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Molybdenum-99 (Mo-99) Processing Facility Off-Gas System Experience

Conversion Process Lessons

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Presentation scope

- Overview of the Mo-99 processes based on Uranium (U)-fission
- Why do we need to care about off-gas?
- How to treat the active/inactive off-gas
- International concern

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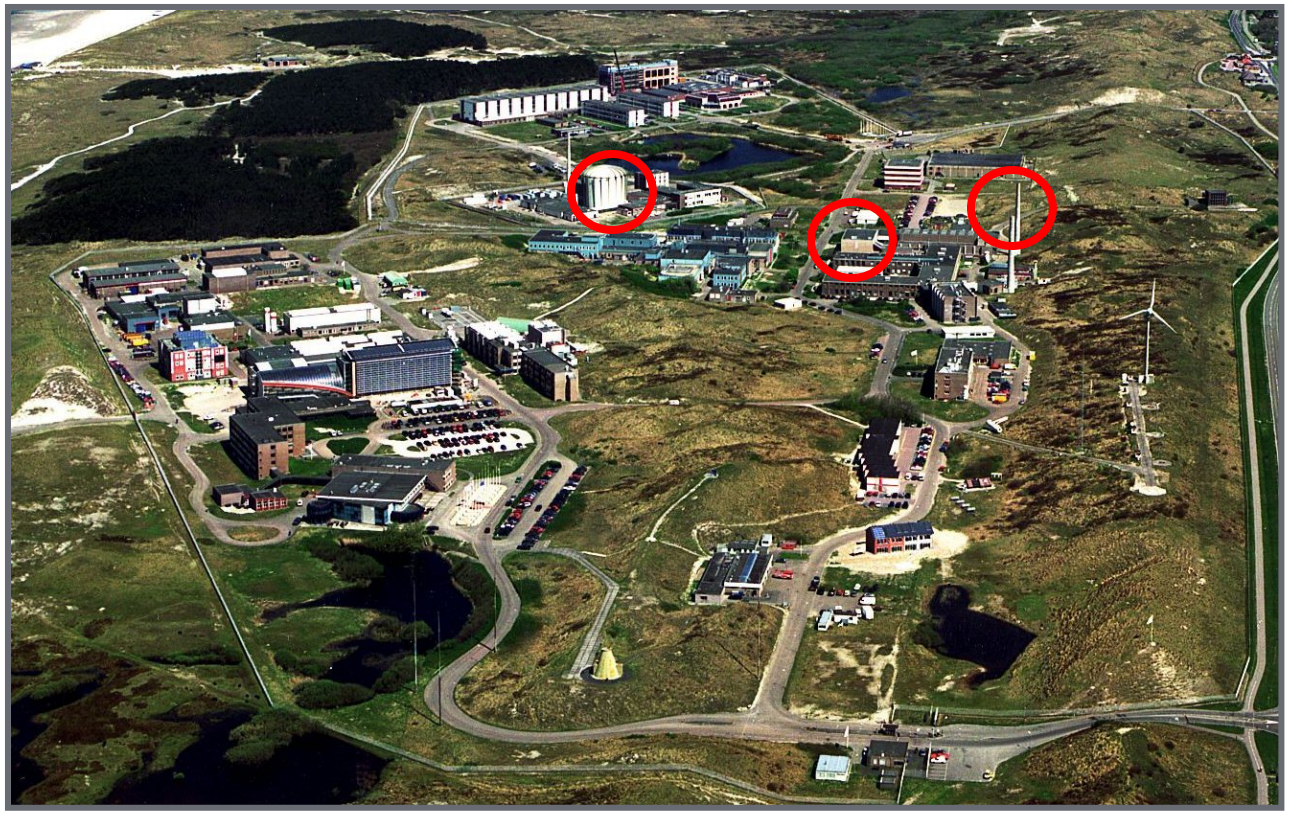
Petten, the Netherlands site



