Technical Inquiry

Fukushima Diiachi and Caesium Contamination

Developed by:

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Technical Inquiry Summary. HDIAC received a technical inquiry concerning caesium 137 contamination from the Fukushima Daiichi Nuclear Power Plant Disaster in East Japan on March 11, 2011. The customer is especially interested in cleanup efforts.

Background Information: Several searches were conducted in our database, DTIC, and open source records to locate the most current, relevant documents pertaining to the caesium contamination from the Fukushima Daiichi Nuclear Power Plant Disaster.

Key Findings: 4 years after the Fukushima disaster, a clearer picture is beginning to emerge of possible long-term environmental consequences. Caesium 137 deposition ranging from 0.02 tp 3.7 megabecquerels per square metre were detected at sites 25-60km away from the plant; the higher levels were found in Iitate soil, 40km from the plant.

Analysis: After analysis of the literature, there is not much cleaning up going on at the Fukushima Daiichi disaster area. TEPCO, the company that operated the plant is not in charge of the cleanup and decommissioning. Caesium-137 measured 18,000 becquerels, 200 times the permitted level, two years after the disaster. The Fukushima Daiichi accident produced radioactive gaseous, liquid, and solid wastes. The gaseous emissions were released in the early days of the accident and have dispersed and decayed to small levels and are no longer a health threat. Based on measurements in November, TEPCO has already declared that significant gaseous releases have stopped and that the temperatures in all three reactors are <75°C (167°F).

Liquid waste management and the cleanup and management of the water that was injected into the reactors and SFPs had been a major concern. For many weeks following the accident, rainwater mixed with the water that had been injected into the reactors and SFPs was accumulating in NPS buildings and tanks. As the buildings and tanks filled up, additional temporary storage tanks were brought in to hold the water. In June, the first of two temporary wastewater cleanup systems was started. As of this writing at the end of 2011, two temporary wastewater processing systems are in service operating at ~90% capacity, cleaning more water than is being injected into the reactors and SFPs. Water levels in the buildings are slowly decreasing, and plans are in place to start work in 2012 on a new, more permanent long-term wastewater processing facility.

The solid wastes at the Fukushima Daiichi NPS consist of:

- Secondary wastes accumulating as a result of the water treatment processes (such as sludge and filter resins)
- Radioactive particles that were released during the reactor building explosions and drifted away and settled across downwind areas
- Contaminated rubble and materials from in and around the NPS buildings (including deforestation and other organic debris cleared to make room for storage tanks and buildings)
- Radioactive nuclear fuel in the SFPs and in the damaged reactors.

Plans are being developed and implemented to monitor and, if necessary, clean up or remove radioactive contamination from surrounding areas on the Fukushima NPS site. Much of the contaminated rubble and materials around the NPS buildings and in the roadways has been removed, and work has started on rubble removal from the refueling floors of Units 3 and 4.

Planning is in progress to start moving the fuel from the SFPs to interim or long-term storage or reprocessing facilities within the next couple of years. Studies are in progress or planned to determine the best methods to be used to defuel the reactors, remove the spent fuel from the SFPs, and treat and dispose of the accumulated radioactive wastes.

Because of damage to the RPVs, PCVs, and reactor buildings, contaminated water injected into the reactor cores is leaking into the turbine buildings. This situation required the quick design of two water treatment systems. One was a short-time-frame installation, and the other was a mid-term installation. The two water treatment systems are still being used to process wastewater to remove oil, contamination, and brine. The water is being processed at a rate of ~50 m3/hour.

Contaminated water is being generated at a rate of 25 m3/hour from reactor core injection and 200 to 500 m3/day from groundwater in-leakage. The processed water is being reused to inject into the RPVs to minimize the volume of new water used. The systems initially experienced equipment and operational problems caused by quick installation and operator unfamiliarity. The systems are currently operating above 90% capacity. TEPCO has been able to reduce the inventory of contaminated water creating enough margin to increase the cooling injection rates into the RPVs.

The waste sludge from the oil separator, reverse osmosis membrane, and desalination units is being stored on-site in temporary tanks. In addition, Units 5 and 6 are experiencing groundwater intrusion of 200 m3/day that is slightly contaminated but below release limits. However, TEPCO is unable to release this water because of current environmental policy issues. Therefore, TEPCO is spraying this water on the NPS site to alleviate storage concerns. Similarly, the NPS has a large volume of tritiated water at a tritium concentration of 103 Bq/m3. The total amount of the accumulated water is increasing at ~200 to 720 tons/day. This volume will eventually challenge the storage capacity. Multiple tank farms containing several hundred tanks for a total volume of >111,000 m3 and a megafloat barge to store 10,000 m3 of water have been added to the NPP site.

