

Radiation Readings on the Island of Hawaii (Big Island)

We used a [Radex RD1212](#) Geiger counter to record [ionizing radiation](#) readings around the [island of Hawaii, USA](#). The typical trade wind pattern that blows from east to west was present during the testing and the volcano was erupting and producing large amounts of [volcanic smog \(vog\)](#). For reference, the average background radiation levels are typically 0.09 to 0.11 micro-sieverts ($\mu\text{Sv/h}$) per hour in the USA. This is what we found with **peak value in red**:

Drive from [Kona](#) to [Milolii](#):

Product model: Radex 1212 and Radex 2510

Serial number: 04140101003009

File name: DeviceData.txt

Period	From	$\mu\text{Sv/h}$	
5m	12/17/2015 10:53:42	0.07	Left Kona
5m	12/17/2015 10:58:42	0.07	
5m	12/17/2015 11:03:42	0.09	
5m	12/17/2015 11:08:42	0.08	
5m	12/17/2015 11:13:42	0.08	
5m	12/17/2015 11:18:42	0.08	
5m	12/17/2015 11:23:42	0.07	
5m	12/17/2015 11:28:42	0.07	
5m	12/17/2015 11:33:42	0.08	
5m	12/17/2015 11:38:42	0.07	
5m	12/17/2015 11:43:42	0.07	
5m	12/17/2015 11:48:42	0.07	
5m	12/17/2015 11:53:42	0.07	
5m	12/17/2015 11:58:42	0.07	
5m	12/17/2015 12:03:42	0.06	
5m	12/17/2015 12:08:42	0.08	
5m	12/17/2015 12:13:42	0.08	

5m 12/17/2015 12:18:42 0.06 Arrived at Milolii

This drive produced below average radiation readings. It is suspected that the vog was increasing radiation absorption by the atmosphere which reduced the environmental radiation readings.

Drive from [Kona](#) to [Hilo](#) via the [Mauna Kea Visitors Center](#):

