked the design of the new phone so much that he personally gave an order to launch it into mass production without redesigning the antenna. He also cancelled real-world testing before the launch – the testing process usually takes a minimum of 14 weeks.⁹⁶⁷ Within three weeks of the launch, Steve Jobs and Apple were denying that the new phone had flaws. This position angered many people and attracted media attention to the problem. Ultimately, the company had no choice but to admit the problem, issue a temporary solution for the 25 million customers who had already bought the phone (a free case for the phone) and update the software.

2.4.2 Complexity, Cost Reductions, Arrogance and The Toyota Problems (USA–Japan, 2000s)



With recalls of millions of Toyotas in 2010, the automaker has been facing heavy criticism over the design of its cars, about concealment of information concerning known defects and on the matter of the arrogance of middle-managers in

⁹⁶⁵Boeing 787 Dreamliner battery problems, http://en.wikipedia.org/wiki/Boeing_787_Dreamliner_battery_problems.

⁹⁶⁶State of emergency with the aircraft Sukhoi SuperJet 100 during 2011–2014, RIA Novosti, Feb. 25, 2014.

⁹⁶⁷Yukari Iwatani Kane, Niraj Sheth, Apple Knew of iPhone Issue, The Wall Street Journal, July 16, 2010.

dealing with customers' complaints. The general perception in the West is that a main cause of this apparent drift away from the Toyota Way is the cost reduction war between carmakers. Interestingly, the typical view of Japanese business persons and researchers represented also by the Japanese media is different, emphasizing that the accidents happened because Toyota tried to produce too complicated products and did not manage the raising complexity imposed by social pressure and market demand.

2.4.2.1 Toyota's Cost Reduction Challenge

The typical narrative of the West draws attention to the need for companies to monitor the activity of competitors, while the market forces of supply and demand lead to a situation where prices on similar products become equalized. Usually, the race to keep prices competitive with similar products results in the reduction of production costs by any means necessary. Thus, Carlos Ghosn, Chairman and CEO of the Renault-Nissan Alliance, initiated an aggressive downsizing campaign in the late 1990s to rescue Nissan, the second largest car producer in Japan, from imminent bankruptcy. He was so successful with huge cost reductions—10 % down on supplier parts and US\$2.25 billion in savings—that he was nicknamed “*le cost killer*” and “*Mr. Fix It*”.⁹⁶⁸ Toyota was forced to respond and adopt a similar action: the company launched a cost-cutting strategy called “*Construction of Cost Competitiveness for the 21st Century*” (CCC21) and may have perhaps broken its own cardinal rule that “*customers are always prior to profits*”.⁹⁶⁹ CCC21 had an impact on many spheres of Toyota production. After its implementation, Toyota faced extensive recalls of cars because of flaws in design and supplied parts; between 2004 and 2006, the company recalled more vehicles than ever before in its history. In 2006, Japanese investigators found out that, since 1996, Toyota had been aware of a defective relay rod on the Toyota Hilux Surf, but recalled the model only after a lawsuit was initiated by relatives of people killed in a crash caused by the defective rod. Before the crash, Toyota managers thought that problems occurred only in “*unusual and extreme conditions*”.⁹⁷⁰ Information about flaws in car designs, shortcomings in manufacturing processes and production defects in parts from other suppliers was not communicated well within the world's largest car-maker: according to insiders from the American branch of Toyota, “*working for the company is like working for the Central Intelligence Agency, where information is shared only on a ‘need to know’ basis*”.⁹⁷¹

⁹⁶⁸David Austen-Smith, Daniel Diermeier, Eitan Zemel, Unintended Acceleration: Toyota's Recall Crisis, The Kellogg School of Management, Northwestern University, 2011.

⁹⁶⁹Ken Bensinger, Toyota tried to cut costs on recalls. Los Angeles Times, February 22, 2010.

⁹⁷⁰David Austen-Smith, Daniel Diermeier, Eitan Zemel, Unintended Acceleration: Toyota's Recall Crisis, The Kellogg School of Management, Northwestern University, 2011.

⁹⁷¹William J. Holstein, Toyota Recall Highlights Deep Organizational Failures, CBS (Money Watch), Feb. 9, 2010.

