Norwegian University of Science and Technology - NTNU
Department of industrial economics and technology management

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ENGLISH

EXAM IN TIØ4201

RISK GOVERNANCE

Saturday 17th December, 2011

Time: 09.00 - 13.00

Support materials:	D	No written and handwritten examination support materials are permitted.

Censorship is due 17th January, 2012

Task 1 counts 50 %, and tasks 2 and 3 counts 25 % each for the evaluation of the exam.

Task 1: The disaster in Japan, 11 March 2011 in a risk governance framework (50 %)

Case description:

Following a major earthquake, a 15 meter tsunami disabled the power supply and the cooling system of three Fukushima Dai Ichi reactors, causing a nuclear reactor accident. All three cores in the three reactors largely melted in the first three days. The reactors proved robust seismically, but vulnerable to the tsunami. A preliminary international report says the release of radioactivity into the atmosphere is reaching 40 % of the total from Chernobyl.

This tsunami was literally a "once-in-a-millennium" event, says Professor Fumihiko Imamura from Tohoku University in Sendai.

Japan is a modern, rich and technologically advanced society with high consciousness of dangers from earthquakes, tsunami and nuclear power. It is a vulnerable country with priorities on societal safety and security, and high competence and great resources on preventive measures and emergency capacities. Nevertheless we got a series of events resulting in disastrous consequences. We will look at some risk governance deficits.

In this environment it would be reasonable to expect that consideration of earthquake and tsunami effects would merit the highest consideration when assessing the risks related to these hazards. The risk from earthquake and tsunami should have been assessed critical. Loss of cooling can result in the catastrophic overheating of the reactor core, potentially leading to a core meltdown.

The Fukushima Dai Ichi plant was designed to withstand 5.7 m tsunami waves, even though a 6.4 m wave had hit the shore close by 10 years before the plant went on-line. Although the plant was not washed away by the tsunami, the 15 meter high wave created another problem.

The reactors require constant forced cooling using electrically powered pumps. The backup generators installed to ensure that cooling pumps remained operational even if the main

power to the plant is lost, were installed in a basement vulnerable to flooding. When the tsunami hit the seawall and spilled over the top, the floodwaters poured into the backup generator room, knocking out the diesel backup generators. The cooling system stopped. With no power to run the pumps, the reactor cores began to overheat. Although the reactors survived the earthquakes and the tsunami, without power to run the pumps the plant was in trouble.

The cascade of events at Fukushima had been foretold in a report published in the U.S. several decades ago. The 1990 report by the U.S. Nuclear Regulatory Commission, an independent agency responsible for safety at the country's power plants, identified earthquake-induced diesel generator failure and power outage leading to failure of cooling systems as one of the "most likely causes" of nuclear accidents from an external event.

Before the Fukushima Dai Ichi accident, Japan was not prepared for the great losses of critical civilian infrastructures after big earthquakes, and not prepared against larger tsunamis than what was assumed in design (e.g. seawalls to prevent extreme waves in turning inland). After the accident: - standards and criteria are now under discussion. The direct effects of the earthquake, the tsunami, the radiation effecting large areas, and the loss of energy supply caused major interacting problems to the population, infrastructures – especially transportation, and to industrial production.

There had been criticism before the accident that nuclear regulator is a part of the Ministry of Economy, Trade and Industry which promotes nuclear. The Japanese government will now take forward a reform in organizing the nuclear safety regulatory regime in order to win public confidence on the government work on nuclear safety and strengthen its function.

The answering of the questions below should be based on information from the case description, but you are also free to use other knowledge you have about the disaster, and also to base parts of your answers on describing own assumptions about aspects of the events using your imagination and fantasy.

Question 1.1. Attributions and risk management strategies

Will you regard the disaster in Japan as mainly caused by nature or is it "man-made" (ref. Rousseau's comments on the earthquake in Lisbon, 1755)? What are the implications for risk management?

Question 1.2. Factual knowledge about the risk

Comment on the factual knowledge about the risk (the hazards, probabilities and consequences) before the accident. Also identify deficiencies regarding energy – barrier strategies before the accident.

Question 1.3. Assessing potential surprises and responses to early warnings

Discuss the cascading events in Japan in relation to the concept "black swans"? What were the responses of the nuclear industry to early warnings, and how will you relate that to the organizing of the regulatory authority and to conflicting objectives of stakeholders?

Question 1.4. Understanding complex systems

Discuss the disaster in relation to Murphy's law and the concept of "vulnerability" expressed in terms of the "Normal Accident Theory". The advanced student can supplement the discussion with ideas from complexity theories.

Question 1.5. Other Risk Governance failures

Identify and comment some other significant failures and deficiencies related to risk governance prior to and during the Fukushima accident.

Task 2 Multiple choice tasks (25 %)

Answer the multiple choice questions below.
There can be several correct options for each question.
Plus points are given for correct answered options, minus points for erroneous or lacking options.
Give the answers in a simple table like:

Question number	Answer
1	x, y
2	z
…..	

1 Which are the two dimensions that decide the vulnerability of a socio-technical system according to the "Normal Accident Theory"?

a) Organizational redundancy
b) Interactions
c) Mindfulness
d) Couplings
e) Resilience

2 If there is high ambiguity related to a risk, which risk management strategy or strategies should be used:

a) Precautionary-based (resilience-based)
b) Discourse-based
c) Regulation-based
d) Risk-based
e) Experience-based

3 The purpose of the appraisal phase in risk governance, is among others, to:

a) Define the object to be studied
b) Judging the tolerability of the risk
c) Assess concerns
d) Identify hazards

e) Follow up measures
f) Analyze risk

4 In what phase(s) of risk governance may deficits (failures and deficiencies) occur?

a) Pre-assessment
b) Risk appraisal
c) Risk evaluation/characterization
d) Risk management
e) Risk communication

5 Risk can be defined as:
a) expected loss
b) an already known event
c) a combination of probability of and consequences of adverse effects
d) a hazard
e) uncertainty about and severity of the consequences of an activity with respect to something humans value

6 If risk reduction is considered unnecessary, the risk is judged as:
a) Tolerable
b) In-acceptable
c) In-tolerable
d) Acceptable

7 Which of these methods are applied in concern assessment?
a) Surveys
b) Fault tree analysis
c) Meetings with stakeholders
d) Bayesian analysis
e) Event tree analysis

8 IRGC defines risk governance as:
a) a comprehensive management system designed to handle different safety elements
b) the totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analyzed and communicated, and how management decisions are taken
c) a coordinated set of activities and methods that is used to direct an organization and to control the many types of risks that can affect its ability to achieve objectives.
d) the identification, assessment, and prioritization of risks
e) a framework to ensure that socio-technical systems function safely under various disturbances

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Task 3 Miscellaneous (25 %) (større skriftstørrelse)

Give short answers to the following questions:

Question 3.1. Discuss the difference between ambiguity and uncertainty

Question 3.2. What are the main differences between "Resilience Engineering" and traditional approaches to safety? What are the four main abilities in a resilience engineering model?

Question 3.3. What does the ALARP-principle mean?

Question 3.4. What are the benefits of applying several perspectives for understanding accidents and risk?

Question 3.5. What is the difference between ”taking a risk” and ”running a risk”?