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Comparing Chernobyl Disaster to an ATR Accident

In previous issues of this newsletter, EDI presented documented evidence of the serious public hazard the Advanced Test Reactor (ATR) poses in the event of an accident. [1] In this issue, EDI will put this hazard into a context of other major nuclear reactor events so the numbers can have substantive meaning.

Although the Three-Mile Island (TMI) nuclear reactor melt-down so far remains the worst U.S. commercial accident, little is known about how much radiation was released because the radiation monitoring instruments pegged off-scale. What is known about TMI - is between 12 and 24 curies of radioactive iodine were released. It is crucial to remember that TMI had a sealed concrete containment dome that prevented much of the radiation from catastrophic release to the atmosphere. [2] The ATR does not have any credible radiation containment because it is housed in an ordinary steel sheathed industrial building built – along with the reactor - in the 1960s.

The Department of Energy/Idaho National Laboratory SL-1 reactor explosion – that killed three operators - is the worst U.S. non-commercial accident. These TMI/SL-1 radioactive releases are significant and have continuing health impacts on surrounding residents, but pale in comparison to Chernobyl and potential ATR releases.

Environmental Defense Institute presents –below- documented data that compares these two events and show how the Chernobyl nuclear reactor disaster compares to a potential ATR accident. Moreover, DOE's ATR is a self-regulated nuclear reactor. This means neither the Nuclear Regulatory Commission nor the congressionally mandated Defense Nuclear Facility Safety Board is exercising jurisdiction over ATR's operations. No outside independent oversight and no accountability with catastrophic consequences, spell a disaster waiting to happen.

The Environmental Protection Agency (EPA) and the Idaho Department of Environmental Quality have jurisdiction over INL/ATR operations, however fail to take any regulatory action other than minor hazardous materials violations. Based on Centers for Disease Control's final INL report these releases between 1952 and 1992 were **10,848,480 curies**. [3] This past radiation imposed on the deliberately non-informed public is unconscionable. Current radiation burden on INL and nuclear bomb downwinders must not be increased with an additional potential catastrophic ATR accident.

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[1] See EDI website for previous Newsletters and a complete analysis of the Freedom of Information Act documents released by the U.S. District Court of Wyoming in Keep Yellowstone Nuclear Free, Environmental Defense Institute and David McCoy v. U.S. Department of Energy, in U.S. District Court for the District of Wyoming (06-CV-205-D).
All available at; http://environmental-defense-institute.org/publications

[2] TMI operators did intentionally, gradually over time, release large amounts of radioactive gases to prevent an explosion, and contaminated water to the Susquehanna River. See video documentary "Three Mile Island Revisited."

[3] Final Report; Identification and Prioritization of Radionuclide Releases from the Idaho National Engineering Laboratory; Centers for Disease Control and Prevention; Department of Health and Human Services; October 8, 2002; Risk Assessment Corporation, page 53. This report is part of CDC's INEEL Dose Reconstruction Project.

"The Chernobyl disaster triggered the release of substantial amounts of radiation into the atmosphere in the form of both particle and gaseous radioisotopes, and is the most significant unintentional release of radiation into the environment to date. It has been suggested that the Chernobyl disaster released as much as 400 times the radioactive contamination of the Atomic bombings of Hiroshima and Nagasaki. The radioactivity released at Chernobyl tended to be more long lived than that released by a bomb detonation hence it is not possible to draw a simple comparison between the two events." [4]

Radiation exposure standards; In the below exposure table, it must be kept in mind what the U.S. radiation standards are currently. Updated EPA Title 40 Protection of Environment (40 CFR 61.92 Standard) states: "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive **in any year** an effective dose equivalent [whole body] of **10 mrem/yr [0.01 rem/yr]."**

Chernobyl Doses Compared to Potential ATR Accident Doses

Exposure – Doses *	**Chernobyl within 30 km** [5]	**Advanced Test Reactor Accident** [6]
Internal Inhaled (adult public)	3-150 mSv = 15 rem	13.2 rem [7] 96 rem [8]
Internal Inhaled (public child)	10-700 mSv = 70 rem	Not available
Thyroid Inhaled (adult public)	20-1000 mSv = 100 rem	323.0 rem [9] 185.0 rem [10]
Thyroid Inhaled (child public)	20-6000 mSv = 600 rem	Not available
Ingested (adults public)	3-180 mSv = 18 rem	Not available
Ingested (children public)	20-1,300 mSv = 130 rem	Not available
Worker	16.5 rem	7,380,000 rem [11]
Worker (thyroid)	Not available	8,030,000 rem [12]

***** For conversion units sieverts to rems and additional references on above table - see Endnotes at the newsletter end.