2.4.2.2 The Acceleration Pedal Problem

During the crisis of the uncontrolled acceleration of certain Toyota vehicles (2009–2010), investigators published internal correspondence between Toyota managers, confirming that 37,900 customer contact reports of unintended acceleration had been logged in Toyota's complaint coding system⁹⁷² since the early 2000s. This problem had led to 34 deaths and thousands of customer complaints to the National Highway Traffic Safety Administration (NHTSA).⁹⁷³ Toyota knew about problems with gas pedals made by an Indiana-based supplier, and that the unintended acceleration problem only existed on US-made cars.⁹⁷⁴ Nevertheless, the company did not launch a detailed investigation of the problem and made only a limited recall, because of the significant incurred expenses: in 2007, they saved up to \$100 million on a limited recall of floor mats in Camry and Lexus ES sedans.⁹⁷⁵ But, in autumn 2009, the American media released a recording of a conversation between a 911 call center employee and the driver of a Lexus ES 350 in San Diego, California, who was asking for help with a stuck accelerator pedal. During the call, the car crashed, and all four occupants were killed.⁹⁷⁶ This case led to severe accusations of Toyota by the American media and attracted the attention of regulators. According to Jim Press, Toyota's former U.S. chief, *"The root cause of their problems is that the company was hijacked, some years ago, by anti-(Toyoda) family, financially oriented pirates... [These executives] didn't have the character necessary to maintain a customer first focus"*.⁹⁷⁷

The Japanese view emphasizing the role of complexity, and of mistakes in managing it, is well represented by economic professor Takahiro Fujimoto from the University of Tokyo, a leading authority on the Toyota production system and automotive product development. Toyota has been a frontrunner in making very complex products, like hybrids or luxury cars, at very high volume and then growing the volume. In addition, constraints on cars have grown tremendously in the last decade: *"What was okay 10 years ago is not okay now... some of the things that are part of the Toyota problem now were not a big problem 20 years ago. So customers and society are fussier and fussier about what they expect from car... For example, with the Prius recall, the problem resulted because Toyota tried to*

⁹⁷²Letter to James E. Lentz, President and CEO, Toyota Motor Sales, USA, Inc., Congress of the United States, Committee on energy and commerce, from Chairmen Waxman and Stupak, June 29, 2010.

⁹⁷³Brady Dennis, Toyota hit by new surge of reported fatalities in vehicles, The Washington Post, Feb. 16, 2010.

⁹⁷⁴William J. Holstein, Toyota Recall Highlights Deep Organizational Failures, CBS (Money Watch), Feb. 9, 2010.

⁹⁷⁵Ken Bensinger, Toyota tried to cut costs on recalls. Las Angeles Times, Feb. 22, 2010.

⁹⁷⁶'There's no brakes... hold on and pray': Last words of man before he and his family died in Toyota Lexus crash, The Daily Mail, Feb. 3, 2010.

⁹⁷⁷Alan Ohnsman, Jeff Green and Kae Inoue, Toyota Recall Crisis Said to Lie in Cost Cuts, Growth Ambitions, Bloomberg, February 26, 2010.

*improve fuel efficiency and safety and quietness at the same time through a nice combination of very powerful regenerating brakes, plus the latest antilock brake system, plus the hydraulic braking system. But the relationship between the three kinds of brakes changed with the new design, and then drivers could have an uneasy experience when there was switching between the different brakes a little bit... Toyota failed to see this problem in the right way, at least in the beginning.*⁹⁷⁸

Akio Toyoda, the president of Toyota, grandson of the company's founder, in his testimony before the US Congress in February 24, 2010, confirmed this view: *"At times, we do find defects. But in such situations, we always stop, strive to understand the problem, and make changes to improve further. In the name of the company, its longstanding tradition and pride, we never run away from our problems or pretend we don't notice them. Toyota has, for the past few years, been expanding its business rapidly. Quite frankly, I fear the pace at which we have grown may have been too quick [to train adequately our personal]. I would like to point out here that Toyota's priorities have traditionally been the following: first, safety; second, quality; third, volume. These priorities became confused. And we were not able to stop, think, and make improvements as much as we were able to before, and our basic stance to listen to our customers' voices to make better products has weakened somewhat. We pursued growth over the speed at which we were able to develop our people and our organization, and we should sincerely be mindful of that".*⁹⁷⁹

