



Canadian Nuclear  
Safety Commission

Commission canadienne  
de sûreté nucléaire



*Canadian Nuclear Safety Commission  
Health Effects, Dosimetry  
and Radiological Protection  
of Tritium*

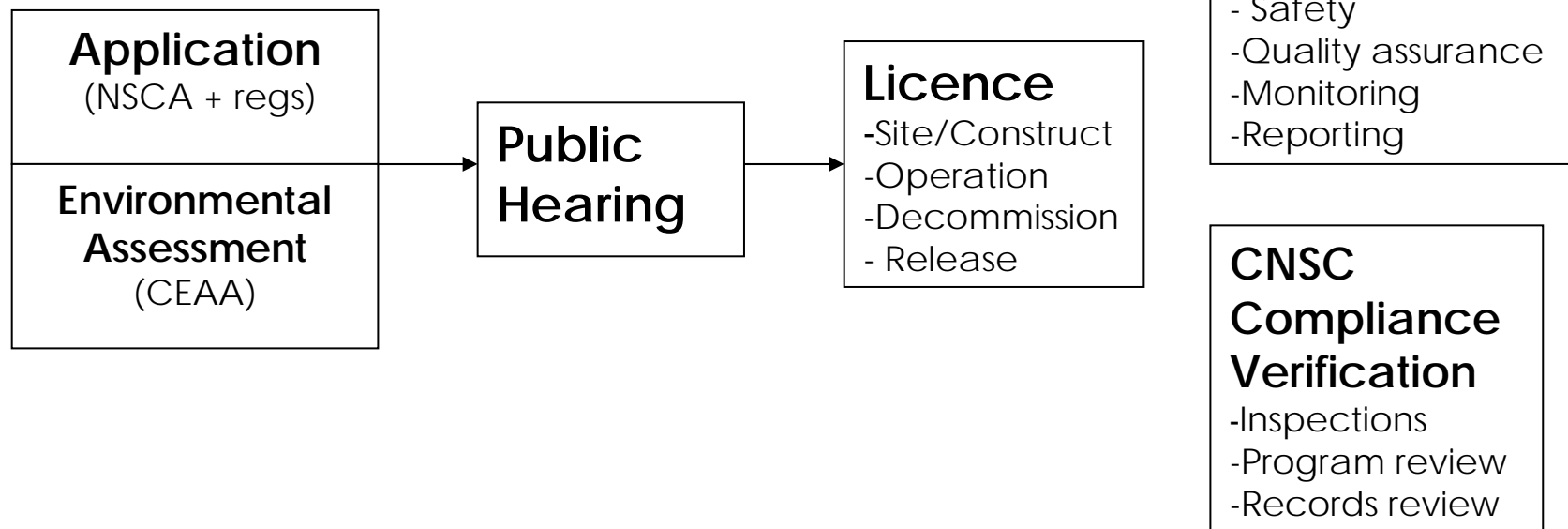
Presentation to Ontario Ministry of Environment,  
Standards Development Branch  
Drinking Water Standards Section  
January 27, 2010 - Toronto

**Patsy Thompson, Ph.D.**

# Public Hearings Provide Opportunity for Input into Licensing Processes



Public hearings give affected parties and members of the public an opportunity to be heard before the Commission



# *Regulatory Controls*

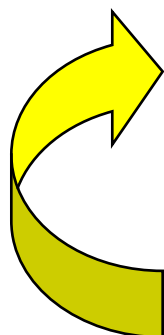


- Licensing  
Tritium activity in excess of 1 GBq requires a license under the NSCA
- Dose Limits  
Doses to workers and public must not exceed dose limits in Radiation Protection Regulations and must be ALARA
- Derived Release Limits (DRL)  
Emissions are limited such that an exposure at a DRL would result in a dose of 1 mSv to the most exposed member of the public (critical group)

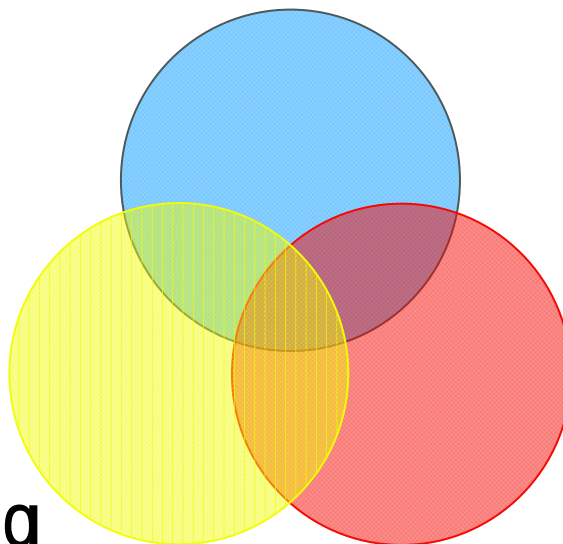
# *Protection of Human Health and the Environment*



Assessment



Monitoring



Controls



# *Regulatory Controls*



- Action Levels

Licensees must establish actions levels in monitored systems or processes (ex. stack releases, effluents) where an exceedence may indicate a loss of control.

- Environmental Management System

Licensees must have adequate provision for protection of the environment by policies, programs and procedures

- Reporting

Licensee must report effluent and environmental monitoring results quarterly or annually and upon exceedence of an action level.