The variation of radiation doses in the above table is due to different DOE documents cited and different ATR accident scenarios analyzed by DOE. The Chernobyl radiation doses to children are a crucial component because researchers know all-to-well that children – especially infants – are more

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[4] Wikipedia; "Chernobyl Disaster Effects," citing International Commission for Radiation Protection (ICRP), and 53 other sources. Herein after referred to Wikipedia. http://en.wikipedia.org/wiki/chernobly_disaster_effects

[5] Wikipedia Foundation, Inc. is a non-profit organization.

[6] 2004 Chapter 15 Severe Accident Analysis – Upgraded Final Safety Analysis Report for the Advanced Test Reactor (SAR), herein after referred as SAR; And Emergency Management Hazards Assessments for Reactor Technology Complex (HAD-3, 2004) herein after referred to as HAD-3. These reports contain dose data for various accident scenarios. For a complete analysis see; http://environmental-defense-institute.org/publications

[7] SAR, page 15.8-10; Total Effective Dose Equivalent (whole body dose), at off-site low population zone. See Endnote # V .

[8] HAD-3, page 129; Based on a source term rate of 5.0 E+6 R/hr; at 500 meters (1,640 feet) 2 rem/hour (96 rem at 48 hours); also see page 139 for 48 hour dose rate for ATR loss-of-coolant accident downwind total effective dose equivalent. See Endnote # III at the newsletter end.

[9] HAD-3, page 148; "At INL boundary – 48 hours; Committed Effective Dose. See Endnote # IV below.

[10] SAR, page 15.8-10; "The dose calculated for 100% core melt considers release of 64% of the source term in the first day and remainder over the next 10 days; the total dose is 185 rem thyroid and 13.2 rem EDE (whole body**)** at the LPZ [low population zone]." See Endnote # V below.

[11] HAD-3, pages 32 and 34. "Downwind dose at 30 meters; 7.38 E+6 Total Effective Dose Equivalent; 9.00 E+7 Committed Effective Dose, in rems." See Endnote # VI below.

[12] HAD-3, page 148; Committed Effective Dose; 8.03 E+6 rem at 30 meters. See Endnote # IV below.

impacted due to the fact that they are still growing and body cell division is much higher than adults. The bottom line is that all of these ATR accident exposure doses are all greater than the Chernobyl releases.

DOE's own previous Environmental Impact Statement on NASA's plutonium-238 production states: **the ATR released 1,802 curies in 2000 and 1,180 curies in 2003 to the atmosphere.** [13] On average that is about 1,491 curies/year; so over an eight year period 2000 through 2009 (given ATR's continuous operation) about 13,419 curies may have been released to the air. These high emissions from ATR suggest liquid waste is first sent to the ATR cooling towers w/o treatment and the precipitates are then pumped to INTEC evaporators or the percolation ponds. This represents a significant hazard to INL workers and the downwind public, and violation of regulatory limits (Radioactive Emission Standard 40 CFR 61.92 cited above). Where are the EPA/ID state regulators?

DOE's Sites Become the Nation's New Yucca Mountain?

Sue Sturgis reports 11/13/09 in *Facing South* that. "Earlier this year President Obama canceled the federal government's plans to store high-level radioactive waste from nuclear power plants and weapons facilities at the controversial Yucca Mountain site in Nevada -- but now there are concerns that South Carolina could become a permanent dumping ground for the dangerous waste.

That state is home to the Savannah River Site, a nuclear materials processing center along the Savannah River 25 miles southeast of Augusta, Ga. Built during the 1950s to refine nuclear material for weapons, the site no longer has any operating nuclear reactors and is engaged in cleanup activities.

Given the demise of Yucca Mountain, business leaders in South Carolina and Georgia are expressing worries that high-level waste at the Savannah River Site may now be left there permanently. Scientists have warned about potential environmental contamination from long-term storage of such highly radioactive waste in the Savannah River watershed.