A similar portable skid-mounted water treatment and desalination system is being used to reduce contamination and chlorine levels in the SFPs of Units 2, 3, and 4. These SFPs had seawater injected into them during the event. The system is being moved to the Unit 2 SFP as cleanup has been completed on Unit 4. In many ways, the Fukushima Daiichi NPS has evolved from a nuclear power electric generation site into a large water treatment facility.

Site cleanup has been accomplished through the use of ten remotely controlled vehicles including backhoes, bulldozers, and dump trucks. The site has two remote vehicle control rooms that are used to control all the debris-removal construction equipment. One control room operates a backhoe, a dump truck, and a lift truck. The second control room operates two backhoes, a bulldozer, two dump trucks, and two lift trucks. All the items and materials removed from the yard area around the NPS have been stored in metal containers (4- to 8-m3 volume). Larger and less contaminated items are stored in bulk in a new solid-waste building. Each container has an assigned number and is labeled with its container number, where the debris is from, dose rate, and type of debris. This will be used to maintain inventory control during eventual transport off-site and waste disposal.

Removal of reactor building structures damaged by the explosions will be required to allow removal of spent fuel and ultimately core material. Planning is currently in progress for removal of fuel from the SFPs to storage containers within the next few years after the structures are removed.

Frequent monitoring and development of plans for environmental cleanup or removal of harmful levels of radioactive contamination from areas surrounding the NPS are progressing. The magnitude of the cleanup outside of the NPS site has required the Japanese government to take ownership for these tasks.

http://fukushima.ans.org/report/cleanup

Sources: Resources used are attached.

Date: 20150420
Criteria: (ALL_TEXT_FIELDS CONTAINS_OR {caesium}) AND (ALL_TEXT_FIELDS CONTAINS_OR {fukushima})
Execution Time: 00 seconds
Below are the Top 5 hits that match your criteria.
CSHERLINE - CSTAFF - U Copyright - Y Export - Y
IAC Number: CB-196860
AD Number:
Date Received: 2011-05-17
Title: A Long Shadow Over Fukushima.
Author(s): Smith, Jim
Corp Source Code: 396495
Corp Author Name: PORTSMOUTH POLYTECHNIC (UNITED KINGDOM)
Descriptive Note: Journal Article
Publish Date: 2011-04-07
Page Count: 1
Country: GB
Distribution Code: PUBLIC
Distribution Statement: Approved for Public Release; Distribution Unlimited. Copyrighted Material. Availability: Nature, 472: 7, 7 April 2011.
Abstract: Three weeks after the Fukushima accident, a clearer picture is beginning to emerge of possible long-term environmental consequences. The US Department of Energy (DOE) aerial survey of radiation doses was a crucial development. A clear trace reaching out 30-40 kilometres northwest of the plant marked a zone of dose rate above 125 microsieverts per hour, a level at which immediate evacuation is often advised. Already, external doses are rapidly declining as a result of the decay of short-lived isotopes. But, as with the 1986 Chernobyl accident, it is caesium-137, with a half-life of 30.2 years, that will determine the long-term impact on the contaminated region and its residents. The extent of caesium-137 contamination at Fukushima is not yet clear, but available data indicate very high levels in some areas. The 30 March press release from the International Atomic Energy Agency (IAEA) reports caesium-137 deposition ranging from 0.02 to 3.7 megabecquerels per square metre (MBq m-2) at sites 25-58 kilometres from the Fukushima plant. The higher values are consistent with Japanese soil data from Iitate village, 40 kilometres northwest of the plant. Perhaps surprisingly, there is still no clear information on caesium-137 contamination within 20 kilometres of the plant (the distance of the evacuation zone), although the DOE map implies that this could be of the order of megabecquerels per square metre if the isotopic composition of deposits near the plant is similar to that in the area farther to the northwest.

Title: Effects of the Fukushima Nuclear Meltdowns on Environment and Health, February 16th, 2012.
Author(s): Rosen, Alex
Corp Source Code: 609613
Corp Author Name: HEINRICH HEINE UNIV DUSSELDORF (GERMANY)
Descriptive Note: Manuscript
Publish Date: 2012-02-16