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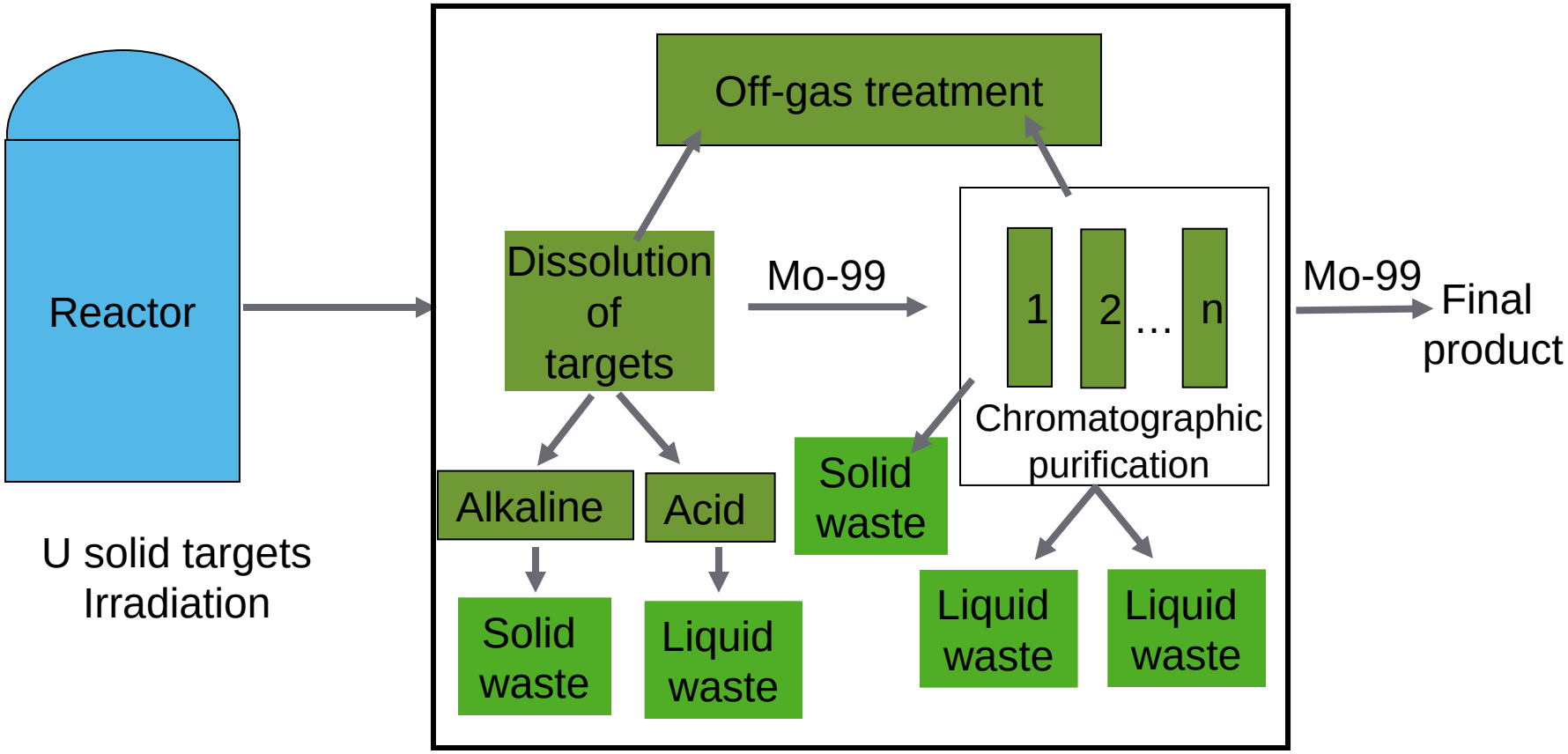
Mo-99 Current Production in a Nutshell

Highly Enriched Uranium (HEU) or Low-Enriched Uranium (LEU) Facility



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Why do we need to care about the off gas releases?

- Environmental concerns
- Countrywide regulations
- International concern
    - Comprehensive Nuclear Test Ban Treaty Organization (CTBTO)

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What are the isotopes in the off gas?