This week the SRS Community Reuse Organization -- a nonprofit group working to diversify the region's economy and a supporter of the Yucca Mountain site -- released a report calling for a special blue-ribbon panel to study options for disposing of the waste.

As the preface states:

The government's about face on this critical issue leaves state and local leaders with more questions than answers. Those responsible for public safety, job creation, image enhancement and citizen confidence must now lead in a new reality. They must come to terms with their community's lingering -- perhaps permanent -- role as caretaker for the Nation's highly radioactive waste.

As a region, we are now left wondering what's next. How we will come together in unity to address a path forward in the wake of this broken promise -- one that has implications of the longest possible term and a potential chilling effect on the region's future growth and prosperity?

The group's report says that if and when a panel is assembled to plot a new strategy for high-level nuclear waste storage, the Savannah River Site region's leaders should get a 'seat at the table'."

Idaho National Laboratory's Radioactive Waste Problems

The radioactive waste issues discussed above at the Savannah River Site (SRS) are virtually the same as the DOE's Idaho National Laboratory (INL) due to their designation by DOE as high-level non-commercial-foreign imported spent reactor fuel (SNF) storage/reprocessing sites. SRS got the aluminum-clad SNF fuel and INL got the stainless steel/zirconium clad and other experimental SNF fuel. This designation by SNF cladding is to accommodate/facilitate the specialization of reprocessing which is

[13] DOE/EIS-0287 pg. 4-30; DOE/DEIS-0373D, pg 3-26.

different with each fuel cladding type. Reprocessing of spent nuclear fuel is the chemical separation of highly enriched uranium/ plutonium for reuse in other military/space missions. INL spent nuclear fuel inventory (including imported foreign) is about 768.5 metric tons heavy metal (an accounting "slight of hand" that only includes the mass of highly enriched uranium and plutonium) and not the total weight. DOE deliberately does not consider spent nuclear fuel a waste based on the spurious premise that it is an unprocessed resource. Other DOE documents put the total weight of INL spent nuclear fuel at 1,458 metric tons containing 6,530,000,000 curies. [14]

Additionally, INL has a high-level wast inventory (not including contents of high-level waste tanks) of about 4,400 cubic meters (cm) solid calcine and one million gallons of high-level liquid waste primarily from reprocessing; 125,000 cubic meters transuranic waste; 170,000 cubic meters low-level waste; 3,380 cubic meters mixed-low-level hazardous waste. [15] EDI considers this INL waste inventory data significantly understated based on previous EDI FOIAs. In addition to the above waste, DOE's documentation shows INL buried waste in the Radioactive Waste Management Complex Subsurface Disposal Area contains 65,000 cm Navy greater-than-class-C low-level waste; 1,455 kilograms plutonium; 90.282 metric tons spent nuclear fuel. [16]

This extremely radioactive waste continues to contaminate the underlying Snake River Aquifer – thus posing a long-term threat to Idaho's future. [17]

It must be noted that DOE's Sandia and Los Alamos National Laboratories also have similar radioactive waste issues. It is insanely unconscionable to continue producing this extremely toxic waste that will remain deadly for tens of thousands of years, when there is no safe permanent disposal repository!

Tom Udall Leads Bipartisan Group in Introducing RECA Amendments Act of 2010

Bill Would Expand Relief for Americans Sickened by Radiation Exposure

U.S. Senator Tom Udall (D-NM) led a bipartisan group of senators in introducing the Radiation Exposure Compensation Act (RECA) Amendments of 2010, which would provide expanded restitution for Americans sickened from working in uranium mines or living near atomic weapons tests.

Senator Udall was joined in introducing the legislation by Sens. Jeff Bingaman (D-NM), Mike Crapo (R-ID), Mark Udall (D-CO), James Risch (R-ID), and Michael Bennet (D-CO). Companion legislation will be introduced in the House this week by Rep. Ben Ray Luján (D-NM-3).

Among other things, the RECA Amendments of 2010 would build upon previous RECA legislation by further widening qualifications for compensation for radiation exposure; qualifying post 1971 uranium workers for compensation; equalizing compensation for all claimants to $150,000; expanding the downwind exposure area to include seven states; and funding an epidemiological study of the health impacts on families of uranium workers and residents of uranium development communities.