Product model: Radex 1212 and Radex 2510

Serial number: 04140101003009

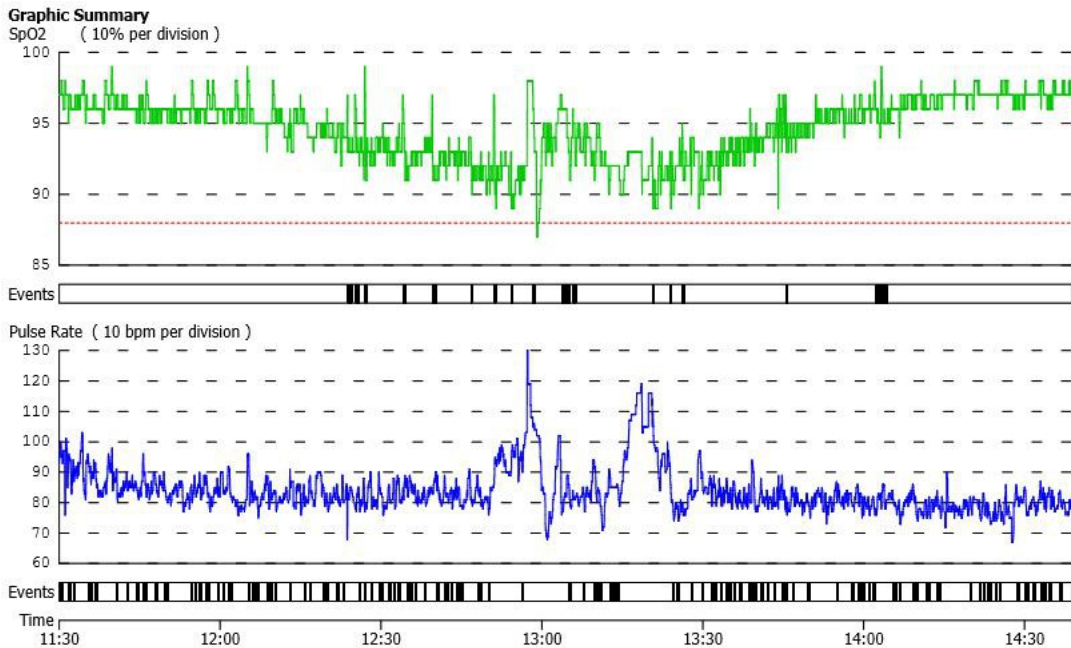
File name: DeviceData.txt

Period From μ Sv/h

5m	12/18/2015 11:31:35	0.08	Left sea level Kona on highway 190
5m	12/18/2015 11:36:35	0.09	
5m	12/18/2015 11:41:35	0.08	
5m	12/18/2015 11:46:35	0.08	Passed 1,500 feet
5m	12/18/2015 11:51:35	0.08	
5m	12/18/2015 11:56:35	0.08	Passed 2,000 feet
5m	12/18/2015 12:01:35	0.08	
5m	12/18/2015 12:06:35	0.07	
5m	12/18/2015 12:11:35	0.07	
5m	12/18/2015 12:16:35	0.08	Turned onto highway 200
5m	12/18/2015 12:21:35	0.09	
5m	12/18/2015 12:26:35	0.08	
5m	12/18/2015 12:31:35	0.10	
5m	12/18/2015 12:36:35	0.08	
5m	12/18/2015 12:41:35	0.08	Turned onto Mauna Kea summit access road
5m	12/18/2015 12:46:35	0.09	
5m	12/18/2015 12:51:35	0.10	Arrived at 9,200 feet Mauna Kea visitor center
5m	12/18/2015 12:56:35	0.12	
5m	12/18/2015 13:01:35	0.11	
5m	12/18/2015 13:06:35	0.11	
5m	12/18/2015 13:11:35	0.13	

5m	12/18/2015 13:16:35	0.11	
5m	12/18/2015 13:21:35	0.11	
5m	12/18/2015 13:26:35	0.11	
5m	12/18/2015 13:31:35	0.11	Left Mauna Kea visitor center
5m	12/18/2015 13:36:35	0.09	
5m	12/18/2015 13:41:35	0.10	
5m	12/18/2015 13:46:35	0.09	Turned onto highway 200
5m	12/18/2015 13:51:35	0.09	
5m	12/18/2015 13:56:35	0.08	
5m	12/18/2015 14:01:35	0.07	
5m	12/18/2015 14:06:35	0.07	
5m	12/18/2015 14:11:35	0.07	
5m	12/18/2015 14:16:35	0.06	
5m	12/18/2015 14:21:35	0.07	
5m	12/18/2015 14:26:35	0.06	
5m	12/18/2015 14:31:35	0.07	
5m	12/18/2015 14:36:35	0.07	Arrived into sea level Hilo

Due to the altitude change of 9,200 feet, we recorded blood oxygen (SpO2) and pulse rate with a [CMS50E Fingertip Pulse Oximeter](#):



As can be seen, the blood oxygen dropped to the lowest level while at 9,200 feet and heart rate increased during the forty minutes spent walking around at high altitude. The peak ionizing radiation values were recorded at 9,200 feet, which was the expected outcome as ionizing radiation increases with altitude.

Drive through [Puna - Pahoa](#) to [Kalapana](#) to [Isaac Hale Beach Park/Pohoiki](#) to [Ahalanui Hot Pond](#) to [Keaau](#):

Product model: Radex 1212 and Radex 2510

Serial number: 04140101003009

File name: DeviceData.txt

Period	From	$\mu\text{Sv/h}$	
5m	12/19/2015 17:27:20	0.07	Left Pahoa
5m	12/19/2015 17:32:20	0.07	
5m	12/19/2015 17:37:20	0.06	
5m	12/19/2015 17:42:20	0.07	Kalapana
5m	12/19/2015 17:47:20	0.07	
5m	12/19/2015 17:52:20	0.06	
5m	12/19/2015 17:57:20	0.07	
5m	12/19/2015 18:02:20	0.07	
5m	12/19/2015 18:07:20	0.07	
5m	12/19/2015 18:12:20	0.07	Isaac Hale Beach Park & Pohoiki
5m	12/19/2015 18:17:20	0.07	Ahalanui Hot Pond
5m	12/19/2015 18:22:20	0.08	
5m	12/19/2015 18:27:20	0.08	Puna Geothermal
5m	12/19/2015 18:32:20	0.07	Passing by Pahoa
5m	12/19/2015 18:37:20	0.07	
5m	12/19/2015 18:42:20	0.07	
5m	12/19/2015 18:47:20	0.07	
5m	12/19/2015 18:52:20	0.06	Arrived into Keaau

It was interesting that the peak radiation readings occurred in the area of Puna that is noted for its geothermal activity.

