Radiation Protection Issues:
Challenges for Communication, Coordination and Consistency in the Response to Emergencies

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1. Aim

2. Selected Issues with Communication Challenges
   a) Quantities, Units, and Exposure
   b) Public Protection
   c) ‘Contamination’
   d) Radiation Risks and Effects

3. Epilogue:
   Misunderstandings ⇒ Psychological Effects
1.
Aim
The aim of the paper is to discuss challenges in

- communication,
- coordination and
- consistency

in the response to emergencies,

which can be derived from radiation protection issues identified by ICRP following Fukushima.
Terms of Reference for Task Group 84 of the ICRP Main Commission

Initial Lessons Learned from the NPP Accident in Japan vis-à-vis the ICRP System of Radiological Protection

Approved by the Main Commission on June 18, 2011
Issues identified by ICRP

1. inferring radiation risks;
2. attributing radiation effects;
3. quantifying radiation exposure;
4. assessing internal exposures;
5. managing emergency crises;
6. protecting rescuers and volunteers;
7. responding with medical aid;
8. justifying disruptive protective actions;
9. transiting from the emergency to an existing situation;
Issues identified by ICRP

10. rehabilitating evacuated areas;
11. categorizing public exposures due to an accident;
12. restricting public individual doses;
13. caring for infants and children;
14. considering pregnant women;
15. monitoring public protection;
16. dealing with ‘contamination’ of territories, rubble and residues, and consumer products;
17. recognizing psychological consequences; and,
18. fostering the sharing of information.
2.

Selected Issues with Communication Challenges
Selected Issues with Communication Challenges

a) Quantities, Units, and Exposure

b) Public Protection

c) ‘Contamination’

d) Radiation Risks and Effects
a) Quantities, Units, and Exposure
Confusion with quantities and units
Activity (Bq, curies)

Fluence (cm⁻²)

Absorbed Dose (Gy, rad)

Equivalent Dose (organ) (Sv, rem)

Effective Dose (Sv, rem)

W_R

W_T
Confusion with the relevance of internal exposure
United Nations

General Assembly

United Nations Scientific Committee
on the Effects of Atomic Radiation

Fifty-ninth session
Vienna, 21 to 25 May 2012

Agenda item 4(e)
Technical discussions

BIOLOGICAL EFFECTS OF SELECTED INTERNAL EMITTERS

Information contained in this document is preliminary and only for internal use by the Committee. It should, therefore, not be cited in any published material until final approval by UNSCEAR.
Confusion with dose levels: assessed theoretical levels vis-à-vis monitored real levels
A lesson from Chernobyl: radiation doses measured in vivo were much lower than doses theoretically estimated.
Preliminary dose estimation from the nuclear accident after the 2011 Great East Japan Earthquake and Tsunami
annual dose
mSv/year

Natural Background

Few people
In few areas ⇒ ~100

TYPICALLY HIGH

Many people
In many areas ⇒ ~ 10

TYPICALLY HIGH

Majority of people
around the world ⇒ ~ 2.4

AVERAGE

~ 1

MINIMUM

Doses
Estimated Theoretically
b) Public Protection
Confusion with Individual dose restrictions
Emergency

Emergency Aftermath Extant Situations

Planned Situations

Exclusion, exemption, clearance

100

20

4 orders of magnitude

↑

↓

Dose limit

0.01
A typical question from the public is:

*What is the rationale for permitting doses of 20 mSv per year after an accident, when the dose limit is 1 mSv per year and therefore doses greater than 1 mSv per year were unacceptable before the accident?*
Planned Exposure Situations
(‘Practices’)

Restrictions: dose limits and constraints

Expected additional dose

Extant Radiation Exposure

Activity introduced
Extant Dose
1 – 10 mSv/y

Limit to expected additional dose = 1 mSv/y

Individual restriction = ‘Delta’ Dose

Extant Dose
1 – 10 mSv/y
Interventional situation
Emergency and Existing Situations

Extant Dose

Avertable Dose

How much?

Should it be reduced?

Reference levels
Emergency

Emergency Aftermath Extant Situations

Planned Situations

Exclusion, exemption, clearance

Reference Level

Dose limit

100

20

1

0.01
Interventional situation
Emergency and Existing Situations

Should disruptive measures shall be undertanken to reduce it?
The ICRP Principle of Justification:

“Any decision that alters the radiation exposure situation should do more good than harm.”
Is evacuation justified?
Lost in translation?
• The Japanese expression for dose limit, 線量限度, is less ambiguous than its English version.
• 線量 means dose, used as an adjective, and
• 限度 means bound, boundary, end, border, brim, edge, verge, used as a substantive;
• Namely, 線量限度 means a boundary of dose that shall not be exceeded under no circumstance.
• It is therefore unsurprising that the Japanese population was perplexed with the use of dose restrictions higher than the dose limits.
Hans Blix’s dictum:

“There is much confusion on the subject of the regulation of low doses, .....people are surprised that what we term a dose limit is lower than the natural background radiation doses that we unavoidably incur .....few decision makers understand...the... control [of] additions to background doses.”

Last key note address as IAEA DG – Seville; Nov.17, 1997
Dose limit that is not a limit?
Confusion with the protection of children
Are Children Properly Protected?