Professor Fujimoto emphasized that all the problems associated with the Toyota recalls were design quality problems rather than manufacturing quality problems. He is adamant in pointing out that *"to my knowledge they are not trying to hide the problems. But when a very complex problem happened, they were not sure to what extent this was a responsibility for the company, and to what extent other parties were responsible. So their attitude was, 'Wait a minute. This is complicated'. They were sure that they were not the only party responsible for this problem... But it is also obvious that Toyota was at least partly responsible for many problems that were popping up one after another. Probably what they should have done was to deal with it as quickly as possible – [such as send] a senior person to America as quickly as possible and then have [the company] apologize for whatever [it felt was their] responsibility. So a partial but thorough apology, and definitely a quick apology, was what they had to do. But they probably hesitated to come to the U.S. because they were not sure to what extent they were responsible for those*

⁹⁷⁸Interview of Professor Takahiro Fujimoto by Professor MacDuffie, Under the Hood of Toyota's Recall: 'A Tremendous Expansion of Complexity', Knowledge@Wharton, March 31, 2010, <http://knowledge.wharton.upenn.edu/article/under-the-hood-of-toyotas-recall-a-tremendous-expansion-of-complexity>.

⁹⁷⁹Toyota gas pedals: is the public at risk? Hearing before the Committee on oversight and government reform House of Representatives one hundred eleventh Congress, second session, serial No. 111-75, February 24, 2010, <http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg58346/html/CHRG-111hhrg58346.htm>.

*problems. Then people saw that as, 'Gee, Toyota is escaping from responsibility for this problem'. This is not what Toyota meant – but the way they handled the initial problem was very bad, I think.*⁹⁸⁰

It is thus the combination of growing complexity, pushed by competition as well as society demands, together with overconfidence in being able to deal with the problems that led to Toyota's crisis. Overconfidence led Toyota managers to underestimate the difficulties in handling the novel kinds of arising complexities, and to believe that Toyota would do better than other companies: *"Ironically, as a result they probably took in way too much complexity. It was [beyond] their capacity"*.⁹⁸¹ According to professor Fujimoto, arrogance is the number one enemy of the Toyota philosophy: *"But they didn't take this seriously until big problems happened. I would probably say middle managers, particularly at headquarters, started to deviate from the Toyota Way by being arrogant, being overconfident, and also they started not to listen to the problems that customers raised"*.⁹⁸²

2.4.2.3 Public Perception Versus Reality

The Big Three US motor manufacturers Ford, General Motors, and Chrysler, who were in a complicated financial situation at the time, benefited from the accusations of the more successful and profitable Toyota.⁹⁸³ Only then, under public pressure and the threat of losing the American market,⁹⁸⁴ did Toyota finally decide to recall 8.5 million vehicles worldwide to solve the problem of accelerator pedal entrapment by loose floor mats, and other pedal problems. Fortunately for Toyota, suggestions that flaws with their electronic throttle control systems could be the main cause of unintended acceleration were not confirmed by a year-long NHTSA investigation.⁹⁸⁵ The National Highway Traffic Safety Administration (NHTSA) aided by NASA Engineering and Safety Center concluded the following^{986,987}:

⁹⁸⁰Ibid.

⁹⁸¹Ibid.

⁹⁸²Ibid.

⁹⁸³David Bailey and Kevin Krolicki, Toyota U.S. sales reel from crisis; GM, Ford surge, Reuters, Feb. 2, 2010.

⁹⁸⁴William J. Holstein, Toyota Recall Highlights Deep Organizational Failures, CBS (Money Watch), Feb. 9, 2010.

⁹⁸⁵Peter Valdes-Dapena, Pedals, drivers blamed for out of control Toyotas, CNN, February 8, 2011.

⁹⁸⁶National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation, Technical assessment of Toyota electronic throttle control (ETC) systems, February 2011, <http://www.nhtsa.gov/UA>.

⁹⁸⁷NASA Engineering and Safety Center, National highway traffic safety administration Toyota unintended acceleration investigation, Technical support to the National Highway Traffic Safety Administration (NHTSA) on the reported Toyota motor corporation (TMC) unintended acceleration (UA) investigation available at <http://www.nhtsa.gov/UA>.