Drive from [Hilo](#) to [Hawaii Volcanoes National Park](#) to [South Point](#) to [Milolii](#):

Product model: Radex 1212 and Radex 2510

Serial number: 04140101003009

File name: DeviceData.txt

Period	From	$\mu\text{Sv/h}$	
5m	12/22/2015 10:38:11	0.07	Left downtown Hilo – sea level
5m	12/22/2015 10:43:11	0.09	Driving on Kinoole Street, Hilo
5m	12/22/2015 10:48:11	0.07	
5m	12/22/2015 10:53:11	0.08	
5m	12/22/2015 10:58:11	0.06	Passed by Keaau
5m	12/22/2015 11:03:11	0.07	Drove through Kurtistown
5m	12/22/2015 11:08:11	0.07	Drove through Mountain View
5m	12/22/2015 11:13:11	0.07	Passed 2,000 feet
5m	12/22/2015 11:18:11	0.08	Passed 3,000 feet
5m	12/22/2015 11:23:11	0.07	Passed by Volcano Village
5m	12/22/2015 11:28:11	0.08	Arrived at Volcanoes National Park
5m	12/22/2015 11:33:11	0.08	
5m	12/22/2015 11:38:11	0.09	Passed by visitors center and steam vents
5m	12/22/2015 11:43:11	0.07	Stopped at Thomas A. Jaggar Musuem
5m	12/22/2015 11:48:11	0.09	At active volcanic vent overlook
5m	12/22/2015 11:53:11	0.09	At active volcanic vent overlook
5m	12/22/2015 11:58:11	0.09	Left Thomas A. Jaggar Musuem
5m	12/22/2015 12:03:11	0.08	
5m	12/22/2015 12:08:11	0.08	Back at entrance of park
5m	12/22/2015 12:13:11	0.08	Turned onto Chain of Craters Road
5m	12/22/2015 12:18:11	0.08	
5m	12/22/2015 12:23:11	0.08	
5m	12/22/2015 12:28:11	0.06	
5m	12/22/2015 12:33:11	0.08	

5m	12/22/2015 12:38:11	0.08	
5m	12/22/2015 12:43:11	0.07	
5m	12/22/2015 12:48:11	0.07	
5m	12/22/2015 12:53:11	0.06	Arrived at end of Chain of Craters Road – sea level
5m	12/22/2015 12:58:11	0.07	U-turn and drive back up Chain of Craters Road
5m	12/22/2015 13:03:11	0.08	
5m	12/22/2015 13:08:11	0.08	
5m	12/22/2015 13:13:11	0.09	Passed by Muliwai a Pele
5m	12/22/2015 13:18:11	0.08	
5m	12/22/2015 13:23:11	0.07	At top of Chain of Craters Road
5m	12/22/2015 13:28:11	0.08	
5m	12/22/2015 13:33:11	0.07	Left Volcanoes National Park
5m	12/22/2015 13:38:11	0.09	Passed 4,024 feet crest near active volcanic vent
5m	12/22/2015 13:43:11	0.08	Passed 3,500 feet
5m	12/22/2015 13:48:11	0.07	Passed 3,000 feet
5m	12/22/2015 13:53:11	0.07	Passed 2,500 feet
5m	12/22/2015 13:58:11	0.07	Passed 1,500 feet
5m	12/22/2015 14:03:11	0.08	Passed 1,000 feet
5m	12/22/2015 14:08:11	0.07	Passed Pahala and 500 feet
5m	12/22/2015 14:13:11	0.07	Punaluu Black Sand Beach – sea level
5m	12/22/2015 14:18:11	0.07	
5m	12/22/2015 14:23:11	0.07	Whittington Beach Park
5m	12/22/2015 14:28:11	0.07	Stopped at Naalehu
5m	12/22/2015 14:33:11	0.09	Inside Punaluu Bake Shop
5m	12/22/2015 14:38:11	0.07	
5m	12/22/2015 14:43:11	0.07	
5m	12/22/2015 14:48:11	0.07	
5m	12/22/2015 14:53:11	0.08	
5m	12/22/2015 14:58:11	0.08	Left Naalehu
5m	12/22/2015 15:03:11	0.08	Passing through Waiohinu
5m	12/22/2015 15:08:11	0.07	