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Country: DE
Distribution Code: PUBLIC
Distribution Statement: Approved for Public Release; Distribution Unlimited. Copyrighted Material. Availability: Heinrich Heine University, Department
of General Paediatrics, Moorenstr. 5, Ort 40225 Dusseldorf, Germany.
Abstract: The earthquake and tsunami on March 11th, 2011 led to multiple nuclear meltdowns in the reactors of the Fukushima Daiichi nuclear power plant in Northern Japan. Radioactive emissions from the plant caused widespread radioactive contamination of the entire region. The vast majority of the nuclear fallout occurred over the North Pacific, constituting the largest radioactive contamination of the oceans ever recorded. Soil and water samples, as well as marine animals have been found to be highly contaminated. Increased levels of radioactivity were recorded at all radiation measuring posts in the Northern Hemisphere. Fallout contaminated large parts of Eastern Honshu island, including the Tokyo metropolitan area. Within a 20 km radius, up to 200,000 people had to leave their homes. Outside of this evacuation zone, the radioactive fallout contaminated more than 870 km2 of land, home to about 70,000 people who were not evacuated. These people were exposed to harmful radioisotopes and now have an increased risk to develop cancer or other radiation-induced diseases. Many people still live in areas with high contamination. Food, milk and drinking water have been contaminated as well, leading to internal radiation exposure. Most severely affected are children, as their bodies are more susceptible to radiation damage. Preliminary tests have shown internal radioactive contamination of children with iodine-131 and caesium-137. It is too early to estimate the extent of health effects caused by the nuclear disaster. Taking into consideration the studies on Chernobyl survivors and the findings of the BEIR VII report, scientists will be able to estimate the effects once the true extent of radioactive emissions, fallout and contamination are better studied. Large-scale independent epidemiological studies are needed in order to better help the victims of this catastrophe. Claims by scientists affiliated with the nuclear industry that no health effects are to be expected are unscientific and immoral.

Title: Xenon-133 and Caesium-137 Releases into the Atmosphere from the Fukushima Dai-Ichi Nuclear Power Plant: Determination of the Source Term,
Atmospheric Dispersion, and Deposition.
Author(s): Stohl, A. Seibert, P. Wotawa, G. Arnold, D. Burkhart, J. F. Eckhardt, S. Tapia, C. Vargas, A. Yasunari, T. J.
Corp Author Name: NORWEGIAN INST FOR AIR RESEARCH (NILU) KJELLER (NORWAY)
Descriptive Note: Journal Article
Publish Date: 2011-01-01
Page Count: 76
Country: NO
Distribution Code: PUBLIC
Distribution Statement: Approved for Public Release; Distribution Unlimited. Copyrighted Material. Availability: Atmospheric Chemistry and Physics
Discussions, 11: 28319-28394, 2011.

Abstract: On 11 March 2011, an earthquake occurred about 130 km off the Pacific coast of Japan_s main island Honshu, followed by a large tsunami. The resulting loss of electric power at the Fukushima Dai-ichi nuclear power plant (FD-NPP) developed into a disaster causing massive release of radioactivity into the atmosphere. In this study, we determine the emissions of two isotopes, the noble gas xenon-133 (133_e) and the aerosol-bound caesium-137 (137Cs), which have very different release characteristics as well as behavior in the atmosphere. To determine radionuclide emissions as a function of height and time until 20 April, we made a first guess of release rates based on fuel inventories and documented accident events at the site. This first guess was subsequently improved by inverse modeling, which combined the first guess with the results of an atmospheric transport model, FLE_PART, and measurement data from several dozen stations in Japan, North America and other regions. We used both atmospheric activity concentration measurements as well as, for 137Cs, measurements of bulk deposition. Regarding 133_e, we find a total release of 16.7 (uncertainty range 13.4-20.0) EBq, which is the largest radioactive noble gas release in history not associated with nuclear bomb testing. There is strong evidence that the first strong 133_e release started very early, possibly immediately after the earthquake and the emergency shutdown on 11 March at 06:00UTC. The entire noble gas inventory of reactor units 1-3 was set free into the atmosphere between 11 and 15 March 2011. For 137Cs, the inversion results give a total emission of 35.8 (23.3-50.1) PBq, or about 42 percent of the estimated Chernobyl emission. Our results indicate that 137Cs emissions peaked on 14-15 March but were generally high from 12 until 19 March, when they suddenly dropped by orders of magnitude exactly when spraying of water on the spent-fuel pool of unit 4 started. This indicates that emissions were not only coming from the damaged reactor cores, but also from the spent-fuel pool of unit 4 and confirms that the spraying was an effective countermeasure. We also explore the main dispersion and deposition patterns of the radioactive cloud, both regionally for Japan as well as for the entire Northern Hemisphere. While at first sight it seemed fortunate that westerly winds prevailed most of the time during the accident, a different picture emerges from our detailed analysis. Exactly during and following the period of the strongest 137Cs emissions on 14 and 15 March as well as after another period with strong emissions on 19 March, the radioactive plume was advected over Eastern Honshu Island, where precipitation deposited a large fraction of 137Cs on land surfaces. The plume was also dispersed quickly over the entire Northern Hemisphere, first reaching North America on 15 March and Europe on 22 March. In general, simulated and observed concentrations of 133_e and 137Cs both at Japanese as well as at remote sites were in good quantitative agreement with each other. Altogether, we estimate that 6.4 TBq of 137Cs, or 19 percent of the total fallout until 20 April, were deposited over Japanese land areas, while most of the rest fell over the North Pacific Ocean. Only 0.7 TBq, or 2 percent of the total fallout were deposited on land areas other than Japan.

