NEI Nuclear Notes

News and commentary on the commercial nuclear energy industry.

SUNDAY, APRIL 17, 2011

UCS Science: How Many Cancers Did Airlines Really Cause?

There is a lot of confusion about how many excess cancer deaths will likely result from exposure to radiation at low-dose and low-dose-rates. As we see below, 79,000 and 40,000 are reasonable estimates of the number of excess cancers and cancer deaths attributable to the flying in the past decade.

I was inspired to investigate this subject after reading an article in the socialist magazine *Monthly Review* by Lisbeth Gronlund, senior scientist at the Union of Concerned Scientists (UCS), which was entitled "How Many Cancers Did Chernobyl Really Cause?" In this article, she uses the "best possible risk estimates for exposure to low-dose, low-LET radiation in human subjects," which was proposed by the BEIR (Biological Effects of Ionizing Radiation) Committee of the National Academy of Sciences to estimate the number of additional cancers and cancer deaths (above the number of "naturally occurring" cancers) that could be attributed to the Chernobyl accident. It is interesting that Dr. Gronlund's numbers are strikingly different from those put forward by the United Nation's Chernobyl Forum (4000 to 9000 deaths), which used a similar methodology.

Therefore, I decided to apply Dr. Gronlund's methodology to something more familiar to the average person: commercial aviation. Each airline flight exposes its crew and passengers to an excess risk of cancer in the form of cosmic radiation. As the US EPA explains, exposure to cosmic radiation depends on altitude, latitude, and solar activity, but the EPA estimates that "a typical cross-country flight in a commercial airplane" results in "2 to 5 millirem (mrem)" of dose from radiation.

The statistics from the US Bureau of Transportation Statistics indicate that over 7 billion airline passengers (international and domestic) flew in the US between January 2001 and January 2011. Thus, if we assume a fairly low average value of 3 millirem per passenger, then aviation has resulted in a collective dose of 210,000 passenger-Sv over the past decade.

This is quite a large number already, but Dr. Gronlund did not consider the radiation exposure within just one country. She provided

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an estimate for the *entire world*. So we should follow suit.

The US aviation market comprises somewhere between 25 to 30 percent of the entire world's airline passengers (e.g., in 2009, passengers in the US comprised roughly 28% of the airline passengers worldwide, according to IATA statistics). Thus, if we conservatively assume that US passengers comprised 30% of the passengers worldwide during the past decade, then worldwide, the collective dose due to commercial aviation is 700,000 passenger-Sv.

Using Dr. Gronlund's methodology (which was taken from the BEIR VII report), we should assume that "the expected incidence and mortality of solid cancers and leukemia are 0.1135 cancer cases and 0.057 cancer deaths per Sv." Thus, because of radiation exposure due to the airline industry, **the expected number of cancer cases is 79,000, of which some 40,000 should result in death.**

Note however that, because exposure only increases the *probability* of developing cancer, we should keep in mind that no given cancer can be attributed to flying. Moreover, because these additional cancers will be distributed among hundreds of millions of people, it is practically impossible to discern them among all the other cancer cases. (About 42% of the general population have cancer at some point in their lives, and about 20% of the population die because of cancer or complications that result from cancer.)

It is somewhat illustrative to compare these numbers to the numbers presented by Dr. Gronlund for the Chernobyl accident: 68,000 cancer cases with 34,000 deaths. Given these numbers, one can scientifically conclude that the airline industry is far more dangerous -- in terms of deaths due to low-dose exposure to radiation -- than old, Soviet-era nuclear reactors.

In light of these numbers, I expect that the UCS will be setting itself up as an "aviation watchdog" any day now.

Posted by Brian Mays at 3:21 PM ShareThis

14 comments:

Duncan said...

if "a typical cross-country flight in a commercial airplane" results in "2 to 5 millirem (mrem)"

then your "conservative" average of 3 is probably an order of magnitude too large.

most commercial flights are much shorter than cross-country. shorter flights don't fly as high, and since they spend roughly the same amount of time in takeoff, landing, ascent and descent as long-haul flights, they spend a disproportionately shorter time at their peak

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altitude anyway.

Without rerunning your numbers, would a more reasonable estimate be about 5,000/decade?

April 17, 2011 6:53 PM

Brian Mays said...

"An order of magnitude too large"?

No, I don't think so.

While many domestic flights are much shorter, many international flights are much longer. The DOE claims that a round-trip flight from New York to London results in an exposure of 10 mrem (i.e. 5 mrem each way). As far as flights go these days, that's not a very long flight.

In any case, you have missed the entire point of the article.

April 17, 2011 9:09 PM

Robert Hargraves said...

I almost agree. Here's a simple calculation.
3 mrem = 0.03 mSv
0.03 mSv per passenger flight
times 7,000,000,000 flights (10 years)
equals 210,000 passenger-Sv
times 1 cancer per 10 Sv (BEIR VII)
= 21,000 solid cancers
= 10,500 deaths (10 years)

So airlines are killing people with cancer at the rate of 3 people per day.

April 18, 2011 8:11 AM

Brian Mays said...

Robert - The main point where our math disagrees is that you are considering only the passengers in the US, whereas my calculation is for passengers *worldwide* (assuming that the US has about 30% of the world's passengers). Thus, divide your final numbers by 0.3, and you'll see that our results are similar.

"So airlines are killing people with cancer at the rate of 3 people per day."

That's what "UCS Science" says, but realistically, no, not really.

April 18, 2011 8:33 AM

Anonymous said...