- Everything depends on cooling time of the U-target prior to arrival at Mo-99 processing facility.
- Main active off gas in a Mo-99 facility (from U-fission)

Fission Product	Xe-131m	Xe-133m	Xe-133	Xe-135	I-131	Kr-85m
Half-life	11.93 d	2.19 d	5.24 d	9.14 h	8.02 d	4.48 h

- Inactive off gas in some Mo-99 facilities, for example: H_2

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How can we treat the active off gas?

- Most active off gas will be released during digestion of U-solid targets.
- Most active off gas will be released during the irradiation/cooling of the U-solution targets.
- Some off gas will be released during chromatographic extraction and/or purification steps of the process.

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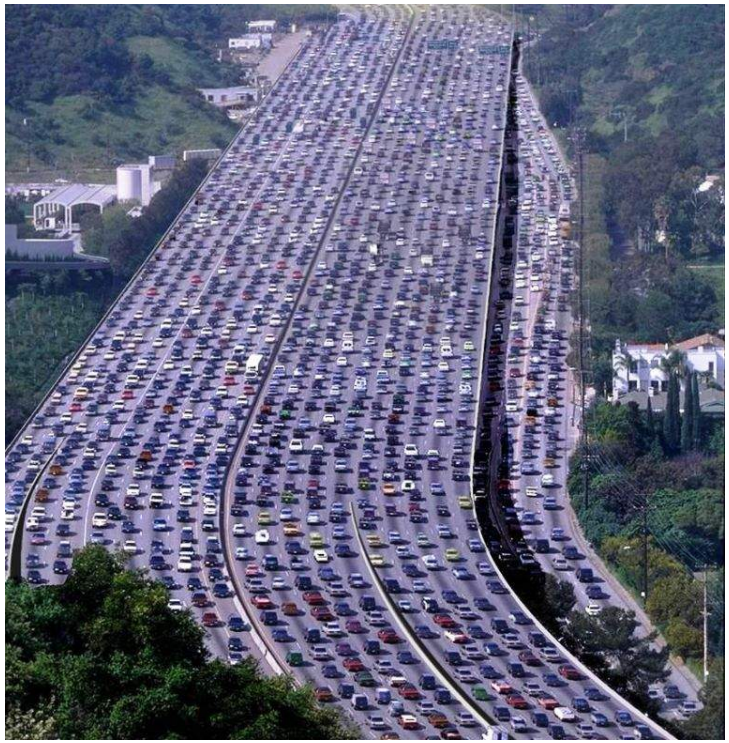
How can we treat the active off gas?

Let these gases decay within a protected and shielded area.



Delay = Decay

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How can we treat the active off gas?

Several options are possible:

1)Shielded vacuum tanks + HEPA or absolute filters (particles > 0.3 µm)

2)Charcoal filters + HEPA /absolute filters

3)Combination of both situations (1) and (2)

4)Condensing off gas (noble gases)/using a copper metal trap for iodine

Chosen option may depend on the chemical process (conversion)

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How can we treat the inactive off gas?

- H_2 during U-solid target dissolution via alkaline solution
- $H_2 + O_2$ – radiolysis of water in U-solution targets
- NO_x – acid dissolution of U-solid targets/U-solution targets