“After conducting the most exacting study of a motor vehicle electronic control system ever performed by a government agency, NASA did not find that the ETC electronics are a likely cause of a large throttle openings in Toyota vehicles as described in consumers’ complaints to NHTSA... NASA found no evidence that any failures of the ETC system had an effect on the performance of the braking system”. Remarkably, they declared that it was mainly *“the publicity surrounding NHTSA’s investigations, related recalls, and Congressional hearings [that] was the major contributor to the timing and volume of complaints”.* Both also noted that *“the vast majority of complaints involved incidents that originated when the vehicle was stationary or at very low speeds and contained allegations of very wide throttle openings, often with allegations that brakes were not effective”.* NHTSA’s analysis indicated that *“the most likely cause of the acceleration was actually pedal misapplication (i.e., the driver’s unintended application of the accelerator rather than, or in addition to, the brake)”.*⁹⁸⁸

The hysteria in the US against Toyota is an example of the “social proof” mechanism that Robert Cialdini has abundantly documented and dissected to describe group actions under social influence.^{989,990} Social influence describes the fact that people will do things that they see other people are doing, such as the famous example of someone looking up into the sky, leading to bystanders then looking up into the sky to see what he was seeing. This may partly explain the initial reluctance of Toyota management to acknowledge the responsibility of their product whose reliability they trusted so much. Thus, we can conclude that Toyota made essentially no mistakes in producing automobiles but made serious blunders in its management of the public perception and in dealing with the politics in Washington, as reported by US⁹⁹¹ as well as Japanese media. As Mr. Yoshimi Inaba, the president of Toyota North America, said: *“there is sometimes a lack of communication because of the language differences, because of the cultural differences... [about] this sticky pedal situation... yes, we knew that probably a year ago in Europe. And I say that had not been shared enough well on this side. So we did not hide it, but it was not properly shared. We need to do a much better job in sharing. Whatever is happening in Europe should be known in the United States so we are all alert”.*⁹⁹² Toyota had thus a problem with managing the cultural difference in driving as well as the different expectations of their customers. Since then, imitating the major US firms that sell extensively to the government or depend on

⁹⁸⁸Ibid.

⁹⁸⁹Cialdini, R. B., *Influence: The Psychology of Persuasion*, Collins; Revised edition, 1998.

⁹⁹⁰Cialdini, R. B., *The science of persuasion*. *Scientific American*, 284, 76–81, 2001.

⁹⁹¹NHTSA report clears up mystery—and hysteria—on Toyota cars, *The Washington Post*, February 9, 2011, http://www.washingtonpost.com/opinions/slowing-the-toyota-furor/2011/02/08/AB35mZF_story.html.

⁹⁹²Toyota gas pedals: is the public at risk? Hearing before the Committee on oversight and government reform House of Representatives one hundred eleventh Congress, second session, serial No. 111-75, February 24, 2010, <http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg58346/html/CHRG-111hhrg58346.htm>.

it for regulations, and must of necessity engage in lobbying (which is protected by the US constitution as an expression of free speech), Toyota has taken steps to strengthen its connections to US politicians and their cronies in Washington so as not to repeat the same mistake.

The recall cost more than \$2 billion.⁹⁹³ Moreover, Toyota was ordered to pay a record US\$1.2 billion to settle a criminal investigation into safety issues—the largest penalty ever levied by the US authorities on an auto company.⁹⁹⁴ These expenses are very significant compared with the previous cost-cutting measures that were an important contributor to the crisis, as suggested by some observers such as Rep. Dennis Kucinich during the testimony of Akio Toyoda before the US Congress in February 24, 2010.⁹⁹⁵

2.4.2.4 Genuine Cases of Concealment of Defects in Automotive Industry

In 2014, information concealment practices were revealed within General Motors, which for ten years had been hiding a defect with a tiny part in the ignition switch. For the sake of a part worth just 57 cents, the concealment caused 13 traffic deaths, and 2.6 million cars had to be recalled.⁹⁹⁶ According to the more recent report of May 22, 2015 by The New York Times,⁹⁹⁷ *“in February 2014, the automaker began recalling 2.6 million Chevrolet Cobalts and other small cars with faulty ignitions that could unexpectedly turn off the engine, disabling power steering, power brakes and the airbags. The switch crisis prompted a wave of additional recalls by G.M. for various safety issues. All told, G.M. recalled more than 30 million vehicles worldwide last year, a record for the automaker.”* And *“Justice Department investigators have identified criminal wrongdoing in General Motors’ failure to disclose a defect tied to at least 104 deaths, and are negotiating what is expected to be a record penalty, according to people briefed on the inquiry.”*

The recent Takata case concerning defective inflator and propellant devices that may deploy improperly in the event of a car crash is also a clear-cut case of risk

⁹⁹³Margaret Cronin Fisk, Toyota Recall Cost to Exceed \$2 Billion, Lawyers Say (Update2), Bloomberg, Feb. 9, 2010.