5m	12/22/2015 15:13:11	0.08	Turned onto South Point Road
5m	12/22/2015 15:18:11	0.07	
5m	12/22/2015 15:23:11	0.07	
5m	12/22/2015 15:28:11	0.07	
5m	12/22/2015 15:33:11	0.08	Stopped at South Point – southernmost tip of the USA
5m	12/22/2015 15:38:11	0.07	
5m	12/22/2015 15:43:11	0.06	Left South Point
5m	12/22/2015 15:48:11	0.07	
5m	12/22/2015 15:53:11	0.07	
5m	12/22/2015 15:58:11	0.07	
5m	12/22/2015 16:03:11	0.07	
5m	12/22/2015 16:08:11	0.07	Turned onto highway towards Kona
5m	12/22/2015 16:13:11	0.07	Passing though Hawaiian Ocean View Estates (HOVE)
5m	12/22/2015 16:18:11	0.08	Passed by Manuka State Park
5m	12/22/2015 16:23:11	0.08	
5m	12/22/2015 16:28:11	0.08	
5m	12/22/2015 16:33:11	0.08	
5m	12/22/2015 16:38:11	0.06	
5m	12/22/2015 16:43:11	0.08	
5m	12/22/2015 16:48:11	0.07	
5m	12/22/2015 16:53:11	0.07	
5m	12/22/2015 16:58:11	0.07	Arrived at Milolii

Consistently above the island of Hawaii background level readings were obtained near to the active volcanic vent which was to be expected, as the ionizing radiation levels underground are typically higher than at the surface. The vent was emitting particles that had come from a deep underground magma chamber.

Drive from [Kona](#) to [Waikoloa](#) to [Kawaehai](#) to [Pololu](#) to [Kapaau](#) to [Hawi](#) to [Waimea](#) to [Waipio](#) to [Honokaa](#) to [Hilo](#). Note that the time used was 3 hours ahead of Hawaii time due to Geiger counter being set to MST. Geiger counter was in shirt breast pocket when driving and placed onto the ground on arrival to location:

Product model: Radex 1212 and Radex 2510

Serial number: 04140101003009

File name: DeviceData.txt

Period	From	$\mu\text{Sv/h}$	
5m	12/01/2016 13:19:17	0.11	At Kona hotel room
5m	12/01/2016 13:24:17	0.11	
5m	12/01/2016 13:29:17	0.12	
5m	12/01/2016 13:34:17	0.10	Checking out
5m	12/01/2016 13:39:17	0.10	Ground reading started
5m	12/01/2016 13:44:17	0.09	
5m	12/01/2016 13:49:17	0.07	
5m	12/01/2016 13:54:17	0.07	Finished ground reading
5m	12/01/2016 13:59:17	0.07	Driving to Waikoloa
5m	12/01/2016 14:04:17	0.07	
5m	12/01/2016 14:09:17	0.07	
5m	12/01/2016 14:14:17	0.08	Stopped for Costco gas
5m	12/01/2016 14:19:17	0.07	Driving
5m	12/01/2016 14:24:17	0.08	
5m	12/01/2016 14:29:17	0.07	
5m	12/01/2016 14:34:17	0.07	
5m	12/01/2016 14:39:17	0.08	
5m	12/01/2016 14:44:17	0.08	Arrived at Waikoloa
5m	12/01/2016 14:49:17	0.09	At Queens Marketplace
5m	12/01/2016 14:54:17	0.09	
5m	12/01/2016 14:59:17	0.08	
5m	12/01/2016 15:04:17	0.08	

