

An update on radiological and nuclear terrorism

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Many thanks to:

- Ron L and the NOCHPS for inviting me to this meeting
- Abel Gonzalez and others from this year's NCRP meeting for their fine presentations, some of which have been excerpted for this one

Threats

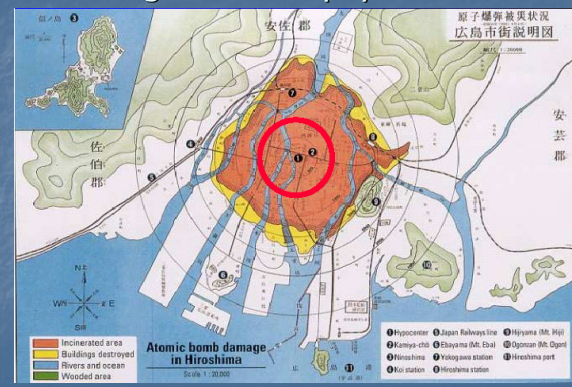
- Nuclear weapons (especially improvised nuclear devices, or INDs)
 - Worried primarily about terrorists obtaining "loose nukes" or fissionable materials
- Radiological weapons ("dirty bombs")
 - Worried primarily about access to orphan sources

Nuclear Terrorism

Nuclear devices

- Hiroshima
 - Weapon size about 15 kT (similar to IND)
 - Total inhabitants, 320,081
 - Deaths, 122,358
 - Injured, 79,130
 - Uninjured, 118,613

Radiological versus physical deaths



Comparison with terrorist device

- No way to predict yield
- Hiroshima was an airburst, while IND would likely be a surface burst
 - Surface burst will be "dirtier" due to inclusion of surface materials in blast
- Site of detonation will influence effects
 - One likely scenario would be in port facilities, although small (suitcase) device, or device in cargo container may be taken or shipped anywhere

Effects

- Blast
- Radiation and fallout
- Thermal
- Firestorm – as in Dresden and Tokyo, may be more destructive than initial blast
 - Firestorm written up in recent Bulletin of the Atomic Scientists
- All depend strongly on yield of device and location of detonation

Making or getting nuclear weapons

- It's thought that up to 40 former Soviet "suitcase nukes" are not accounted for
- There are many research reactors still fueled with HEU
- Pakistan offered nuclear technology to many nations, including N. Korea, Iraq, and Libya – may have sold to others, too
 - It seems likely that Iran is pursuing nuclear weapons as well
- May be able to purchase weapons, Pu, or HEU on nuclear black market
- Breaking news – the IAEA reports that we seem to have lost track of much of Iraq's former nuclear infrastructure

The bottom line

- Terrorist organizations are trying to obtain nuclear weapons or fissionable materials
- There are opportunities to obtain such weapons
- Nuclear weapons effects, even for a "fizzle" or low-yield device, would be very bad
- Nuclear weapons can be smuggled in cargo containers or suitcases – detection is possible, but only if we are looking for something
- We really don't know if such devices are now in the possession of terrorists
 - Al Qaeda has announced its intention to obtain and use nuclear weapons if possible

RDD's

Dirty bombs - doses

- Using FGR 12 DCFs:
 - 1000 dpm/100 cm² of Co-60 would give a dose of only about 1.5 µr/hr
 - 1000 Ci of Co-60 spread over 1 acre would give a dose of about 8 rad/hr
- Other potential RDD isotopes are Cs-137, Ir-192, I-131, Am-241, Cf-252, Ra-226, Sr-90, H-3, P-32, S-35 (according to NYC study)
 - Co-60 has highest external DCF

Sources of sources

- Theft of existing sources
 - Legal purchase of sources
 - Orphan sources
 - Transfer of source to illicit organization
- First two are well-known, will concentrate on last two

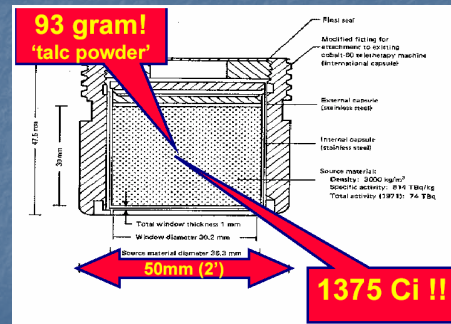
Orphan sources

- Orphan sources are one of today's major problems in radiation safety
- Orphan sources are sources that have been lost to regulatory controls
 - May have been abandoned when the owner goes out of business or dies
 - May have been stolen
 - May have been lost (e.g. soil gauge that bounces out of truck)
- IAEA feels there are likely thousands of dangerous orphan sources, and hundreds of thousands of total orphan sources (NCRP Taylor Lecture, 2004)

Some examples

- The following graphics are from Abel Gonzalez's Lauriston Taylor Lecture at the 2004 Meeting of the National Council on Radiation Protection and Measurements.
- This presentation can be found on-line on the NCRP web page – www.ncrp.com – under the "Publications" tab, and can be downloaded via ftp