⁹⁹⁴Aruna Viswanatha, David Ingram, Ben Klayman, Toyota’s \$1.2 billion settlement may be model for U.S. probe into GM, March 19, 2014.

⁹⁹⁵Toyota gas pedals: is the public at risk? Hearing before the Committee on oversight and government reform House of Representatives one hundred eleventh Congress, second session, serial No. 111-75, February 24, 2010, <http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg58346/html/CHRG-111hhrg58346.htm>.

⁹⁹⁶GM recall linked to 57-cent ignition switch component, The Associated Press, April 01, 2014.

⁹⁹⁷Ivory, D., B. Protess and B. Vlastic, G.M. Inquiry Said to Find Criminal Wrongdoing, The New York Times, 22 May 2015 (www.nytimes.com/2015/05/23/business/gm-inquiry-said-to-find-criminal-wrongdoing.html).

information concealment. The available evidence suggests too much cost-cutting, early realization of problems by Takata (one of the world's leading suppliers of advanced automotive safety systems and products) that were intentionally hidden for years,⁹⁹⁸ eventually obliging many car makers to issue massive car recalls.⁹⁹⁹ *"Under pressure from safety regulators, [Takata] agreed [on Tuesday May 19, 2015] to declare nearly 34 million vehicles defective, doubling the size of its recall in the United States and making it the largest automotive recall in American history".*¹⁰⁰⁰

2.4.3 The 17-Year Poly Implant Prothese Fraud (France, 1993–2010)

The French company Poly Implant Prothese (PIP) was founded by Jean-Claude Mas in 1991. PIP specialized in breast implants. In 1993, Jean-Claude Mas secretly decided to change the formula of the silicon gel used in the implants to reduce production costs. Instead of the expensive medically approved silicon at US\$45/liter, he ordered the use of industrial silicon, which was seven times cheaper at US\$6.5/liter. PIP implants would now consist of 25 % medical gel and 75 % industrial gel, so the cost of producing the new implant was US\$50, instead of US\$68 for an implant filled with 100 % medical gel; and the implants sold for about US\$400 to French cosmetic surgeons and US\$130 to Latin American surgeons. Thus, using the new gel formula allowed PIP to save up to US\$1.6 million per year.

Due to shortcomings in the deregulated legislation of the cosmetic industry in France and the European Union, it had become possible to hide changes in the gel formula for decades. Every year, the company was selling up to 100,000 implants in 60 countries worldwide and, nowadays, more than 300,000 women carry PIP implants¹⁰⁰¹; a significant amount of them live in Latin America and Asia, where regulation and government control over the cosmetic industry are poor. Seventy five percent of all the implants produced by PIP were made with the unapproved gel formula.¹⁰⁰²

⁹⁹⁸Hiroko Tabuchi, Takata Saw and Hid Risk in Airbags in 2004, Former Workers Say, The New York Times, Nov. 6, 2014.

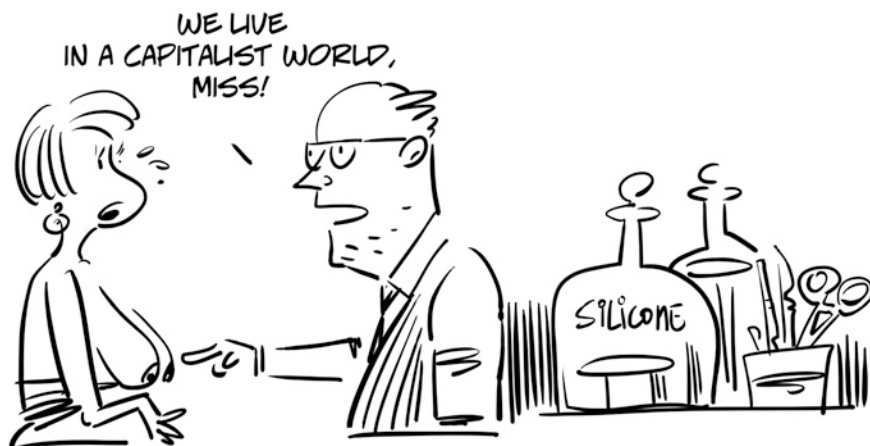
⁹⁹⁹Clifford Atiyeh, Massive Takata Airbag Recall: Everything You Need to Know, Including Full List of Affected Vehicles, Dec. 2, 2014, <http://blog.caranddriver.com/massive-takata-airbag-recall-everything-you-need-to-know-including-full-list-of-affected-vehicles>.