5m	12/01/2016 15:09:17	0.10	
5m	12/01/2016 15:14:17	0.09	
5m	12/01/2016 15:19:17	0.07	Started Ground Reading
5m	12/01/2016 15:24:17	0.07	
5m	12/01/2016 15:29:17	0.08	
5m	12/01/2016 15:34:17	0.07	Finished ground reading
5m	12/01/2016 15:39:17	0.07	Driving to Kawaehai
5m	12/01/2016 15:44:17	0.08	
5m	12/01/2016 15:49:17	0.07	Arrived Kawaehai Harbor
5m	12/01/2016 15:54:17	0.07	Started ground reading
5m	12/01/2016 15:59:17	0.09	
5m	12/01/2016 16:04:17	0.08	Finished ground reading
5m	12/01/2016 16:09:17	0.08	Driving to Polulu Valley
5m	12/01/2016 16:14:17	0.06	
5m	12/01/2016 16:19:17	0.07	
5m	12/01/2016 16:24:17	0.08	
5m	12/01/2016 16:29:17	0.08	
5m	12/01/2016 16:34:17	0.07	
5m	12/01/2016 16:39:17	0.07	
5m	12/01/2016 16:44:17	0.09	Arrived at Polulu Valley viewpoint
5m	12/01/2016 16:49:17	0.07	Ground reading
5m	12/01/2016 16:54:17	0.11	
5m	12/01/2016 16:59:17	0.10	
5m	12/01/2016 17:04:17	0.09	Finished ground reading
5m	12/01/2016 17:09:17	0.08	Driving to Kapaa
5m	12/01/2016 17:14:17	0.08	Arrived at Kapaa
5m	12/01/2016 17:19:17	0.08	Started ground reading
5m	12/01/2016 17:24:17	0.09	
5m	12/01/2016 17:29:17	0.08	Finished ground reading
5m	12/01/2016 17:34:17	0.09	Driving to Hawi
5m	12/01/2016 17:39:17	0.08	Started ground reading at Hawi

5m	12/01/2016 17:44:17	0.09	
5m	12/01/2016 17:49:17	0.08	Finished ground reading
5m	12/01/2016 17:54:17	0.08	Driving to Waimea
5m	12/01/2016 17:59:17	0.09	
5m	12/01/2016 18:04:17	0.07	
5m	12/01/2016 18:09:17	0.08	
5m	12/01/2016 18:14:17	0.09	
5m	12/01/2016 18:19:17	0.08	
5m	12/01/2016 18:24:17	0.08	
5m	12/01/2016 18:29:17	0.08	
5m	12/01/2016 18:34:17	0.08	Arrived Waimea
5m	12/01/2016 18:39:17	0.09	
5m	12/01/2016 18:44:17	0.10	Started ground reading
5m	12/01/2016 18:49:17	0.09	
5m	12/01/2016 18:54:17	0.09	Finished ground reading
5m	12/01/2016 18:59:17	0.07	Driving to Waipio Valley
5m	12/01/2016 19:04:17	0.09	
5m	12/01/2016 19:09:17	0.09	
5m	12/01/2016 19:14:17	0.08	
5m	12/01/2016 19:19:17	0.09	
5m	12/01/2016 19:24:17	0.09	
5m	12/01/2016 19:29:17	0.09	
5m	12/01/2016 19:34:17	0.08	
5m	12/01/2016 19:39:17	0.07	Arrived Waipio Valley viewpoint
5m	12/01/2016 19:44:17	0.07	Started ground reading
5m	12/01/2016 19:49:17	0.08	
5m	12/01/2016 19:54:17	0.09	
5m	12/01/2016 19:59:17	0.08	Finished ground reading
5m	12/01/2016 20:04:17	0.07	Driving to Honokaa
5m	12/01/2016 20:09:17	0.08	Arrived Honokaa
5m	12/01/2016 20:14:17	0.07	Started ground reading