Convert to harmless products: water

Trap in a solution or sorbent

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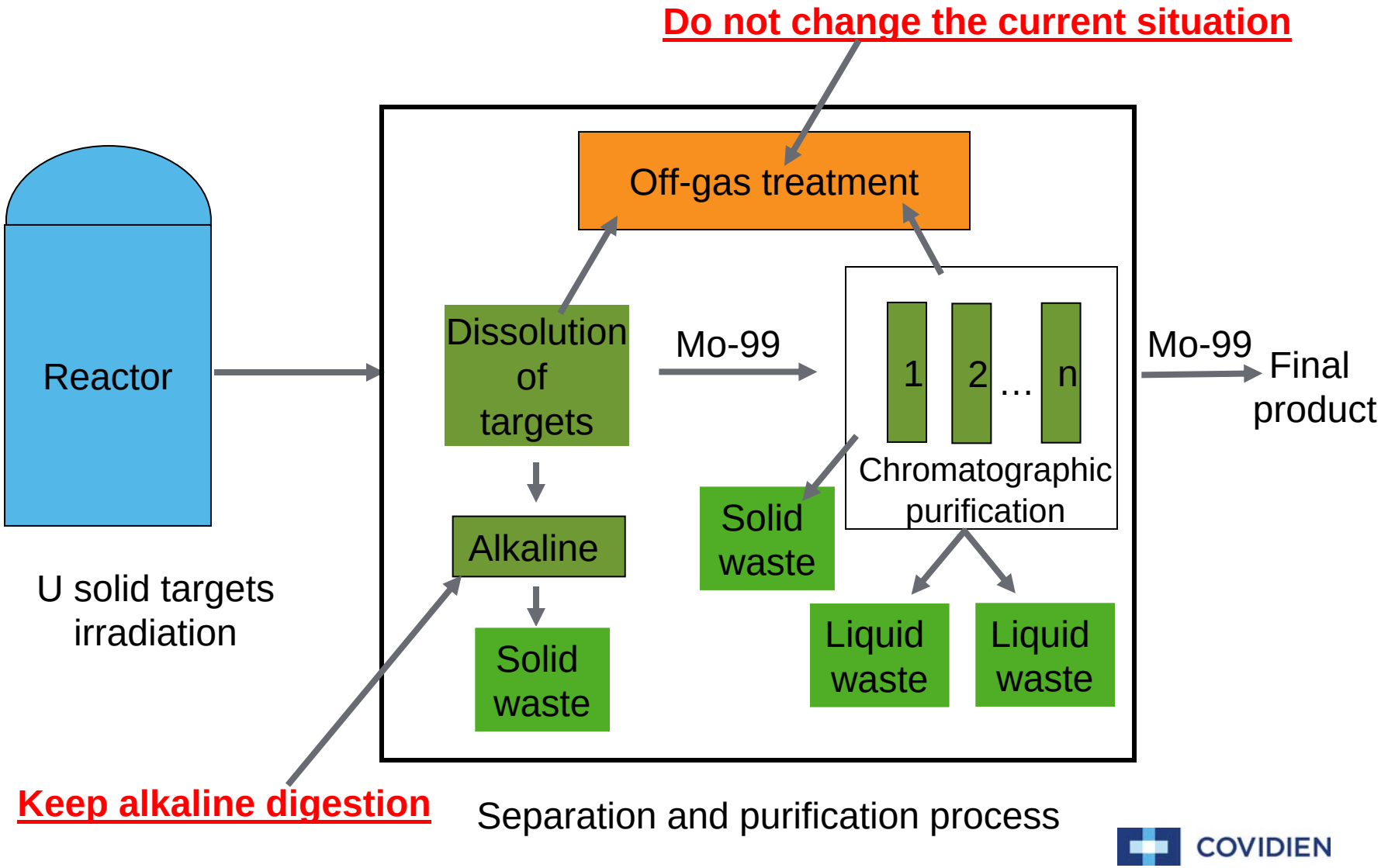
Converting Petten Mo-99 Production to LEU