¹⁰⁰⁰Ivory, D., B. Protess and B. Vlasic, G.M. Inquiry Said to Find Criminal Wrongdoing, The New York Times, 22 May 2015 (www.nytimes.com/2015/05/23/business/gm-inquiry-said-to-find-criminal-wrongdoing.html).

¹⁰⁰¹Jean-François Rosnoble, Makers of fraudulent breast implants on trial in France, Reuters, Apr. 17, 2013.

¹⁰⁰²Alexandria Sage, Natalie Huet, Jean-Francois Rosnoble, Special Report: The French breast implant scandal, Reuters, Feb. 2, 2012.

The gel formula scam only came to light accidentally, when French regulator AFSSAPS (Agence Française de Sécurité Sanitaire des Produits de Santé) initiated an inspection of PIP's plants after numerous complaints from French plastic surgeons and customers about the abnormal rupture rate of PIP implants compared with those of other producers. Jean-Claude Mas was arrested and confessed the fraud: *"I knew that this gel wasn't officially registered, but I did it knowingly because the PIP gel was less expensive ... and of much higher quality... The material was better than that used to make the officially authorized gel"*. However, British surgeons subsequently stated, after 453 patient examinations, that PIP breast implants ruptured in at least 16 % of patients fitted with them—while the usual failure rate does not exceed 1 %.¹⁰⁰³ Twenty cases of different types of cancer were connected with flawed PIP's implants.¹⁰⁰⁴ A former PIP employee testified that there were *"unscientific tests of product quality, such as judging silicone gel by sticking a finger"*. Yves Haddad, a lawyer who represented Jean-Claude Mas, declared to journalists: *"Maybe it's shameful ... [but w]e live in a capitalist world"*.¹⁰⁰⁵



Three factors helped Jean-Claude Mas to conceal for decades the risk of flawed implants.

Firstly, staff at the company was under orders to *"hide the truth"*. Some of them were convinced by Mas that the industrial gel they were using was *"better than that used to make the officially authorized gel... We organized everything to escape being*

¹⁰⁰³Sarah-Kate Templeton and John Follain, French breast implant ruptures '16 times worse', The Australian, Jan. 09, 2012.

¹⁰⁰⁴Jean Yves Henry, Les prothèses mammaires PIP, <http://www.medecine-integree.com/les-protheses-mammaires-pip/#.VN0uXCixXrY>.

¹⁰⁰⁵Alexandria Sage, Natalie Huet, Jean-Francois Rosnoblet, Special Report: The French breast implant scandal, Reuters, Feb. 2, 2012.

monitored". Some of the staff *"kept quiet because they were worried about their jobs"*. Some testified: *"Mas would tell them we used the silicone oil for creams, certainly not breast implants... We were very uncomfortable and let Mas do all the talking"*. Others were simply not aware of changes in the gel formula. As a result, Mas was able to declare that they had been working with it for decades without any problems.¹⁰⁰⁶

Secondly, NuSil, the American gel that was medically approved worldwide, was purchased from the California-based NuSil Technology. The founder of NuSil Technology was Donald McGhan—who also distributed PIP's saline implants in the USA. McGhan had started his career at a Dow Corning laboratory where the first breast implants were made in the early 1960s, but, in 2009, he was given a 10-year jail sentence for wire fraud: he had been illegally using money from clients of a real estate company in an attempt to build yet another implant business.¹⁰⁰⁷ Jean-Claude Mas and Donald McGhan had a mutual business interest in working together: McGhan distributed PIP's saline implants on the American market and, in return, his company was able to export its silicon gel for decades without fear of possible competition from other medical gel suppliers.