# *Tritium released from Canadian Facilities in 2006 (Bq/y)*



<b>Facilities</b>	<b>Gaseous Emissions</b>		<b>Liquid Effluents</b>
	<b>HTO</b>	<b>HT</b>	<b>HTO</b>
NPPs	2.0E+15	9.5E+13 (TRF)	1.6E+15
WMF	5.5E+13	-	4.4E+10
Tritium light	8.5E+13	3.1E+14	4.5E+10
Research	3.2E+14	9.6E+11	9.5E+13
Laboratories	7.8E+11	1.7E+11	6.6E+10

# *Occupational and Public Doses*



- Public
  - Doses to critical group from tritium are typically 0.5-70  $\mu\text{Sv}$  per year
- Occupational
  - Average annual doses due to tritium at NPPs are typically less than one mSv and tritium comprises about 20% of the effective dose
  - Annual average dose at tritium light manufacturers is less than 0.5 mSv

# *CNSC Tritium Studies*



- Direction to staff from the Commission
- Enhance the information available to guide regulatory oversight of tritium processing and releases
- Number of studies being conducted (project charter)
- Evaluation of regulatory regime and recommendations to the Commission

# *Health Effects -Laboratory Studies*



## *What was reviewed*

- Deterministic effects
  - lethality
  - teratogenic effects
  - reproductive effects
- Stochastic effects
  - cancer
  - hereditary effects
- Health effects of OBT
- Non-radiological effects
  - transmutation
  - isotopic effects

# *Health Effects -Laboratory Studies*



## *Main Findings*

- No observed deterministic effects below ~ 1 GBq delivered acutely (injection)
- Cancer in mice observed at approximately 1 GBq per gram body weight per day (~mGy/day) but there are very few studies



# *Health Effects - Laboratory Studies*



## *Conclusion*

Research to date indicates that no health effects should occur with the existing regulatory control and limits for tritium are protective.

# *Relative Biological Effectiveness*



## *What was reviewed*

- Overview of major reviews on Tritium RBE  
AGIR, Little and Lambert, Kocher et al, Environment  
Canada, Myers and Johnston
- Summary of RBE laboratory studies broken down by  
type of reference radiation (X ray and gamma) and  
test conditions (*in vivo* and *in vitro*)

# *Relative Biological Effectiveness*



## *Main Findings*

- Overall RBE for tritium is about
  - 1.4 with X-ray reference
  - 2.2 with gamma ray reference
- Preference in literature is to use gamma ray as the reference
- Chronic exposure about 30% higher than acute, but likely artefact of reference radiation i.e. chronic mostly gamma, acute mostly X-ray
- very few studies of RP related RBE values

# *Relative Biological Effectiveness*



## *Conclusions*

Tritium beta radiation is about 1.4 times more biologically effective than 250 kVp X-rays and 2.2 times compared to gamma rays.

# *Health Effects - Epidemiology*



## *What was studied*

- Cohort studies of radiation workers
- Case-control studies of childhood leukaemia & birth defects in offspring and pre-conception exposure of parents
- Studies of people living in the vicinity of nuclear facilities
- Scientific reviews of the literature
- Advocacy group reviews

# *Health Effects - Epidemiology*



## *Main Findings*

- A large number of epidemiological studies involving radiation workers, their offspring, and members of the public living in the vicinity of nuclear facilities have been reviewed.
- In general, the available epidemiological studies do not contain enough detail (i.e., tritium specific doses) to estimate risks from tritium exposure.
- The risk to workers, offspring and the general public from all CNSC licensed radiation sources is low. Tritium represents only a fraction of total radiation sources, thus tritium risk is only a fraction of total risk, which is low.

# *Health Effects - Epidemiology*



## *Conclusion*

- To date epidemiological studies provide no evidence of a raised risk associated with tritium at past and current exposures to members of the public and workers.
- To date epidemiological studies have shown that the risk of cancer at doses below about 100 mSv is similar to that of the general population

# *CNSC Perspective on Proposed Tritium Drinking Water Standard*



Support a lowering of the current drinking water standard of 7 000 Bq/l on the basis of:

- Pollution prevention principle;
- Principle of minimising to the extent possible contamination of food and drinking water with anthropogenic carcinogens

# *CNSC Perspective on Proposed Tritium Drinking Water Standard*



Any proposed standard should be

- Based on a transparent rationale
- Achievable and practical
- Usable in many source protection frameworks

# *CNSC Perspective on Proposed Tritium Drinking Water Standard*



CNSC staff is of the opinion that 100 Bq/l would be

- Safe, practical and achievable
- Responsive to the principles of pollution prevention and protection of drinking water quality

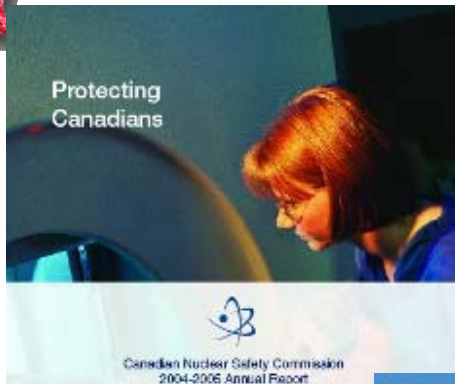
# Questions?



More information at website:  
<http://www.nuclearsafety.gc.ca>

Thank You -

Patsy Thompson, Ph.D.  
Director General, Directorate of  
Environmental and Radiation  
Protection and Assessment





Canadian Nuclear  
Safety Commission

Commission canadienne  
de sûreté nucléaire



**CNSC**  
Canadian Nuclear Safety Commission  
**Canada**

[nuclearsafety.gc.ca](http://nuclearsafety.gc.ca)