Why do so many people perpetuate the fallacy that someone cannot criticize a given societal danger without being hypocritical unless they also simultaneously are mobilized against ALL similar dangers?

For some reason, this only seems to be true of those who dispute nuclear power opponents. No one criticizes Race for the Cure for only focusing on breast cancer, rather than every type of cancer from every source.

Yet nuclear power opponents are frequently chided for not mobilizing against air travel, radon in houses, bananas, etc.

One may disagree with nuclear power opponents of course, as we see here every day. But why is it fair to say their criticisms are not valid simply because they don't address every single radiation risk in the world?

April 18, 2011 1:10 PM

Brian Mays said...

It's fair to say that their criticisms are not valid because they are based on bad science.

April 18, 2011 1:42 PM

Anonymous said...

They're using BEIR and UNSCEAR numbers. What, specifically, did they do incorrectly?

April 18, 2011 6:48 PM

Robert Hargraves said...

The LNT calculations used by the Chernobyl Forum (and us on this blog) show 9,000 people MAY die from excess cancers from Chernobyl. Yet the same calculation says 10 per day (worldwide) from airplane flights -- an order of magnitude more!

Visit slides 70 and 71 from
http://home.comcast.net/~robert.hargraves/public_html/2.Fear.pdf

to see a summary of Chernobyl Forum report, with and without LNT and BEIR VII assumptions.

April 18, 2011 9:50 PM

David B. Benson said...

Now do the exercise for the radiological riks alone of living dowwind of a coal reactor.

April 18, 2011 11:20 PM

nedclark said...

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TPN : Atomic

Please stop the meaningless "Straw-Man" comparisons between exposures to external radiation vs. exposure by ingestion of radioactive `fall-out'.

Yes, we know that cruising-altitude flight subjects us to increased solar (and extra-solar) radiation...but the chances of a single cell being struck more than once per flight is rather low (think of `never stepping into the same stream twice).

This is decidedly not the case when a radioactive particle is, say, inhaled, and settles into an alveoli of the lung... where that particle proceeds to continuously bombard the adjacent cells numerous times - each time, increasing the chances that an "(un)lucky strike" to genetic material will initiate mutation.

Decidedly different mechanisms, with distinctly different levels of danger.

April 19, 2011 12:35 AM

Robert Hargraves said...

NedClark, both "internal" and "external" radiation impacts are measured in Sieverts (Sv). One Sv is one Gray, except for neutrons and alpha particles where 1 Gy = about 20 Svs. One Gyis 1 watt-second of energy absorbed PER KILOGRAM OF BODY MASS. It doesn't matter whether the radiation came from some cosmic ray or beta decay of a banana in your stomach; it all happens internally. Svs measure the damage from ionizing energy absorbed.

That said, there are specially damaging incidents, such as you mentioned. Inhaling radon and having the (un)lucky incident of the radon atom decaying to polonium is bad for your health. The polonium adheres to the unprotected (by epidermis) surface of an alveoli in your lung. There it will alpha decay and cause cellular damage, and rarely DNA damage, which might lead to lung cancer. Indeed radon is the second leading cause of lung cancer, after smoking. I know of no other examples of direct or statistical evidence of cancer caused by radiation less than 100 mSv.

April 19, 2011 9:26 PM

Brian Mays said...

"They're using BEIR and UNSCEAR numbers. What, specifically, did they do incorrectly?"

Well, you could say that they failed to apply common sense. There are two ways of looking at it:

1. There's the naive hypothetical approach that every bit of exposure to ionizing radiation involves risk, no matter how small the dose. While this has the advantage of being conceptually easy to understand

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and computationally simple, it fails to explain our common, every-day experience with naturally occurring background radiation.

2. Or these extrapolations into low-dose and low-dose-rate exposures are gross oversimplifications that suffer from a paucity supporting scientific evidence. Thus, collective-dose calculations based on very small exposures to large numbers of people result in figures that are little more than nonsense, with almost no basis in reality.

The BEIR Committee has (somewhat stubbornly) stuck with the first view, whereas other scientific organizations -- e.g., the American Nuclear Society (PDF), the Health Physics Society (PDF), and to some extent the World Health Organization -- have adopted the second view. It is their opinion that an analysis such as the one performed by Dr. Gronlund is highly inappropriate for exposures that result in an individual dose of less than 5 rem (50 mSv) in a year. Dr. Gronlund's analysis begins with individual exposures on the order of only 10 mSv and proceeds to pile on deaths from exposures at the microSv level to arrive at a suitably (for her) high number.

Very few credible scientists defend an analysis such as this, but if you still want to adhere to the first view, then you *must* admit that commercial aviation is causing cancers and premature deaths at an alarming rate -- up to 20 cancers a day on average to its passengers, half of which are fatal, according to the numbers above. The same model was used for both calculations, and the total number of (hypothetical) deaths are comparable.

By the way, I should add that "nedclark" simply doesn't know what he is talking about. His assertion that ingestion somehow results in more potent sieverts is pure nonsense. These factors have already been considered in estimating the effective dose.

April 19, 2011 9:30 PM

Anonymous said…

Has anyone seen the following note at BNC?

http://bravenewclimate.com/2011/04/05/measuring-our-monsters/#comment-125083

Here was my comment:

I'm trying to tease out the implications of this study. How do we know the differences between Cher swallows and Spanish swallows are due to radiation? Is there an alternative explanation? if it is, does it manifest in the rest of the wildlife?

If low level radiation causes these genetic abnormalities, why don't we see this in studies of hi and low level radiation areas?

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