Thirdly, flaws in legislation helped Mas mislead the regulator and the certifying agency. AFSSAPS was the regulator of PIP, but did not certify cosmetic products—which, by the way, are much less strictly certified than pharmaceuticals. Jean-Claude Mas invited TUV Rheinland, a private German company, to certify PIP's factory and implants. In all documents, PIP was demonstrating the use of NuSil, the American medical gel. Because of the absence of legal requirements about unannounced inspections from AFSSAPS and TUV Rheinland, PIP was informed of upcoming checks ten days in advance according to European guidelines. Moreover, during yearly audits, TUV Rheinland did not make any random on-site lab tests of the implants. Mas testified: *"Since 1997, we automatically hid the products that allowed us to make the PIP gel... because I knew they weren't abiding to regulation"*.¹⁰⁰⁸ After the truth was revealed, the French regulator declared that the fraud was so sophisticated that *"it's not evident that an inspection, even an unannounced one, could have been effective"*.¹⁰⁰⁹ Also, PIP was focusing on expansion to the emerging markets of Latin America and Asia, where regulation of the cosmetic industry was weaker than in France.¹⁰¹⁰ Regulators in these countries relied on previous validation of the quality of the implants issued by European institutions, and did not carefully test the implants.

In the first few years, the low quality of the PIP implants was not obvious to surgeons throughout the world: statistics about the rupture of PIP's implants

¹⁰⁰⁶Alexandria Sage, Natalie Huet, Jean-Francois Rosnoblet, Special Report: The French breast implant scandal, Reuters, Feb. 2, 2012.

¹⁰⁰⁷Tom Hals, Exclusive: The troubled history of PIP's implants man in America, Reuters, Jan. 10, 2012.

¹⁰⁰⁸Alexandria Sage, Natalie Huet, Jean-Francois Rosnoblet, Special Report: The French breast implant scandal, Reuters, Feb. 2, 2012.

¹⁰⁰⁹Ibid.

¹⁰¹⁰Ibid.

became alarming only during years after implantation.¹⁰¹¹ In many emerging countries, such statistics were totally absent. In 2000, the FDA (US Food and Drug Administration) made an inspection of a PIP factory in La Seyne-sur-Mer in Southern France after the regulator had received 1810 reports about problems with PIP's saline implants. Immediately after the inspection, FDA prohibited the sale of PIP's saline implants in the USA, because of evidence of the use of “*adulterated*” material in the production of saline implants.¹⁰¹² Nevertheless, there is no confirmation that the FDA shared information about its findings with French colleagues from AFSSAPS.¹⁰¹³ It was only 10 years later in March 2010, after numerous complaints from French surgeons and customers on the low quality of PIP's silicon implants, that the AFSSAPS made a comprehensive inspection of the PIP factory: the inspectors accidentally found six discarded plastic containers of Silopren industrial gel. It took 17 (!) years from the first attempts of Jean-Claude Mas to conceal what was going on at PIP to reveal a world-wide fraud, which affected more than 300,000 patients!

Dow Corning and other corporations knew that silicon breast implants were porous when they marketed them. In 1994, these manufacturers agreed to pay \$4.75 billion to 60,000 affected women.^{1014,1015} Throughout the 1980s and 1990s, class-action lawsuits claimed that Dow Corning's silicone breast implants caused systemic health problems. The claims first focused on breast cancer and then drifted to a range of autoimmune diseases, including lupus, rheumatoid arthritis and various neurological problems. This led to numerous lawsuits beginning in 1984 and culminating in a 1998 multibillion-dollar class action settlement. As a result, Dow Corning was in bankruptcy protection for nine years, ending in June 2004 during which time it largely withdrew from clinical market.¹⁰¹⁶

2.4.4 Other Cases with Risk Information Concealment: Tobacco and Food Industries

Misguided and ultimately counterproductive attempts to save money and increase profitability can be seen in other retail industries too. Of course the most

¹⁰¹¹Dr. Joseph Mele, PIP Silicone Breast Implants—Not in the US, <http://www.sanfranciscoplasticsurgeryblog.com/pip-silicone-breast-implants-not-in-the-us>.

¹⁰¹²Tom Hals, Exclusive: The troubled history of PIP's implants man in America, Reuters, Jan. 10, 2012.

¹⁰¹³Dr. Joseph Mele, PIP Silicone Breast Implants—Not in the US. <http://www.sanfranciscoplasticsurgeryblog.com/pip-silicone-breast-implants-not-in-the-us>.

¹⁰¹⁴<http://www.nytimes.com/1997/08/19/us/dow-chemical-deceived-women-on-breast-implants-jury-decides.html>.

¹⁰¹⁵<http://www.singerpubs.com/ethikos/html/dowcorning.html>.