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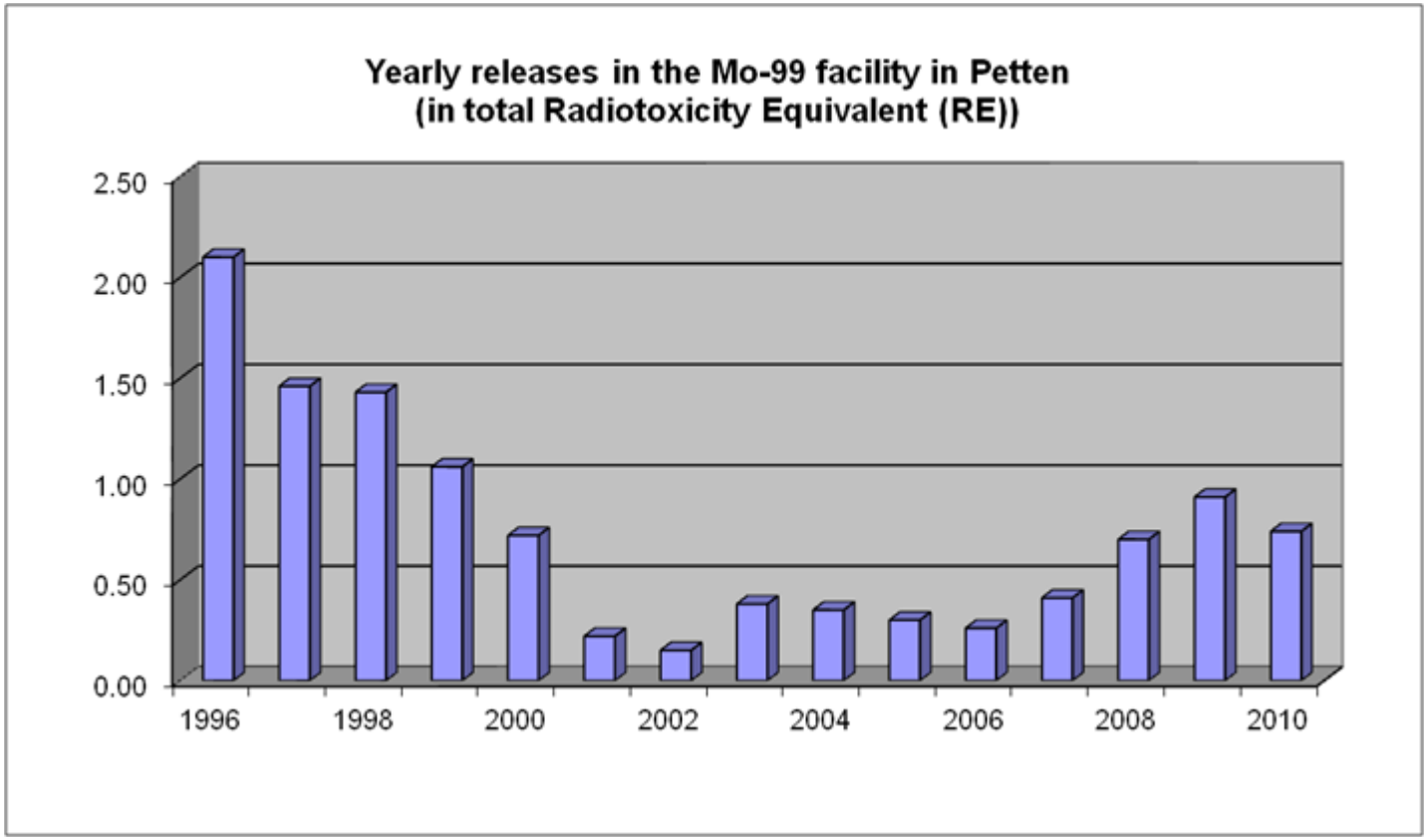
Petten's Example



Limit of the entire hot cell laboratory (including the Mo-99 plant) = **60 RE**

Measured specifically at charcoal filters for aerosols, noble gases and iodine

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International Concern - Mo-99 Facilities' Releases

Fission Product	Half-life	Time unit	$^{235}U_f$	$^{235}U_{he}$	$^{238}U_f$	$^{238}U_{he}$	$^{239}Pu_f$	$^{239}Pu_{he}$
^{131m}Xe	11.934	d	0.05	0.06	0.05	0.06	0.05	0.07
^{133m}Xe	2.19	d	0.19	0.29	0.19	0.18	0.24	0.42
^{133}Xe	5.243	d	6.72	5.53	6.76	6.02	6.97	4.86
^{135}Xe	9.14	h	6.6	5.67	6.97	5.84	7.54	6.18

Cumulative fission yields in % for six fission modes relevant to nuclear explosions, induced by fission spectrum neutrons (f) and high energy neutrons (14.7 MeV) (he).

^{133}Xe has high production rates and a not too short half-life. Therefore this xenon isotope is the one most observed in environmental samples.