Title: Fallout Forensics Hike Radiation Toll.
Author(s): Brumfiel, Geoff
Publish Date: 2011-01-01
Distribution Code: PUBLIC
Distribution Statement: Approved for Public Release; Distribution Unlimited. Copyrighted Material. Availability: Nature, 478: 435-436. 2011.

Abstract: The disaster at the Fukushima Daiichi nuclear plant in March released far more radiation than the Japanese government has claimed. So concludes a study that combines radioactivity data from across the globe to estimate the scale and fate of emissions from the shattered plant. The study also suggests that, contrary to government claims, pools used to store spent nuclear fuel played a significant part in the release of the long-lived environmental contaminant caesium-137, which could have been prevented by prompt action. The analysis has been posted online for open peer review by the journal Homeland Defense and Security Information Analysis Center (HDIAC) Page 2 of 3 http://hddata1:8080/hdstart/tabularResults.do 4/20/2015 Atmospheric Chemistry and Physics.

Title: Consequences of Severe Radioactive Releases to Nordic Marine Environment.
Author(s): Iosjpe, M. Isaksson, M. Joensen, H. P. Lahtinen, J. Logemann, K. Palsson, S. E. Roos, P. Suolanen, V.
Corp Author Name: NORWEGIAN RADIATION PROTECTION AUTHORITY OSTERAS (NORWAY)
Descriptive Note: Research Report
Publish Date: 2013-02-01
Distribution Code: PUBLIC
Distribution Statement: Approved for Public Release; Distribution Unlimited. Availability: NKS Secretariat, PO Box 49, DK-4000 Roskilde, Denmark.
Abstract: In the report, consequences of hypothetical severe nuclear accidents releases to Nordic marine environment are preliminary considered. The considered marine area comprises the Baltic Sea (Sweden, Denmark, Finland) and the North Atlantic (Iceland, Faroes, Norway) areas. The hypothetical severe nuclear accidents can be related to nuclear power plants, nuclear powered submarines or ice-breakers. Quite comprehensive survey on radioactive source terms of extremely severe nuclear power and submarine accidents has been done. This enables to estimate more realistically possible radioactive releases of various elements and nuclides to marine environment. One recent reference is of course the Fukushima accident and estimated releases there. The marine flows and dilution circumstances around the Nordic nuclear power plants and in the Baltic Sea area in general, has been studied. Respectively marine flows related to Iceland and Faroes coasts are considered with measured data and with preliminary 3D-model simulations. The substantial depth of sea water in the North Atlantic affect vertical concentration profiles to some extent. At Icelandic or Faroese waters, a potential submarine accident would likely occur in a well defined water mass, and radioactivity from the accident would be detected and spread with the flow regime of the water mass in the world ocean. Based on hypothetical severe accidents scenarios, preliminary consequence calculations has been done. It should be emphasised that the considered severe accident cases, considered in this study, do not directly attach any specific Nordic nuclear power plant or any specific submarine type. The considered radioactive releases will, however, provide specified references for more extensive consideration of environmental consequences of severe - or minorradioactive releases to Nordic marine environment. As a reference, the release amounts from a 3000 MWth reactor size were used. Based on source term analyses, the chosen release fractions in the study were: iodine 20_ (of the total core inventory), caesium 10_, tellurium 10_, strontium 0.5_, ruthenium 0.5_. The considered release event to marine environment were assumed to start ten hours after shutdown of the reactor. Total released amounts of the most important nuclides were estimated to be:

4.85x10(17) Bq (I-131), 7.29x10(16) Bq (Cs-134) and 4.17x10(16) Bq (Cs-137). Due to the highly contaminated sea food, the arising doses to human from a hypothetical severe nuclear power plant accident would be high especially in local sea area. Based on preliminary results, annual individual doses could be ten to some hundreds of millisieverts from local sea area. The most important nuclides were Cs-134, Cs-137 and I-131 causing 96_ of the total ingestion dose. In the Baltic Sea area, the arising doses from a severe nuclear power plant accident assumed to happen e.g. at Gulf of Finland, would be about 1/10,000 compared to doses in the local sea area. Thus the arising maximum annual individual dose for fish pathway is in the level of 0.1 mSv in the Baltic Sea area. Submarine accident assumed to happen at Icelandic waters, has been analysed in the study. The calculated collective dose rates to man as well as doses to a critical group are significantly lower than doses from natural sources. However, in local considerations dose-rates are significantly higher than the negligible component to the annual individual dose obtained from natural sources (UNSCEAR, 2000) and, therefore, have to be taken into consideration during evaluation of the accident consequences.