Dr. Alexey Ubee

Nuclear Energy Development and Nuclear Security

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CONTENTS

• NUCLEAR ENERGY AND NUCLEAR TECHNIQUES
• NUCLEAR AND RADIOLOGICAL THREAT
• KEY NUCLEAR SECURITY ELEMENTS
• CHALLENGES AND OPPORTUNITIES
A Fundamental Balance

Peaceful Uses of Nuclear Technology

Non-proliferation of Nuclear Weapons
Fuel Cycle Overview

- **Uranium Mining**
- **Uranium Milling**
- **Conversion & Enrichment**
- **Light Water Reactor**
- **MOX Fuel Fabrication**
- **Advanced Reactor**
- **Light Water Reactor Fuel Cycle**
- **Advanced Fuel Cycle**
- **Fabrication**
- **Reprocessing**

- **Uranium Fuel**
- **Plutonium Fuel**
- **Spent Fuel**
Nuclear Energy

Planning and training

Uranium exploration and production

Power production

Research reactors

Spent fuel and waste

Decommissioning
Nuclear Power

- Nuclear energy since 1954
- Fast development in 1970s to 1980s
- An important part of a global energy mix – 13%
- 438 reactors in operation and 68 under construction
- World energy demand is expected to more than double by 2050, and expansion of nuclear energy is a key to meeting this demand while reducing pollution and greenhouse gases
- A number of countries are expressing interest in introducing nuclear power
- Nuclear energy continued to play an important role in global electricity production despite the accident at the Fukushima Daiichi nuclear power plant.
Phased Approach to Nuclear Power

Considerations before decision to launch → Prep work for construction → Construction → Operation → Decommissioning
Nuclear Applications

Diagnosis and Treatment of Disease

Changing Environment

Food Safety

Human Health

Water Resources

Sustainable Agriculture
Nuclear Applications in Food and Agriculture

- **Insect Pest Control**
  - by Sterile Insect Techniques

- **Animal Production & Health**
  - by RIA, ELISA, PCR, etc.

- **Plant Breeding & Genetics**
  - by Mutation Techniques

- **Soil & Water Management & Crop Nutrition**
  - by Isotopic and Nuclear Techniques

- **Food & Environmental Protection**
  - by Food Irradiation and Radio-analytical Techniques
**Some examples of Radioactive sources**

**Category I**

<table>
<thead>
<tr>
<th>Element</th>
<th>Half-life</th>
<th>Used in</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strong Gamma and Beta emitters:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cobalt 60</td>
<td>5.3 years</td>
<td>Radiotherapy; irradiating bacteria in spices and other food products</td>
</tr>
<tr>
<td>Cesium 137</td>
<td>30 years</td>
<td>Radiation devices to treat cancers; equipment to monitor wells for oil</td>
</tr>
<tr>
<td>Iridium-192</td>
<td>74 days</td>
<td>Treating prostate cancer; detecting faults below the surface of certain materials</td>
</tr>
<tr>
<td><strong>Strong Beta emitter:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strontium 90</td>
<td>29 years</td>
<td>Medical and agricultural research; provides a long-lived source of electricity, and has often been used to power remote locations such as lighthouses and weather stations</td>
</tr>
</tbody>
</table>
High Risk Isotopes

All of the Category I radioactive sources pose the greatest security risk for a RDD

- Americium-241
- Californium-252
- Cesium-137
- Cobalt-60
- Iridium-192
- Plutonium-238 and -239
- Radium-226
- Strontium-90 and others

Risk assessment:

- **How much energy** does it produce?
- **What type of radiation** does it produce?
- **What is its half-life** (high vs. low radioactivity)?
- **How much** of the radioactive material is available?
- **How prevalent** is the radioactive material (and *where* is it found)?
- **What is the radioactive material’s shape, size and portability?** and
- **How easy is it to disperse** the material over a wide area?
THE NUCLEAR AND RADIOLOGICAL THREAT