- Parents do not believe that children are adequately protected by the radiation protection standards.
<table>
<thead>
<tr>
<th>Nominal Population</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole</td>
<td>5.7</td>
</tr>
<tr>
<td>Adult</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Detriment-adjusted nominal risk coefficients for stochastic effects after exposure to radiation at low dose rate [% Sv\(^{-1}\)]

30%
EFFECTS OF RADIATION EXPOSURE ON CHILDREN
Confusion with the protection of pregnancy
Should I terminate my pregnancy?
Confusion with public monitoring
Why members of the public are not monitored?

If it is done for them….

….why not for them
c) ‘Contamination’
‘Contamination’ is a confusing term

- from Latin *contaminare*, ‘made impure’.

- Religious origin (e.g., no-kosher food)

- Professional denotation: presence of radioactivity

- Public connotation: radioactive danger
Translation confuses the term even more! e.g., translation to Japanese

Contamination → 汚染

- 汚 → Dirt, Filth
- 染 → Dyed
The food is ‘contaminated’, but do not worry the ‘contamination’ is low?
‘Contaminated’ Territories
Is it safe for me and my family to live here?
‘Contaminated’ Rubble
May I dump this waste in the truck or shall I phone the radioactive waste management group?
‘Contaminated’ Consumer Products
Guidelines for Drinking-water Quality

FOURTH EDITION

World Health Organization
Application of the Concepts of Exclusion, Exemption and Clearance

SAFETY GUIDE

No. RS-G-1.7
Incoherence in drinking liquids

+ + + = 10 Bq/l for $^{137}$Cs

+ + + = 1000 Bq/l for $^{137}$Cs
Incoherence in non-edible vs. edible

+ +

= 1000 Bq/kg for $^{137}$Cs

+ +

= 100 Bq/kg for $^{137}$Cs
These kakis (persimmons) contain 90 Bq/kg, but when dried they contain 110; are they edible?
Is it safe for me and my family to eat this food?
Why I am permitted to drink this water but not to swim in it?
We were told this water is contaminated; shall we use it?
ICRP 104 may be helpful
Radiation Risks and Effects
Death toll from Japan nuclear catastrophe could top 500,000

DATE: 13 AUGUST 2011 POSTED BY: SPECIAL TO THE CANADIAN

John H. Large has been reported as having predicted that the death toll in the years ahead could top the 500,000 attributed to the Chernobyl accident of 1986 and warned that panicked repair attempts could lead to an even greater disaster. Mr. Large, a British nuclear engineer, said: “The Japanese don’t know how to deal with it. They’re ad-libbing.

“Just throwing water on to the reactors, when they cannot get inside to see what the situation is, could mean the fuel goes critical again.

“And while the radiation leak so far is only a tenth of that at Chernobyl, that was in a rural area with a low population. In Japan it’s an urban, densely packed area so the potential numbers of deaths and cancers are much higher.”

Mr. Large is an independent nuclear engineer and analyst primarily known for his work in assessing and reporting upon nuclear safety and nuclear related accidents and incidents [LINK] From the mid-1960s until 1986 Large was an academic in Brunel University’s School of Engineering, where he undertook research for the United Kingdom Atomic Energy Authority.

Mr. Large prepared a critical review of the preliminary report of the IAEA Fact Finding Mission undertaken to Fukushima Dai-ichi in May 2011. [LINK][LINK]
Will I be one of the 500,000?
Collective dose (person-sieverts) \times \text{Nominal Risk Coefficient (0.05/Sv)} = \text{Number of corpses}

Fifty-ninth session
(21-25 May 2012)
§25. The Committee has addressed the attribution of health effects to different levels of exposure to ionizing radiation, and has reached the following conclusions:

(f) ... increases in the incidence of health effects in populations cannot be attributed to chronic exposure to radiation at levels that are typical of the global average background levels of radiation....

Therefore, the Scientific Committee does not recommend multiplying very low doses by large numbers of individuals to estimate numbers of radiation-induced health effects within a population exposed to incremental doses at levels equivalent to or lower than natural background levels.
Natural Background

- **Few people** in few areas ⇒ ~100
- **Many people** in many areas ⇒ ~ 10
- **Majority of people** around the world ⇒ ~ 2.4
- **~ 1**

**Annual dose mSv/year**

- **Very high**
- **Typically high**
- **Average**
- **Minimum**

Locations:
- Namie, Iitate
- Katsurao, Minami-Soma
- Naraha, Iwaki
In sum, at low radiation doses ....

1. **EFFECTS** cannot be *retrospectively demonstrated* and, therefore, *actual effects can not be attributed*.

   ...however...

2. **RISKS** can be *prospectively inferred* and, therefore, it is ethically correct to protect people even at low doses.
Risk is akin to

Probability

i.e., to the ability to estimate by inference
the prospective possibility of health effects

Health effects are akin to

Provability

i.e., to the ability to reveal by evidence
the retrospective true existence of health effects
3. Epilogue: Misunderstandings ⇒ Psychological Effects
Probably the big lesson of Fukushima

- The described confusions are not free of charge.
- They are responsible of the only serious health consequence attributable to Fukushima: psychological effects!
Depression
Grieving
Chronic anxiety
Post-traumatic Stress Disorder
Insomnia
Severe headaches
Smoking and alcoholism
Anger
Desperation
Parents’ Anguish
1. In sum, we should humbly recognize our failures in communication and its challenges in the response to emergencies.

2. I submit that we have the ethical duty of:
   - learning from these failures and
   - resolving their challenges.
Thank you!

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