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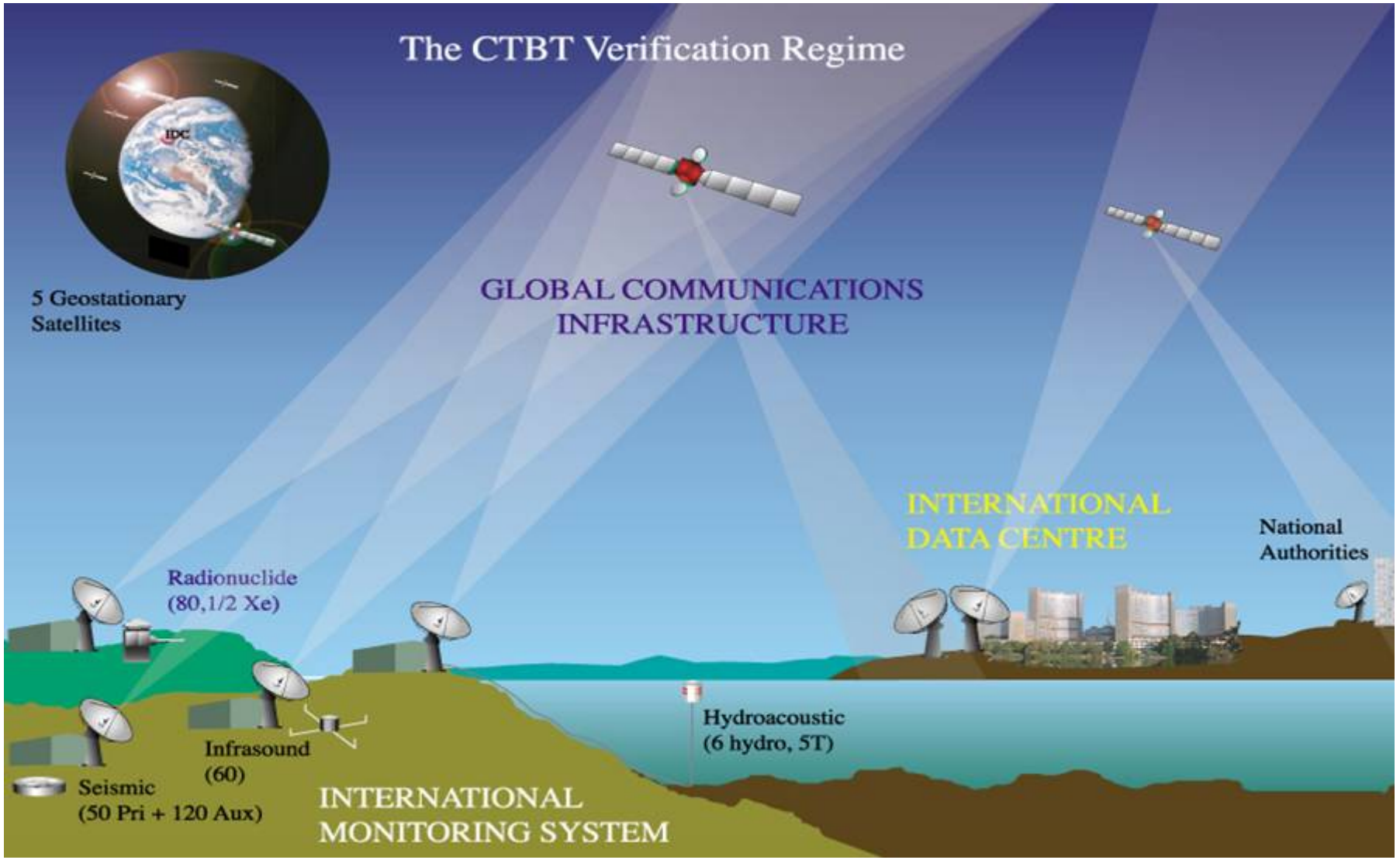
International Concern - Mo-99 Facilities' Releases