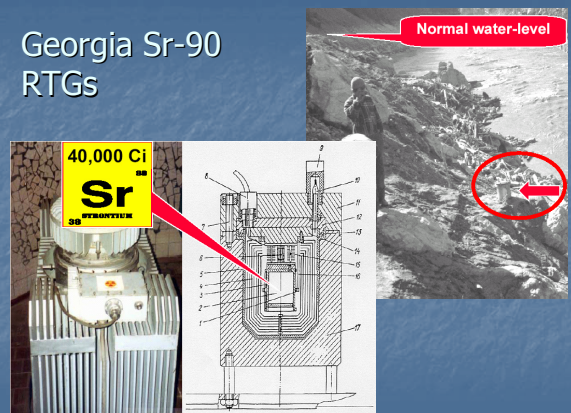
The Goiania source



Goiania

- 14 people severely overexposed, 4 died
 - 249 people contaminated (of 112,000 monitored)
 - 85 houses contaminated
 - 5000 cubic meters of radioactive waste generated during cleanup
- Now – extrapolate to NYC or LA after an RDD attack...

Georgia Sr-90 RTGs





Transfer of sources

- Current laws require that sources be transferred to a licensee
- However, the source *buyer* provides a copy of the license in many cases
- This means that someone with a false (or altered) license can obtain a source by purchase from vendor or third party
- There have been instances in which high-activity sources have been transferred to other nations as well, although not yet to terrorists

What should be needed for source transfer

- Copies of license should be provided only by regulatory authority
- Transfer of source should be registered with seller's regulatory authority
- Seller should be required to obtain written confirmation from regulatory authority prior to shipment
 - May wish to have shipping company confirm all paperwork is appropriate prior to shipment
- **We should not ship high-activity sources anywhere based only the assurance of the recipient!**

A more recent concern from RDDs

- Radiation dose from surface contamination is not likely to cause health risks
- However, under some scenarios, inhalation dose may be significant

Inhalation pathway

- Under most circumstances, the inhalation pathway gives the highest dose
- Isotope

Isotope	ALI	100 ALI	DAC
■ Cs-137	200 μCi	20 mCi	6×10^{-8} $\mu\text{Ci/ml}$
■ Co-60	30 μCi (Y)	3 mCi	10^{-8} $\mu\text{Ci/ml}$
■ Am-241	0.006 μCi	0.6 μCi	3×10^{-12} $\mu\text{Ci/ml}$
■ Pu-238	0.007 μCi (W)	0.7 μCi	3×10^{-12} $\mu\text{Ci/ml}$

- 100 ALI will produce a dose of about 500 rem
 - This dose as an acute exposure is normally lethal to 50% of the population

More on inhalation

- In reality, it's not quite that bad
- ALI is based on receiving 5 rem in a year to the whole body
- Acute exposure is much worse than chronic exposure, so 500 rem over the course of a year will not be lethal to 50% of the population
- This means that a 1 Ci Am-241 source may be able to cause several hundred fatalities, but will almost certainly not cause hundreds of thousands

Emergency response considerations

In the aftermath of an attack...

- Need to be able to perform relatively rapid radiological triage at the scene and at the emergency room
- Need to try to keep some hospitals from becoming contaminated so that they can take non-radiological patients
- Need to convince medical personnel to show up and remain at work

Radiological triage

- Persons with less than 10 rem should need no attention or follow-up
- 10-100 rem should have follow-up tracking
- 100-1000 rem need medical attention
- Greater than 1000 rem should just be made comfortable
- To do this, we need to develop a reliable and rapid biodosimetry device or procedure

Radiological triage at site of attack

- Since the inhalation pathway is likely the most serious, we need to develop a rapid means of determining inhalation dose
- May try measuring contamination levels as a proxy for airborne concentrations
- Goal is to quickly identify those persons who will benefit from medical attention
 - Those receiving neither lethal nor trivial doses of radiation

Radiological triage in ER

- Need to quickly perform biodosimetry to determine on whom medical efforts are best spent
 - In particular, those with doses of a few to several hundred rem are those who need attention from physicians
- "Gold standard" is examining metaphase lymphocytes for dicentric chromosomes
- However, may be able to look for other biomarkers, such as activation of DNA damage repair genes or presence of repair proteins

Contamination controls

- The most seriously injured victims should receive immediate medical attention
- However, if they are heavily contaminated, this may cause hospitals to become contaminated, interfering with their ability to function post-incident
- It may be necessary to close off some hospitals to RDD victims so that the city can continue to care for its normal sick and injured

And another problem...

- Some studies have suggested that medical personnel may leave work early or refuse to come to work because of exaggerated fears of radiation and contamination
- It may be necessary to begin educating medical workers now so that, if there is a radiological or nuclear attack, they will respond appropriately

Summary

- New information makes the threat of radiological and/or nuclear attack seem higher than before
- There are a great many possible weapons available for misuse
- We must take steps to try to prevent an attack, but we must also assume that one will be successfully launched

Summary (con't)

- In the event of an attack, the inhalation pathway will likely be the most limiting
- We need to find ways (and instruments) to quickly and accurately assess dose at the site of an attack and in the ER
- And we have to hope that none of this will ever be needed, even as we assume an attack is coming at any time