¹⁰¹⁶http://en.wikipedia.org/wiki/Dow_Corning.

notorious, flagrant and—for decades at least—successful attempt to conceal the truth from the public took place within the world tobacco industry, causing up to 6 million deaths per year from smoking worldwide.¹⁰¹⁷ In 1992, Judge H. Lee Sarokin, during the tobacco-related case of *Haines v. Liggett Group*, had this to say: “All too often in the choice between the physical health of consumers and the financial well-being of business, concealment is chosen over disclosure, sales over safety, and money over morality. Who are these persons who knowingly and secretly decide to put the buying public at risk solely for the purpose of making profits and who believe that illness and death of consumers is an apparent cost of their own prosperity? As the following facts disclose, despite some rising pretenders, the tobacco industry may be the king of concealment and disinformation”.¹⁰¹⁸



Like the tobacco industry, the world food industry has decades of experience in concealing the truth from the public, most notably about the high sugar content of many processed foods. Some examples of concealment within the food industry on a national scale follow. In the middle of the 1980s, because the domestic meat industry was highly profitable, the British Government concealed facts at all stages and even corrupted evidence about the mad cow disease,¹⁰¹⁹ which led to more than 200 deaths during the following decades.¹⁰²⁰ In 2013, the meat adulteration scandal in 14 European countries (the undeclared or improperly declared

¹⁰¹⁷Tobacco, The World Health Organization, July 2013.

¹⁰¹⁸R. Kluger, *Ashes to Ashes—America’s Hundred-Year Cigarette War, the Public Health, and the Unabashed Triumph of Philip Morris*, New York, Alfred A. Knopf Publishing House, 1996, p. 676.

¹⁰¹⁹Richard Lacey, *Mad Cow Disease: The History of BSE in Britain*, Cypsel, 1994, p. xx.

¹⁰²⁰Variant Creutzfeldt-Jakob disease, The World Health Organization, Feb. 2012.

horse meat) revealed a notable failing in the traceability of the food supply chain, raising fear that other harmful additives could be incorporated as well without the disclosure to the consumers.¹⁰²¹ In 2006, an outbreak of salmonella occurred in Cadbury's chocolate, affecting up to 37 people, after the existence of the salmonella bacteria at Cadbury Schweppes's factory in Marlbrook (UK) had been concealed for six months.^{1022,1023} Milk scandals occurred in China in 2004 and 2008, when it was revealed that companies producing infant formula had reduced its nutritional value—causing 13 baby deaths from malnutrition—and added inexpensive melamine and other compounds such as cyanuric acid, ammeline and ammeline to infant formula to increase their apparent protein content—affecting more than 300,000 babies, of whom 54,000 were hospitalized and six died.^{1024,1025} After investigating the case, a World Health Organization (WHO) expert stated: *“It was a large-scale intentional activity to deceive consumers for simple, basic, short-term profits”*.¹⁰²⁶

Retail Production Industry: Why Risks Were Concealed

- **Companies prioritised short-term profitability** and used all means necessary to gain a competitive advantage by launching products as quickly and cheaply as possible, at the expense of the quality of their products and the long-term health and loyalty of customers.
- This happened in some cases as the path of least (short-term) effort to **respond to the pressure from emerging competition or other appearing stressors**.
- In a capitalistic free market system, a narrow view is that firms aim at **maximizing shareholder value and nothing else counts**. In such rational optimization framework, additional considerations involving the physical health of consumers, if not directly impacting the financial well-being of business, will be relegated, ignored or simply negated. Of course, this is a short-term view, but humans tend to be biased towards short-term preferences.

¹⁰²¹http://en.wikipedia.org/wiki/2013_meat_adulteration_scandal.

¹⁰²²Fiona Walsh, Salmonella outbreak costs Cadbury £20 m, The Guardian, Aug. 3, 2006.

¹⁰²³Nick Britten, Cadbury's let salmonella get into bars, Telegraph, July 14, 2007.

¹⁰²⁴2008 Chinese milk scandal. http://en.wikipedia.org/wiki/2008_Chinese_milk_scandal.

¹⁰²⁵Chinese protein adulteration. http://en.wikipedia.org/wiki/Chinese_protein_adulteration.

¹⁰²⁶China's Melamine Milk Crisis Creates Crisis Of Confidence, Voice of America, Nov. 1, 2009.

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