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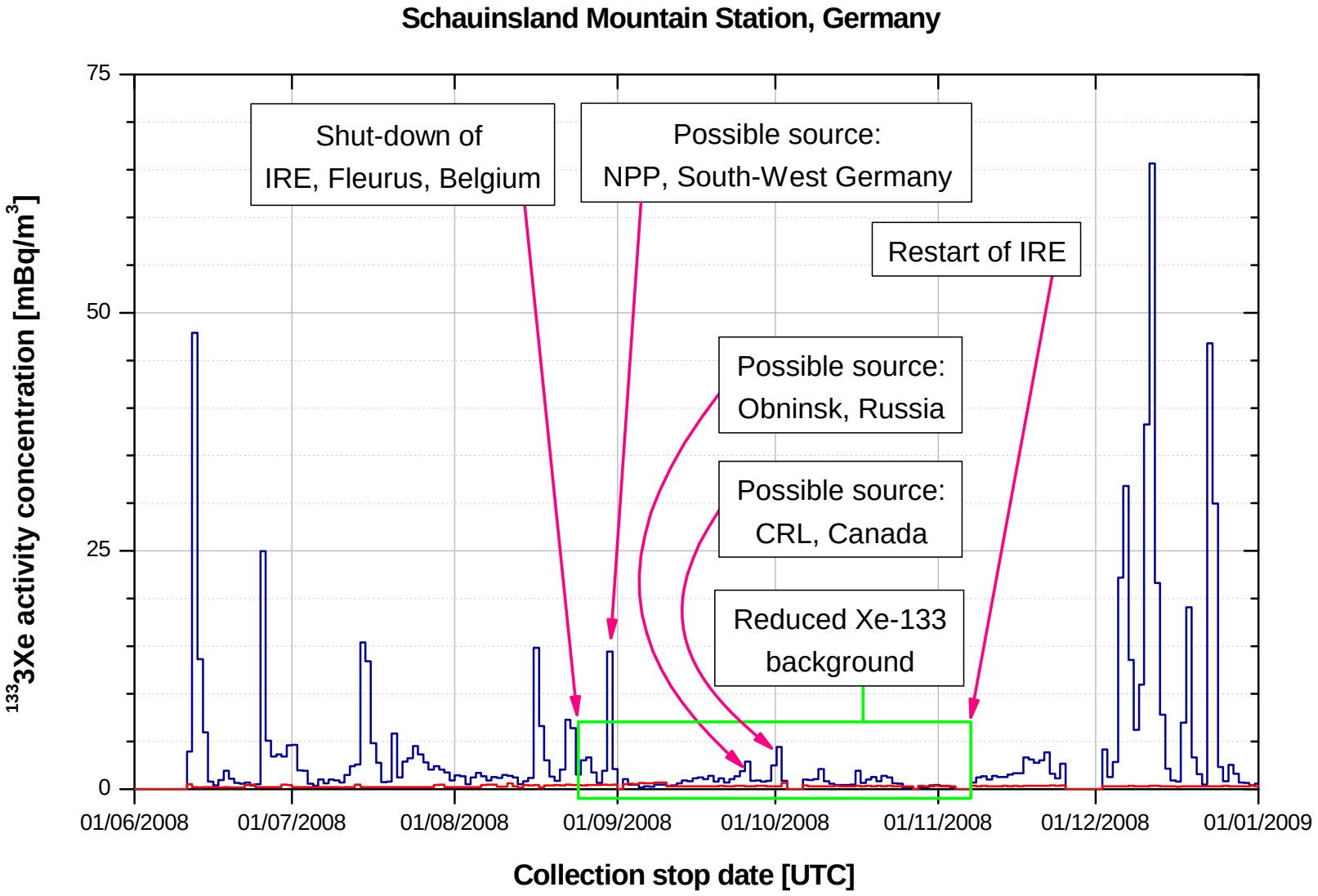

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Conclusions

- Off-gas is an important concern in Mo-99 facilities (existing or new) for many reasons
  - Environment
  - Countrywide regulations
  - International safety
  - CTBTO
- The choice for an off-gas treatment depends on
  - Chemical process – existing or to be developed
  - Cost
  - Physical space