5m	12/01/2016 20:19:17	0.09	
5m	12/01/2016 20:24:17	0.09	
5m	12/01/2016 20:29:17	0.08	Finished ground reading
5m	12/01/2016 20:34:17	0.08	Driving to Hilo
5m	12/01/2016 20:39:17	0.07	
5m	12/01/2016 20:44:17	0.07	
5m	12/01/2016 20:49:17	0.07	
5m	12/01/2016 20:54:17	0.07	
5m	12/01/2016 20:59:17	0.07	
5m	12/01/2016 21:04:17	0.07	
5m	12/01/2016 21:09:17	0.07	
5m	12/01/2016 21:14:17	0.06	
5m	12/01/2016 21:19:17	0.06	Arrived Hilo
5m	12/01/2016 21:24:17	0.07	Stopped at downtown
5m	12/01/2016 21:29:17	0.09	
5m	12/01/2016 21:34:17	0.08	
5m	12/01/2016 21:39:17	0.07	
5m	12/01/2016 21:44:17	0.07	
5m	12/01/2016 21:49:17	0.08	
5m	12/01/2016 21:54:17	0.08	Left downtown
5m	12/01/2016 21:59:17	0.07	Arrived Hilo hotel
5m	12/01/2016 22:04:17	0.06	Checking in
5m	12/01/2016 22:09:17	0.06	
5m	12/01/2016 22:14:17	0.08	
5m	12/01/2016 22:19:17	0.07	
5m	12/01/2016 22:24:17	0.07	Started ground reading
5m	12/01/2016 22:29:17	0.07	
5m	12/01/2016 22:34:17	0.10	
5m	12/01/2016 22:39:17	0.08	Finished ground reading
5m	12/01/2016 22:44:17	0.08	At hotel room

The Kona hotel room gave the highest readings and probably reflected that imported items to Hawaii had been used to construct and furnish the room. Guests can also deposit particles of higher

radioactivity into rooms from personal items from a foreign country carried with them in their suitcases. Radioactive hotel room smoke detectors may also cause elevated readings. The ground radiation at Polulu Valley viewpoint was slightly elevated as compared to the other ground readings obtained.

Summary

The Island of Hawaii has a background radiation level that seems to average 0.07 microsieverts per hour. In areas of geothermal activity or volcanic activity, these readings slightly increase to 0.08 to 0.09 microsieverts per hour. The highest readings were obtained at the Mauna Kea Visitors Center where 0.11 to 0.13 microsieverts per hour was recorded due to what appeared to be the high altitude ionizing radiation levels. Radiation levels have been known for about a century to increase at higher altitudes. We did not venture up to the 13,796 feet high summit of Mauna Kea due to the [known biological hazards that this toxic environment presents to the human.](#)

These readings can be contrasted to those obtained in and around the Tucson, Arizona, USA area. Background air levels in the City of Tucson are between 0.09 to 0.14 microsieverts per hour. Ground readings are slightly higher at 0.15 to 0.18 microsieverts per hour. Air readings of 0.09 to 0.19 microsieverts per hour and ground readings of 0.22 to 0.28 microsieverts per hour were obtained at the Kitt Peak National Observatory. The readings can be viewed here:

http://environmentalradiation.com/tucson_radiation_readings.pdf

The highest human environmental exposure radiation readings that have been obtained were found on high altitude jet aircraft. A jet aircraft at cruising altitude can be as high as 3.27 microsieverts per hour. These readings can be viewed here:

http://environmentalradiation.com/altitude_radiation.pdf

<http://environmentalradiation.com/Daytime%20Nighttime%20Flying%20Radiation%20Readings.pdf>