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[14] Integrated Data Base Report, US Spent Nuclear Fuel and Radioactive Waste Inventories, DOE/RW-0006, Rev11.

[15] Idaho High-Level Waste and Facility Disposition, Final Environmental Impact Statement, September 2002, page 4-81, DOE/EIS-0287. And, Final Environmental Impact Statement, Proposed Nuclear Weapon's Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel, 2/1996, DOE/EIS-0218F. And, Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotopic Production Missions in the U. S. page 3-80, DOE/EIS-0310, December 2000.

[16] Buried TRU Contaminated Waste Information for USDOE Facilities; June 2000. http://idahocleanupproject.com

[17] See EDI's "Aquifer Report" that additionally documents Snake River Plain Aquifer contamination and that this waste interred in a known flood zone. Available on EDI's website Publications.

"Uranium and weapons development of the Cold War era left a gruesome legacy in communities of mine workers and downwinders," Tom Udall said. "For more than two decades, the United States has tried to compensate in some way for the resultant sickness and loss of life. Today we are taking the next step to close this sad chapter in history and to improve the reach of compassionate compensation to those Americans who have suffered, but have not qualified under RECA in its current form."

"This bill extends the life of the original compensation initiative, expands the list of compensable diseases, and makes it easier for claimants to prove their illnesses are related to their exposure to uranium. Enacting this bill would ensure that more Americans made sick during the Cold War finally get the compensation they deserve," said Bingaman, who worked on the original RECA law, as well as the 2000 law that made several improvements to the program. "I'm particularly pleased that it recognizes Trinity site down winders who have suffered much, but who have never been compensated."

"The victims of this testing have waited years for just compensation, and the cruel irony is that the federal government has postponed action for so long that many aren't living to see this bill passed," Crapo said. "I remain optimistic that expanding the scope and reach of this program can succeed. It is the right thing to do because there are so many people affected throughout the region."

"We must never forget the heavy price that thousands of Americans paid during the Cold War arms race," Mark Udall said. "Many victims exposed to radiation during that time have spent decades not only dealing with the impacts on their health, but fighting the government for help. This bill helps expand the scope of RECA so we can ensure that those who deserve compensation can finally get it."

"There is no doubt that Idahoans were impacted by nuclear testing done years ago. They deserve help for the health effects they have suffered and this bill is a way to provide that," Risch said.

"During the Cold War, thousands of Coloradans worked to build the nation's nuclear arsenal at great detriment to their health," Bennet said. "We as a country are still working to compensate those workers and their families for what they have had to endure, including, in some cases, the loss of a loved one. These adjustments will help provide these employees the benefits they deserve."

"The legacy of uranium mining still afflicts families and communities today, and it is critically important to ensure that these Americans are compensated for what they've endured. Senator Udall's legislation recognizes the many individuals who have been impacted but unable to receive compensation for their suffering. These Americans have waited long enough," Luján said.

Specifically, the **Radiation Exposure Compensation Act Amendments of 2010** would:

- Extend compensation to employees of mines and mills employed from Dec. 31, 1971, until Dec. 31, 1990**.** These are individuals who began working in uranium mines and mills after 1971 when the U.S. stopped purchasing uranium, but failed to implement and enforce adequate uranium mining safety standards. Many of these workers have the same illnesses as pre-1971 workers who currently qualify for RECA compensation.
- Add core drillers to the list of compensable employees, which currently only includes miners, millers and ore transporters.
- Add renal cancer, or any other chronic renal disease, to the list of compensable diseases for employees of mines and mills. Currently, millers and transporters are covered for kidney disease, but miners are not.
- Allow claimants to combine work histories to meet the requirement of the legislation. For example, individuals who worked half a year in a mill and half a year in a mine would be eligible for compensation. Currently, the Department of Justice makes some exceptions for this, but the policy is not codified in law.
- Make all claimants available for an equal amount of compensation, specifically $150,000, regardless of whether they are millers, miners, ore transporters, onsite employees, or downwinders.
- Make all claimants eligible for medical benefits. Currently, only miners, millers and ore transporters can claim medical benefits through the medical expense compensation program.
- Recognize radiation exposure from the Trinity Test Site in New Mexico, as well as tests in the Pacific Ocean.

