University of Colorado Denver
Department of Civil Engineering
CVEN-4000 Senior Seminar

name

date

ENGINEERING in CONTEXT
dcm 2/24/2023

You are an engineer at a consulting firm retained to provide civil engineering design services in the context of the scenario below. Comment on any ethical considerations related to your employment in this case, with appropriate references to the Code of Ethics of the American Society of Civil Engineers. This commentary of 400-800 words is required for CVEN-4000 and will be graded on a pass/fail basis. This commentary will also be used to assess the following:

- Your ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (Student Outcome 1)

For details on our outcome assessment process, see http://engineering.ucdenver.edu/civil/ABET.

The Fukushima Disaster and the Future of Nuclear Power*

Following the 2002 Kyoto Protocol, the Ministry of Economic Trade and Industry in Japan made a multi-year commitment to reduce greenhouse gas emissions by expanding electrical generation by nuclear power. In this environment, nuclear power in Japan grew steadily, reaching 30% of total Japanese electricity production in 2011 with further plans to boost production to 50% by 2030. On March 11, 2011, the most powerful earthquake on record to strike Japan devastated the region, particularly the Sendai area. The earthquake triggered a powerful tsunami with waves that exceeded 130 feet in height and traveled 6 miles inland. The earthquake was so powerful that the main island of Japan was shifted 8 feet to the east.

The Fukushima nuclear power plant featured six boiling water reactors, designed and constructed by General Electric. The reactors were designed to withstand approximately 0.2 g ground accelerations and the plant had massive seawalls to prevent inundation by tsunami waves as large as 20 feet. Both of these limits were exceeded by the March 11, 2011 earthquake and tsunami. The earthquake damaged four of the six reactors at this location and the 46 ft tall tsunami that arrived 45 minutes later severed connection with the electrical grid, rendered auxiliary generators inoperative, damaged external cooling water pumps, and flooded basement areas in the turbine buildings. Only three of the reactors were operating at the time, and while these successfully executed immediate shutdown, some of the pipes leading in and out of the reactors were severed, causing steam to escape and water levels to drop.

Without cooling and ventilation to remove heat generated by natural decay of fission products created before shutdown, reactor temperatures could not be contained even after deployment of fire-fighting equipment to pump seawater directly into the reactors and spent fuel pools. Interaction between fuel elements and high temperature steam produced explosive quantities of hydrogen gas that accumulated in roof areas in three of reactor buildings. This led

* Schmeckpeper, E.R.; Kelley, M.; Beyerlein, S. (2014), Using the EPSA Rubric to Evaluate Student Work on Ethics Case Studies in a Professional Issues Course, Proceedings of 2014 Zone 1 Conference, American Society for Engineering Education, February 16, 2014.

to a series of violent explosions that ultimately ripped through the roof and side of these reactor buildings in the week following the earthquake.

Over 3500 workers participated in plant decontamination. Two workers died from blood loss associated with the hydrogen explosions; two others have exceeded their annual dosage allowed for nuclear workers. A parliamentary panel concluded that TEPCO (plant operator), government, and regulators were negligent in establishing and maintaining safety protocol at Fukushima. The panel points out that the government, regulators, and TEPCO failed to prevent the accident and subsequently "betrayed the nation's right to be safe from nuclear accidents". They concluded that the natural disasters could not be anticipated or necessarily designed for.

This accident once again brought the safety of nuclear power into the forefront of public discussion similar to the Three Mile Island and Chernobyl accidents. By 2012, Japan had taken all 54 of its reactors out of service, reversing 20 years of surplus and resulting in record $18 billion deficit. Oil and natural gas imports have increased and power shortages have been observed at factories. Germany plans to close all reactors by 2020 and will import natural gas and nuclear power created electricity in other countries to make up for the difference. While the reaction in the United States has not been as severe, the projected resurgence of the nuclear industry has not come to fruition. Many nuclear power plants in the United States are nearing the end of their original projected operational life, which is about 40 years. The county's 104 reactors are now on average 32 years old. Instead of building new reactors, reactors are being retrofitted and upgraded in addition to extending their licenses for 40 to 60 years. The cost of building a new reactor makes it risky and potentially cost prohibitive for any organization that is concerned with making a profit. The only 2 planned reactors (under construction) in the US (in Georgia) were designed to use a passive cooling system to avoid some of the problems at Fukushima.

An alternative approach to combating the risk associated with generating electricity via nuclear fission is to reduce consumption. A citizen led movement in Japan is trying to reduce electricity consumption by installing smaller, 20 or 30 amp, circuit-breaker boxes in their homes. The smaller breaker boxes are in contrast to the 100 and 200 amp boxes in most US homes. The restriction is not easy however, as many household items use substantial power (small AC unit – 10 amps, vacuum cleaner – 10 amps, microwave – 6 amps). One author argues that the panic over many "hotspots" near the Fukushima disaster site was unwarranted. The International Commission on Radiological Protection recommends evacuation of a locality whenever the excess radiation dose exceeds 0.1 rem per year. However, citizens of Denver are exposed to three times that amount from the area's natural radiation emissions.

References

Fukushima Nuclear Accident Update Log. (2011). International Atomic Energy Association.
In Japan, People Get Charged Up About Amping Down. (October 3, 2012). The Wall Street Journal.
The Panic over Fukushima. (August 18, 2012). The Wall Street Journal.
Old Reactors, New Tricks. (August, 2012). IEEE Spectrum. pp 31-35.
Japan Panel Blames Disaster on Negligence. (July 6, 2012). The Wall Street Journal.