Interesting Quotes & Internet Links

- “A mathematical model constructed by researchers at Imperial College London predicts the risk of cardiovascular disease (heart attacks, stroke) associated with low background levels of radiation. The model shows that the risk would vary almost in proportion with dose.”
<https://www.sciencedaily.com/releases/2009/10/091022202710.htm>
- “Absorption (electromagnetic radiation)”
[https://en.wikipedia.org/wiki/Absorption_\(electromagnetic_radiation\)](https://en.wikipedia.org/wiki/Absorption_(electromagnetic_radiation))
- “Airplane Radiation Levels to 40,000 Feet”
http://environmentalradiation.com/altitude_radiation.pdf
- “Altitude” <https://en.wikipedia.org/wiki/Altitude>
- “Atmosphere of Earth” https://en.wikipedia.org/wiki/Atmosphere_of_Earth
- “Background radiation” https://en.wikipedia.org/wiki/Background_radiation
- “Chernobyl Exclusion Zone...the "Black Zone" (over 200 $\mu\text{Sv/h}$), to which evacuees were never to return; the "Red Zone" (50–200 $\mu\text{Sv/h}$) where evacuees might return once radiation levels normalized; the "Blue Zone" (30–50 $\mu\text{Sv/h}$) where children and pregnant women were evacuated starting in the summer of 1986”
https://en.wikipedia.org/wiki/Chernobyl_Exclusion_Zone
- “Daytime & Nighttime Flying Radiation Readings” <http://environmentalradiation.com/Daytime%20Nighttime%20Flying%20Radiation%20Readings.pdf>
- “Delayed Radiation Injury (Soft Tissue and Bony Necrosis)” <https://www.uhms.org/11-delayed-radiation-injury-soft-tissue-and-bony-necrosis.html>
- “Drugs Associated with the Development of Interstitial Lung Disease...Aspirin, Oxygen, Radiation”
<http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/pulmonary/interstitial-lung-disease/>
- “Early X-ray machines needed to be set and repeatedly adjusted. To achieve this, radiographers would place their hands between the actively radiating tube and the film plate to check if the apparatus was functioning and that it was well focused on the film. By practicing this for 12 years, Dr. Kells was the first victim of dental X-ray radiation with numerous cancerous tumors on his fingers.” <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4319329/>
- “Electromagnetic interference” https://en.wikipedia.org/wiki/Electromagnetic_interference
- “experimental evidence supported low-dose ionizing radiation exposure causes a significant long-term alterations in lipid metabolisms and endothelial function”
<http://info.cfimedical.com/blog/hypertension-and-high-cholesterol-linked-to-radiation-exposure>
- “Information for Radiation Workers” <http://www.nrc.gov/about-nrc/radiation/health-effects/info.html>
- “Ionizing radiation” https://en.wikipedia.org/wiki/Ionizing_radiation
- “Island of Hawaii (Big Island) Ionizing Radiation Readings”

http://environmentalradiation.com/hawaii_radiation_readings.pdf

- “Long-term side effects of radiation therapy” USA
<http://www.cancer.org/treatment/treatmentsandsideeffects/treatmenttypes/radiation/understandingradiationtherapyaguideforpatientsandfamilies/understanding-radiation-therapy-long-term-side-effects>
- “Long term side effects of radiotherapy” UK <http://www.cancerresearchuk.org/about-cancer/cancers-in-general/treatment/radiotherapy/follow-up/long-term-side-effects-of-radiotherapy>
- “Muscle/joint pain after radiation?” <https://community.breastcancer.org/forum/70/topics/733288>
- “Navajo Uranium Workers and the Effects of Occupational Illnesses”
<http://faculty.washington.edu/stevehar/Dawson.pdf>
- “Nuclear Witnesses: Insiders Speak Out by Leslie J. Freeman” <https://amzn.com/0393300331>
- “Open Letter to the Astronomical Community” <http://environmentalradiation.com/Open%20Letter%20To%20The%20Astronomical%20Community.pdf>
- “Radiation” <https://en.wikipedia.org/wiki/Radiation>
- “Radiation Exposure Compensation Act (RECA) was passed by the U.S. Congress in 1990 to make partial restitution to individuals harmed by radiation exposure resulting from underground uranium mining and above-ground nuclear tests in Nevada.”
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240251/>
- “Radiation health effects” https://en.wikipedia.org/wiki/Category:Radiation_health_effects
- “Radiation: How much is harmful?” http://quartarad.com/index.php?option=com_content&view=article&id=150:radiation-article&catid=36:demo-articles
- “Radiation-induced lung injury” <http://www.uptodate.com/contents/radiation-induced-lung-injury>
- “Radiation-Induced Lung Injury: Assessment, Management, and Prevention”
<http://www.cancernetwork.com/lung-cancer/radiation-induced-lung-injury-assessment-management-and-prevention/page/0/1>
- “Radiation poisoning (disambiguation)”
[https://en.wikipedia.org/wiki/Radiation_poisoning_\(disambiguation\)](https://en.wikipedia.org/wiki/Radiation_poisoning_(disambiguation))
- “Radiation Poisoning Remedies” <http://www.earthclinic.com/cures/radiation.html>
- “Radiation Protection with miso and seaweed - Japanese Nuclear Reactor Meltdown”
<http://melaniegrimes.com/radiation-protection-with-miso-and-seaweed/>
- “She was a dental technician in the Navy and also worked for years in pediatric dental offices and orthodontics as an assistant, calming nervous children, helping them to have good dental experiences, and when she was exposing radiographs, sometimes she admits that she would make it easier on everyone if she would stay with the child while the x-rays were beaming through her hand...Even though the tumor was benign, because of the damage done, the possibility of regrowth and other factors, the decision was made for my friend to have her ring finger amputated.” <http://www.dentalbuzz.com/2013/03/15/fingers-in-the-picture/>
- “Side Effects of Radiation Therapy” <http://news.cancerconnect.com/side-effects-of-radiation-therapy/>

