The following document was compiled in order to shed some light on the situation in Fukushima. I decided to compile this document in order to educate anyone who may be worried about the effects this event may have had on the area of Tokyo. It should provide useful to people in other areas as well.

1. Summary of situation and health risks

The earthquake that hit Japan was about five times more powerful than the plants at Fukushima were built to withstand. [1] In response to the earthquake, all the reactors shut down seconds after the occurrence. On March 12th, around 3:36 PM, a large noise was heard from the #1 reactor and white smoke escaped.[2] This was the first of several complications and what instigated concerns about radiation. People within the area were evacuated immediately. As of now, the government has asked people living within 20 km of the power plant to evacuate and those between 20km and 30km from the power plant to stay indoors.[3] On March 16th, "The United States Nuclear Regulatory Commission (NRC) recommends that U.S. citizens who live within 50 miles (80 kilometers) of the Fukushima Daiichi Nuclear Power Plant evacuate the area or take shelter indoors if safe evacuation is not practical."[4] Keep in mind that my dorm is approximately 246km from the site. I'm actually within Saitama, and about 10km north of Tokyo. I am about 166km outside of the most cautious of the 3 recommended evacuation areas. According to the International SOS: "*The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) stated on March 16 the risk to public health so far is "very low to negligible". This echoed the opinion given by the World Health Organization's China office: "WHO believes that there is* ***currently no significant risk to human health for anyone living outside the 30 km exclusion zone.***"[10]

2. Understanding radiation and health risks

"As the radioactive materials, if they are being released, travel away from the plant, they will be greatly **diluted.**" - Kimberlee Kearfott, Professor, Nuclear Engineering and Radiological Sciences of The University of Michigan. Depending on distance from the source, radiation and risk of radiation poisoning decreases.[14] To give you an idea of exactly how much this risk decreases depending on distance, the following data is from a New York Times and WNN article as presented in a lecture given by Assistant Professor Benjamin Monreal, UCSB Department of Physics on March 16th. On Tuesday, the NY Times reported: "Radiation close to the reactors was reported to reach 400 millisieverts per hour on Tuesday(March 15th) after a blast inside Reactor No.2 and fire at reactor No.4, but has since dropped back to as low as 0.6 millisieverts at the plant gate."[5] According to World Nuclear News on the same day, "Radiation levels on the edge of the plant compound briefly spiked at 8217 microsieverts per hour but later fell to about a third that."[6] Keep in mind that 8000 microsieverts is 8 millisieverts. (Millisieverts per hour is

referring to how much your body will absorb in one hour. People absorb approximately 4 millisieverts from an abdominal x-ray.)[7] By looking at this data, you can understand that given the distance from the source, radiation levels drastically increase or decrease. Just from the area near the reactor until the edge of the plant gate, the radiation level decreases by a factor of 1/666, given the data provided. This distance is less than a kilometer, based on google satellite imagery. In order to understand these levels, keep in mind that the risk of dying of cancer is raised by 1% every 250millisieverts your body absorbs.[8] If I were to stand still in front of the plant gate for 31 hours straight I would absorb about 248millisieverts of radiation, increasing my risk of cancer by 1%. This is at the actual Fukushima plant gate, outside of the actual reactor core. Based on this data, I would not even mind being 30km from the plant, despite the United States NRC's recommendations. My dorm is 246km from the reactor and is completely safe, inside or outside. Based on a reading of approximately 13.52CPM from a Geiger counter in Tokyo at 2:24PM on March 18th, 2011, I will be absorbing approximately 0.00012527777 millisieverts per hour if I am not indoors. [9] (Phoenix, Arizona's level is currently 21CPM, nearly twice that of Tokyo.[13]) You may look at the conversions in source [11], to see how I reached this millisievert value. Given this, my chances of dying of cancer from radiation, un-sheltered in Tokyo will increase by 1% within approximately 1995565.53 years, according to the data provided. If I have one chest X-Ray, I will absorb approximately 798 times the amount of radiation I would get by standing outside in Tokyo for 1 hour.[7]

-If you would like to know more about radiation and nuclear fission in order to understand how all of this works, please look at source [5]. Benjamin Monreal provides a fantastic presentation on this material.
-Another way to understand just how low the current amount of radiation is in Tokyo, eating one banana gives you a radiation dose of 0.0001 millisieverts.[18] If you ate two bananas you would have twice the amount of radiation you absorb by being un-sheltered Tokyo for 1 hour.
-I checked the Geiger counter I mentioned earlier, source [9], once again after finishing this document at 8:35PM. It has decreased from 13.52CPM to 13.14CPM.