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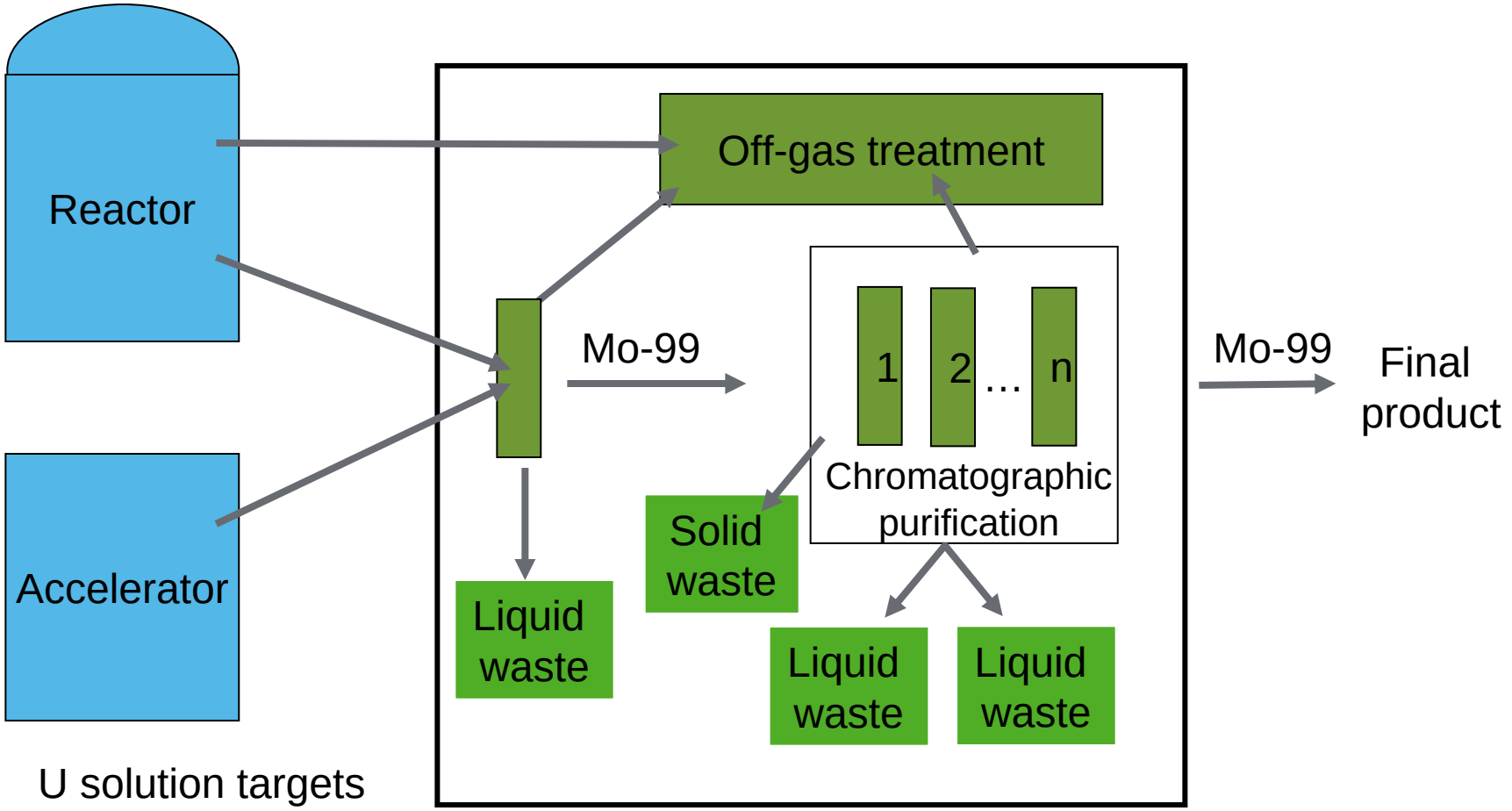
Questions?

Additional slide

Mo-99 Future Production in a Nutshell (LEU facility)



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