- “Sievert” <https://en.wikipedia.org/wiki/Sievert>
- “studies have associated chronic radiation exposure with poor long-term heart health.” <http://www.medicalnewstoday.com/articles/308881.php>
- “The dose limit to non-radiation workers and members of the public are two percent of the annual occupational dose limit. Therefore, a non-radiation worker can receive a whole body dose of no more than 0.1 rem/year from industrial ionizing radiation. This exposure would be in addition to the 0.3 rem/year from natural background radiation and the 0.05 rem/year from man-made sources such as medical x-rays.” https://www.nde-ed.org/EducationResources/CommunityCollege/RadiationSafety/safe_use/exposure.htm
- “The effects of radiation on the long-term trends of the total serum cholesterol levels of the Hiroshima and Nagasaki atomic bomb survivors were examined using data collected in the Adult Health Study over a 28-year period (1958-1986)... We showed that the mean growth curve of cholesterol levels for the irradiated subjects were significantly higher than that for the unirradiated subjects, and that the increase was greater for women than for men... This increase may also partially explain the increased rate of coronary heart disease seen in the atomic bomb survivors.” <https://www.ncbi.nlm.nih.gov/pubmed/10360794>
- “The longer a white miner was exposed to radon gas, the greater the risk of lung cancer.” <http://www.cdc.gov/niosh/pgms/worknotify/uranium.html>
- “Treatment for Radiation-Induced Pulmonary Late Effects: Spoiled for Choice or Looking in the Wrong Direction?” <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2948640/>
- “Tucson Ionizing Radiation Readings” http://environmentalradiation.com/tucson_radiation_readings.pdf
- “we concluded that the predominant injurious agent in these cases was alpha particles from radon progeny. This disease, after a long latent period, usually results in pulmonary hypertension, shortness of breath, and death by cardiopulmonary failure.” <http://www.ncbi.nlm.nih.gov/pubmed/9604184>
- “Wireless Radiofrequency Radiation in Schools” <https://aaemonline.org/pdf/WiredSchools.pdf>
- “workers who were exposed to radiation for a median of 10 years had: 2.8 times higher odds of having skin lesion; 7.1 times higher odds of having orthopedic (back/neck/knee) problems; and 6.3 times higher odds of having cataracts.” <http://newsroom.heart.org/news/healthcare-workers-radiation-exposure-tied-to-range-of-health-problems>
- “WW2 veteran tells how seaweed saved him from the atom bomb” http://www.thisiswiltshire.co.uk/news/8212772.WW2_veteran_tells_how_seaweed_saved_him_from_the_atom_bomb/
- “X-Ray” <https://en.wikipedia.org/wiki/X-ray>

“Replace fear of radiation with curiosity”

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