3. Boiling Water Reactors and Worst Case Scenario

Josef Oehmen compiled a very in-depth article explaining the make up of Boiler Water Reactors, the type of reactor found at Fukushima. I encourage you to read this article in order to maybe better understand the statements in this section. The article [1] can be found in section 5.
Three videos were posted by The University of Michigan College of Engineering.[14][15][16] I'm not going to assume I can provide a better article about these videos, so I'll simply place Ann Arbor's article here.[17]

While exposed spent fuel rods at the failing nuclear reactors in Japan pose new threats, the worst-case scenario would still be unlikely to expose the public to catastrophic amounts of radiation, says a University of Michigan nuclear engineering professor who is an expert on this particular kind of reactor.
"For the public, I don't believe it would be much higher than two additional chest x-rays," said John Lee, a professor in the Department of Nuclear Engineering and Radiological Sciences,

citing the results of the Three Mile Island accident.
While the event appears to have progressed beyond Three Mile Island, Lee said that during that 1979 incident in Harrisburg, Penn., two chest X-rays were the worst radiation exposure experienced by plant workers. The public was exposed to much less.
Lee worked at General Electric during the time the company was making the type of boiling water reactor at the Fukushima plant. His book, "Risk and Safety Analysis of Nuclear Systems," will be published in May.
Spent fuel, which is fuel that has already been used but still retains a level of radioactivity, is a new concern, says Thomas Downar, a professor in the Department of Nuclear Engineering and Radiological Sciences.
"The worst thing that could happen now is the fuel rods could be exposed to the air and that could be, then, down to our last barrier," Downar said. "We could not have a recriticality, or a nuclear explosion. It's physically impossible in this kind of system."
Lee and Downar are among the professors in the No. 1-ranked U-M Department of Nuclear Engineering and Radiological Sciences who are studying the technical issues involved in the emergency situation in Japan.
While the researchers understand that the situation is serious, they stress that a "meltdown" does not necessarily mean a major release of harmful radiation, and that the situation, while dire, is still more akin to Three Mile Island than Chernobyl. A Chernobyl type of explosion is impossible in these plants, Lee said.

In his lecture, Benjamin Monreal also mentions that one of the worse things that could come from the situation in Fukushima is the possibility of burning fuel. (I assume this is also what Ann Arbor means by "exposed spent fuel rods at the failing nuclear reactors in Japan pose new threats*"*) The thing to worry about with burning fuel is that it can produce radioactive smoke, which creates soot that can be carried through the air and settle on streets, plants, and people. In the situation of Chernobyl, where fuel had been burning violently for an extended period of time, the worst plumes were carried approximately 60km.[5] Again keep in mind that Tokyo is approximately 270km from the Fukushima incident.

4. Conclusion

The current situation at Fukushima has caused a lot of stress and panic within Japan, and to my surprise almost even more overseas. I have been warned almost every day by friends and family of the "certain danger" of radiation poisoning from being in Tokyo. Several of my friends are now leaving Japan to farther parts of the country or returning to their home countries. As he mentions in his talk, Benjamin Monreal suggests the most dangerous thing about this kind of situation is being uneducated about it.
I'll end this document with a quote from Monreal's lecture: "One of the funny things that that epidemiological survey [done on victims at Chernobyl] found was: very few cancers but absolutely terrible health outcomes. They founds lot of depression, they found lots of PTSD, they

found lots of stress, lots of fear, because no one told them anything ... Nobody explained to them what a sievert was ... This was a huge educational communication failure and it was absolutely unnecessary ... and that's part of the reason why I'm here. You all have the information, your friends and acquaintances in Japan should have the information. You don't need to listen to authorities to tell you whether you should worry about whatever dose you have. Count the millisieverts. Count them yourself, they'll be in the paper, get a Geiger counter, you can measure them. You decide what your risk tolerance is, and you decide how to respond."[5]

I appreciate you taking the time to read this and I encourage you to have a look at the sources, especially sources [1][5][14][15][16]. If you have any questions feel free to email me at joseph.lovegren@gmail.com

5. Sources

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[2] -http://www.tepco.co.jp/nu/f1-np/press_f1/2010/htmldata/bi1348-j.pdf
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[9] - http://www.ustream.tv/channel/geiger-counter-tokyo (2:24 013.53CPM)
[10] - http://www.internationalsos.com/Japancrisis/default.cfm?content_id=235&language_id=ENG
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[17] - http://www.rdmag.com/News/Feeds/2011/03/general-sciences-japan-worst-case-scenario-unlikely-to-cause-catast/
[18] - http://en.wikipedia.org/wiki/Sievert