- Expand the downwind areas to include all of Arizona, Nevada, New Mexico, Colorado, Idaho, Montana, and Utah for the Nevada Test Site; New Mexico for the Trinity Test Site; and Guam for the Pacific tests.
- Allow the use of affidavits to substantiate employment history, presence in affected area, and work at a test site. Current legislation only allows miners to use affidavits.
- Return all attorney fees to a cap of 10 percent of the amount of the RECA claim, as was mandated in the original 1990 RECA legislation.
- Authorize $3 million for five years for epidemiological research on the impacts of uranium development on communities and families of uranium workers. The funds would be allocated to the National Institute of Environmental Health Sciences to award grants to universities and non-profits to carry out the research."

Editor's note: EDI thanks J. Preston Truman for his media research and posting this news. Go to or click on the below links for two compelling news videos on this RECA legislation.

http://www.ktvb.com/home/US-senators-want-to-expand-radiation-compensation-91630294.html
http://www.azfamily.com/outbound-feeds/yahoo-news/Story-of-Mohave-County-Downwinders-getting-Gov-Brewers-attention-91566924.html

Downwinders' Long Journey to Justice
by Tona Henderson

"This story, reported in the *Idaho Statesman* 4/25/10, is about a long journey for Idaho downwinders. This story is not about me, it's not about Gem County; It's about all downwinders everywhere.

This story is about Idaho, Montana, Colorado, New Mexico, Guam and the South Pacific Islands. It is also about the uncompensated counties in Utah, Arizona and Nevada.

This legislation is about justice for sick people who were poisoned by the fallout from Nevada Test Site in the 1950s and 1960s. It is for the thousands who have died of cancer in Idaho and other downwind areas during this fight.

Many families in the downwind states have stories like mine. Some of these stories are so sad because entire families have died of cancer. Some of these families lived right here in Emmett, Idaho.

Both sides of my family have been in the Treasure Valley since the 1970s. They lived very long lives – until they started dying of cancer after the testing started.

Since the 1950s, I have had 26 family members get cancer, 13 of those have died. One was my cousin, who died of Ewing's sarcoma at the age of 15.

My father developed a thyroid condition in the early 1980s. My mother had breast cancer six years ago. My oldest brother had testicular cancer twice in 2001; his doctors said it was due to radiation exposure. He was 49 at the time. Three years ago, my other brother had prostrate cancer. I have had problems with my thyroid.

Thankfully, this part of my family survived their cancers and the treatments. And, thankfully my younger sister was born after the nuclear testing, and she is in fine health.

Downwinders send a huge thank you to the members of Congress who are fighting for us. We hope and pray this fight will end with the passage the RECA Amendments Act of 2010."

Tona Henderson of Emmet, Idaho is the director of Idaho Downwinders.

Endnotes

I. Conversion Sieverts to Rems; mSv (milisievert) is a unit of radiation effect in living things, the dose in terms of energy alone is in Gy (Grays) but after a quality factor is applied (different forms of radiation have different abilities to cause harm to living things) the dose in Sv is calculated. Sv is the modern SI unit which is a replacement of the cgs system rem. 1000 mSv is equal to 1 Sv which is equal to 100 rem. It is commonly thought that a 1 Sv whole body dose of radiation has a 5% chance of causing cancer.

II. Radiation dose unites used in DOE documents cited include:

Rem = When relative biological effectiveness of a particular radiation type (relative to gamma radiation or alpha radiation is taken into account, the value is multiplied by a quality factor to yield the units rem. The current rem and the older rad unit are equivalent.

TEDE = Total Effective Dose Equivalent; or whole body that includes "internal" (dose received by a radiation source inside the body, e.g. an inhaled dust particle containing plutonium or ingested contaminated water); AND "external" (dose received by a radiation source exposure outside the body, e.g. from a gamma/alpha emitting radionuclides in soil or air).

CDE = Committed Effective Dose Equivalent; The dose value obtained by (1) multiplying the committed dose equivalents for the organs or tissues that are irradiated and the weighting factors applicable to those organs or tissues, and (2) summing all the resulting products. Committed effective dose equivalent is expressed in units of rem or sieverts.

Source Terms = Radiation released from a specific source or combined with related sources during a specific defined time.