- Theft of nuclear weapon
- Theft of nuclear material to make improvised nuclear explosive device IND
- Theft of other radioactive material for RDD or RED
- Sabotage of facility or transport
Inventories – facilities and materials potential targets

> 20,000 nuclear weapons
> 3,000 tons civil and military HEU and Pu

> 480 research reactors (>100 with HEU)
> 100 fuel cycle facilities

438 operating nuclear power plants

> 100,000 Cat I and II radioactive sources
> 1,000,000 Cat III radioactive sources
Identify Categories of External And Internal Threats

• **External threat**
  • Terrorists
  • Protestors
    • Demonstrators
    • Activists
    • Extremists
  • Criminals

• **Internal threat**
  • Insider is anyone with authorized, unescorted access who could:
    • act alone or in collusion with external threat
      • May be passive or active
      • May be violent or nonviolent
Undesired Consequences

Effects of a 10 Kiloton NW

500 m: Most structures destroyed. 100% fatality rate.

1000m: Fatal radiation doses to directly exposed to the blast, serious damage to buildings, significant risk of a firestorm. Most people dead or seriously injured.

1500m: Area would be ravaged by radiation and fires.
Create a Nuclear Firestorm

Explode one weapon in your city

1. CHOOSE A LOCATION

City
[Custom] [World]

or

Address
brno

2. CHOSE A BOMB SIZE

Weapons
[Little Boy - Hiroshima - 15kt]
[Historical Weapons]

or

15 kt

3. CLICK HERE TO DETONATE

OPTIONS

Visibility
[Clear]

- Automatically update map

Reset Map
Hide Google Maps controls

MAP AREA
145 km²
57 mi²

12.0 km X 12.0 km
7.5 mi X 7.5 mi

CERTAIN MASS FIRES AREA
7 km²
3 mi²

radius 1.52 km
radius 0.95 mi

PROBABLE MASS FIRES AREA
13 km²
5 mi²

radius 2.00 km
radius 1.25 mi

FIREBALL HEIGHT
555 m
169 feet
EFFECTS OF “DIRTY BOMB”

• **Medical/Health** Other than the injury from the explosion, the principle health risk at expected dose levels is the possible increased risk of cancer. At 100 mSv the lifetime risk of fatal cancer is believed to be increased from about 20% (all causes) to about 20.5 %

• **Psychosocial** Fear/Panic, Transportation paralysis Demand for medical evaluation Emotional, physical, and cognitive effects

• **Economic** Clean up costs, Impact on commerce
Is the Threat Real?

France Nuclear Power Plant Drones: Mysterious Illegal Flyovers Have Officials Puzzled

By Julia Glum @superjulia j.glum@ibtimes.com on November 03 2014 10:45 AM

Nuclear smuggling deals 'thwarted' in Moldova
- 7 October 2015
Media caption Richard Galpin reports on the attempts by smugglers to sell nuclear material to extremist groups
Moldovan police working with the FBI are reported to have stopped four attempts by smugglers to sell nuclear material to extremists in the Middle East over the past five years.

Is ISIL a Radioactive Threat?
Posted on Nov.07, 2014 in ISIL, Radiological Terrorism by George M. Moore

Y-12 protesters allegedly enter high-security area, spray paint, splash blood
July 28, 2012 By John Huotari 3 Comments

Stuxnet: UK and US nuclear plants at risk as malware spreads outside Russia
by Alastair Stevenson, 11 Nov 2013

Al Qaeda In Pursuit Of Nuclear Weapons/Radiological Material – Analysis
Written by: Muhammad Jawad Hashmi, ScienceBlog, 24 April 2012
Nuclear Security

The prevention and detection of and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities.
Legal binding instruments

**Nuclear Security**
- Convention on the Physical Protection of Nuclear Material (153 Parties) & 2005 Amendment (88)
- Convention on the Suppression of Acts Nuclear Terrorism (88)
- UN Security Council resolutions 1373, 1540, 1977

**Safeguards**
- Nonproliferation Treaty
- Comprehensive Safeguards Agreements (INFCIRC 153)
- Additional protocols (INFCIRC 540)