Appendices

- Code of Ethics of the American Society of Civil Engineers
- Rubric for ABET Student Outcome 1

PREAMBLE

Members of The American Society of Civil Engineers conduct themselves with integrity and professionalism, and above all else protect and advance the health, safety, and welfare of the public through the practice of Civil Engineering.

Engineers govern their professional careers on the following fundamental principles:

- create safe, resilient, and sustainable infrastructure;
- treat all persons with respect, dignity, and fairness in a manner that fosters equitable participation without regard to personal identity;
- consider the current and anticipated needs of society; and
- utilize their knowledge and skills to enhance the quality of life for humanity.

All members of The American Society of Civil Engineers, regardless of their membership grade or job description, commit to all of the following ethical responsibilities. In the case of a conflict between ethical responsibilities, the five stakeholders are listed in the order of priority. There is no priority of responsibilities within a given stakeholder group with the exception that 1a. takes precedence over all other responsibilities. [1]

CODE OF ETHICS

1. SOCIETY

Engineers:

a. first and foremost, protect the health, safety, and welfare of the public;

b. enhance the quality of life for humanity;

c. express professional opinions truthfully and only when founded on adequate knowledge and honest conviction;

d. have zero tolerance for bribery, fraud, and corruption in all forms, and report violations to the proper authorities;

e. endeavor to be of service in civic affairs;

f. treat all persons with respect, dignity, and fairness, and reject all forms of discrimination and harassment;

g. acknowledge the diverse historical, social, and cultural needs of the community, and incorporate these considerations in their work;

h. consider the capabilities, limitations, and implications of current and emerging technologies when part of their work; and

i. report misconduct to the appropriate authorities where necessary to protect the health, safety, and welfare of the public.

2. NATURAL AND BUILT ENVIRONMENT

Engineers:

a. adhere to the principles of sustainable development;

b. consider and balance societal, environmental, and economic impacts, along with opportunities for improvement, in their work;

c. mitigate adverse societal, environmental, and economic effects; and

d. use resources wisely while minimizing resource depletion.

1 This Code does not establish a standard of care, nor should it be interpreted as such.

3. PROFESSION

Engineers:

a. uphold the honor, integrity, and dignity of the profession;

b. practice engineering in compliance with all legal requirements in the jurisdiction of practice;

c. represent their professional qualifications and experience truthfully;

d. reject practices of unfair competition;

e. promote mentorship and knowledge-sharing equitably with current and future engineers;

f. educate the public on the role of civil engineering in society; and

g. continue professional development to enhance their technical and non-technical competencies.

4. CLIENTS AND EMPLOYERS

Engineers:

a. act as faithful agents of their clients and employers with integrity and professionalism;

b. make clear to clients and employers any real, potential, or perceived conflicts of interest;

c. communicate in a timely manner to clients and employers any risks and limitations related to their work;

d. present clearly and promptly the consequences to clients and employers if their engineering judgment is overruled where health, safety, and welfare of the public may be endangered;

e. keep clients' and employers' identified proprietary information confidential;

f. perform services only in areas of their competence; and

g. approve, sign, or seal only work products that have been prepared or reviewed by them or under their responsible charge.

5. PEERS

Engineers:

a. only take credit for professional work they have personally completed;

b. provide attribution for the work of others;

c. foster health and safety in the workplace;

d. promote and exhibit inclusive, equitable, and ethical behavior in all engagements with colleagues;

e. act with honesty and fairness on collaborative work efforts;

f. encourage and enable the education and development of other engineers and prospective members of the profession;

g. supervise equitably and respectfully;

h. comment only in a professional manner on the work, professional reputation, and personal character of other engineers; and

i. report violations of the Code of Ethics to the American Society of Civil Engineers.

Rubric for Performance Indicators of Student Outcome 1:

Performance Indicator	1: Beginning	2: Developing	3: Proficient	4: Exemplary
Formulate the problem and identify key issues/variables	• Missing problem formulation • Missing most key issues / variables • Missing most criteria • Missing most constraints • Missing most assumptions	• Weak problem formulation • Some issues / variables identified, but many missing • Many criteria missing • Many constraints missing • Many assumptions missing	• Adequate problem formulation • Most key issues / variables are identified • Almost all criteria presented for ranking alternatives • Almost all constraints identified • Almost all assumptions identified	• Complete and succinct problem formulation • Key issues / variables identified • All relevant criteria presented for ranking alternatives • All relevant constraints identified • All relevant assumptions identified
Recognize the need for multiple solutions	• Alternative solutions are not presented	• Alternative solutions are not significantly different, i.e., involve only a minor parameter change	• Alternative solutions adequately cover design space • Variety of tradeoffs are presented in alternative solutions	• Alternative solutions cover design space in several significant dimensions • All significant tradeoffs are presented in alternative solutions
Analyze alternative solutions to an engineering problem	• Little analysis • Severely flawed analysis • Criteria not evaluated • Constraints ignored	• Limited analysis of alternatives • Only some criteria evaluated • Only some constraints considered	• Appropriate analysis approach • Mostly correct analysis results • Criteria evaluated with minor errors • Constraints considered with minor errors	• Well thought out or clever analysis approach • Complete and correct analysis results • Complete evaluation of design criteria • Complete consideration of constraints

Illinois Institute of Technology
http://www.ece.iit.edu/~abet/sopi.html
accessed 12/26/2016

Justify a solution to an engineering problem	• Little discussion of analysis results • Missing documentation of decision making process • Arbitrary choice for final solution	• Weak discussion of analysis results • Missing significant steps in decision making process • Weak justification for final soluion	• Adequate discussion of analysis results • Document decision making process • Final solution justified based on design criteria	• Detailed discussion of analysis results • Detailed documentation of decision making process • Clear justification for final solution based on design criteria