III. **Radiation Standards**

Updated EPA Title 40 Protection of Environment (40 CFR 61.92 Standard) states: "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of **10 mrem/yr** [0.01 rem/yr]."

EPA Standards for Uranium Fuel Cycle Normal Operations to general public, 40 CFR 190.10 state: "The annual dose equivalent does not exceed 25 mili-rems [0.025 rem] to the whole body, 75 mili-rems [0.075 rem] to the thyroid, and 25 mili-rems [0.025 rem] to any other organ of any member of the public as the result of planned discharges of radioactive materials, radon and it daughters excepted, to the general environment from uranium fuel cycle operations and to radiation from these operations."

The above 25 mrem for the whole body, critical organ and 75 mrem for the thyroid in 40 CFR part 190.10 as cited above is for all pathways. That is drinking water, air, ingestion of contaminated food, etc. The above (40 CFR 61.92 Standard) 10 mrem is for emission of ambient air - applies only to one pathway. However, **both standards** have to be met separately.

Although the Nuclear Regulatory Commission's "Reactor Site Criteria" sets lower exposure standards, it states; "However, neither its use … as set forth in these site criteria guides are intended to imply that these numbers constitute acceptable limits for emergency doses to the public under accident conditions." [10 CFR-100.11]

Also see Institute for Energy and Environmental Research, *Science for Democratic Action*, August 2009, for detailed critical analysis of the inadequacy of EPA, DOE and NRC exposure regulations to the public. www.ieer.org

III. Footnote # 7; HAD-3, Doc. Page 129 states; "Source Term: 5.0 E+6 **R/h** at 1 ft." [5,000,000 Rem/hour] "RTC [where ATR is located] main parking lot at 500 m could be approximately 2 R/h. Table A.1-20 [later on page 135] provides exposure rate information at several distances, which are based on an initial exposure rate of 5.0 E+6 R/h at 1 foot (0.3048 m) and applying the inverse square equation. Other Barriers and Effects: Although the ATR building structural materials may provide some shielding, no credit is taken for shielding." [Because none can be legitimately be claimed]

IV. (Footnote # 8; Doc. Page; 148; Table A.1-23, ATR LOC, Downwind CDE (thyroid) at 30 m., in Rems at 4 hrs, 6.69E+5 [669,000] ; at 48 hrs. 8.03E+6 [8,030,000]; At INL boundary at 4hrs, 2.69E+1 [26.9] at 48 hrs. 3.23E+2 [323.0] rems.

V. Footnote #9; 15.8-10; "Potential doses due to significant fuel damage and melting in the storage canal (without canal draining) is enveloped by the analysis for the large-break (LOCA) [Loss-of-Coolant Accident]. The dose calculated for 100% core melt considers release of 64% of the source term in the first day and remainder over the next 10 days; the total dose is 185 rem thyroid and 13.2 rem EDE (whole body**)** at the LPZ [low population zone]. The estimated dose at the LPZ is 57.4 rem thyroid and 4.1 rem whole body for failure of eight fuel elements."

This above estimate is based on failure of only eight fuel elements; however, it fails to include the full canal fuel inventory.

"Fuel elements may be out of storage during various evolutions (e.g., while in transient to the reactor, for inspection or for leak testing of the clad) and canal draining events could cause melting of the irradiated fuel elements." Although DOE offers no numbers, this event could release significant radiation into the ATR facility and the environment since the ATR has little or no containment.

VI. Footnote # 10; Doc. Pg. 32 and 34,Table 6, "TRA-670 (ATR and ATRC) Radiological release scenarios that have the potential for being classified as operational emergencies"); "ATR/ATRC Accident Fission Product Release Downwind Dose (in Rems at 30 meters, 2.5 hours) Scenario; TEDE 7.38 E+6; 7,380,000 rem, CDE 9.00 E+7; 90,000,000 rem

VII. HAD-3, Page; 139; Table A.1-22, ATR LOC, Downwind TEDE in Rems forty-eight hr.

VIII. SAR, page 15.12-22 through 23, Table 15.12-7; "ATR inventory at scram is 1.11 E+9 or 1,110,000,000 curies and the source term 1.74E+08 or 174,000,000 curies that includes Iodine species source terms at 4.25E+6 or 4,250,000 curies."