~ 900 locations worldwide with various NM
~ 2,100 inspections/year
Nuclear Security Plan 2014—2017

September 2013: Board of Governors approves new Nuclear Security Plan for next four years

Estimated annual budget: US$ 27-30 mln

Approx. 80-85 % extra-budgetary funded

Objective:

Contribute to global efforts to achieve worldwide, effective security wherever nuclear or other radioactive material is in use, storage and/or transport, and of associated facilities.

by supporting States, upon request, in their efforts to meet their national responsibilities and international obligations, to reduce risks and to respond appropriately to threats
THE KEY NUCLEAR SECURITY ELEMENTS

- Threat Characterization and Assessment
- Institutional, Legal and Regulatory Framework
- Protection Systems
- Nuclear Material Accountancy and Control
- Sustainability
- Nuclear Security Culture
- Cyber Security
Interrelations in Nuclear Security

NUCLEAR SECURITY SYSTEM

Conventions, Laws, Regulations, Regulatory bodies, Enforcement, Threat assessment, Accounting and control, Physical protection, Detection/response, Coordination, Security culture

TARGETS for CONSEQUENCES

- Nuclear weapons
- Nuclear material
- Radioactive material
- Facilities
- Transports
- Transits
- Technology
- Cyberspace
- Sensitive information

THREAT INDICATORS

- Terrorist organizations
- Criminal organizations
- Terrorist and criminal acts (murders, kidnapping...)
- Political and economic instability, unemployment, social insecurity, corruption
- Civil wars
- Religious tensions
- Extremes wealth/poverty
NUCLEAR SECURITY - COUNTRY SITUATION

State Borders

State Interior

Target

Nuclear facilities

Facilities where radioactive sources are present

Strategic locations

Nuclear or radioactive materials
Computer and Information Security

The IAEA Computer and Information Security programme is focused on preventing computer acts that could directly or indirectly lead to:

a. *unauthorized removal* of nuclear/other radioactive material

b. *sabotage* against nuclear material or nuclear facilities

c. *theft* of nuclear sensitive information
Challenges and Opportunities

• Expanding nuclear sector:
  • More than 50 countries plan to enhance their use of nuclear technology even after Fukushima
  • More nuclear and radioactive materials, facilities and transport
  • More Front-end and Back-end Nuclear Fuel Cycle activities
  • Privatized nuclear sector requires transparency in the national requirements, to enable effective implementation by operators
  • Globalization of nuclear trade – free trade zones
  • Clear responsibility on operators

• Non nuclear use of NM (sources containing Pu 239, DU shielding containers…)

• Connection between NM smugglers and proliferators of sensitive technologies

• Vulnerabilities in cyber space
Challenges and Opportunities (cont’d)

- Entry into force of 2005 Amendment to CPPNM by 2016
- Complete suite and ensure wider implementation of Nuclear Security Guidance documents
- IAEA impartial peer reviews and advisory services not yet de facto the norm
- Generalization of INSSPs (88 out of 116 completed and/or in development, 33 to be initiated)
- Increased worldwide awareness on nuclear security issues (e.g. Conferences, Symposia, Outreach events…)
- Recognition of IAEA leading role in nuclear security (BoG, GC resolutions, Nuclear Security Summits…)
- IAEA is a global platform (162 MSs) playing a proactive, collaborative, and sustainable role in nuclear security
Some useful links

General IAEA web site www.iaea.org
PRIS Power reactor information system http://www.iaea.org/programmes/a2/
Research reactors database http://www.iaea.org/worldatom/rrdb/
IAEA - iNFCIS. Integrated Nuclear Fuel Cycle Information System
DIRAC (DIRectory of RAdiotherapy Centres)
http://www-naweb.iaea.org/nahu/dirac/default.asp
IAEA Technology review
http://www.iaea.or.at/Publications/Reports/ntr2008.pdf
RAND Worldwide Terrorism Incident Database
http://www.rand.org/ise/projects/terrorismdatabase/
Thank you for your attention!
Questions?