

Nuclear inspections on NORM shipments in the port of Antwerp

Pascal Fias – AV Controlatom

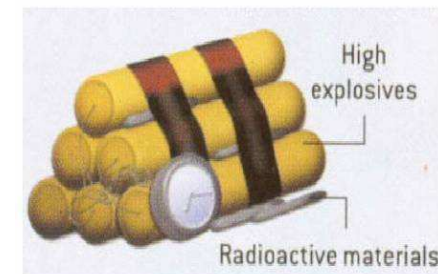


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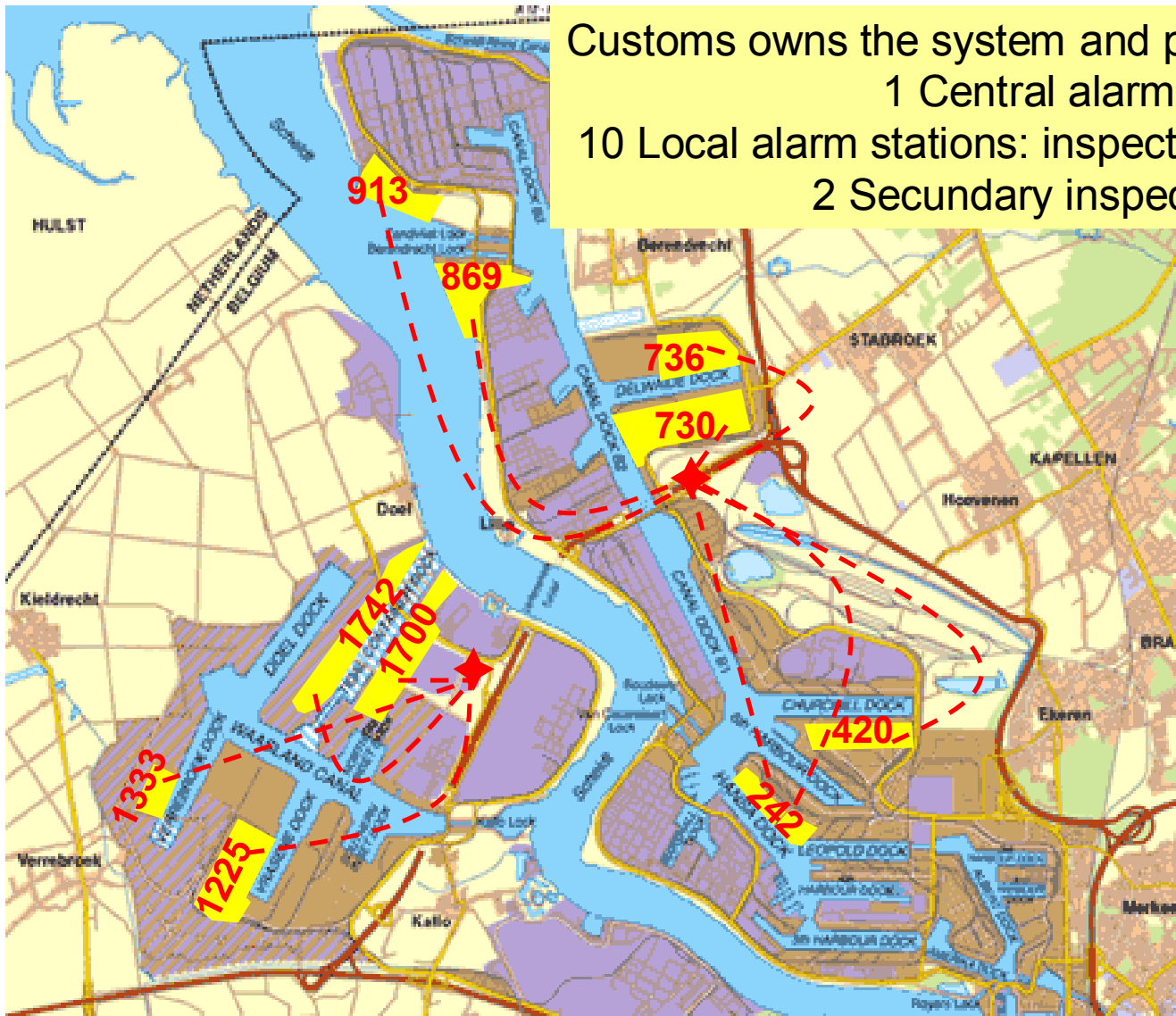
Nuclear inspections – Why?

- Goal 1: Counter nuclear terrorism
 - To detect and to deter nuclear smuggling
 - “Dirty bomb” and nuclear weapons
- Goal 2: Radiation protection of public
 - Detect unwanted sources and radioactive contaminations in “non-radioactive” shipments
 - Positive side-effect of the inspections

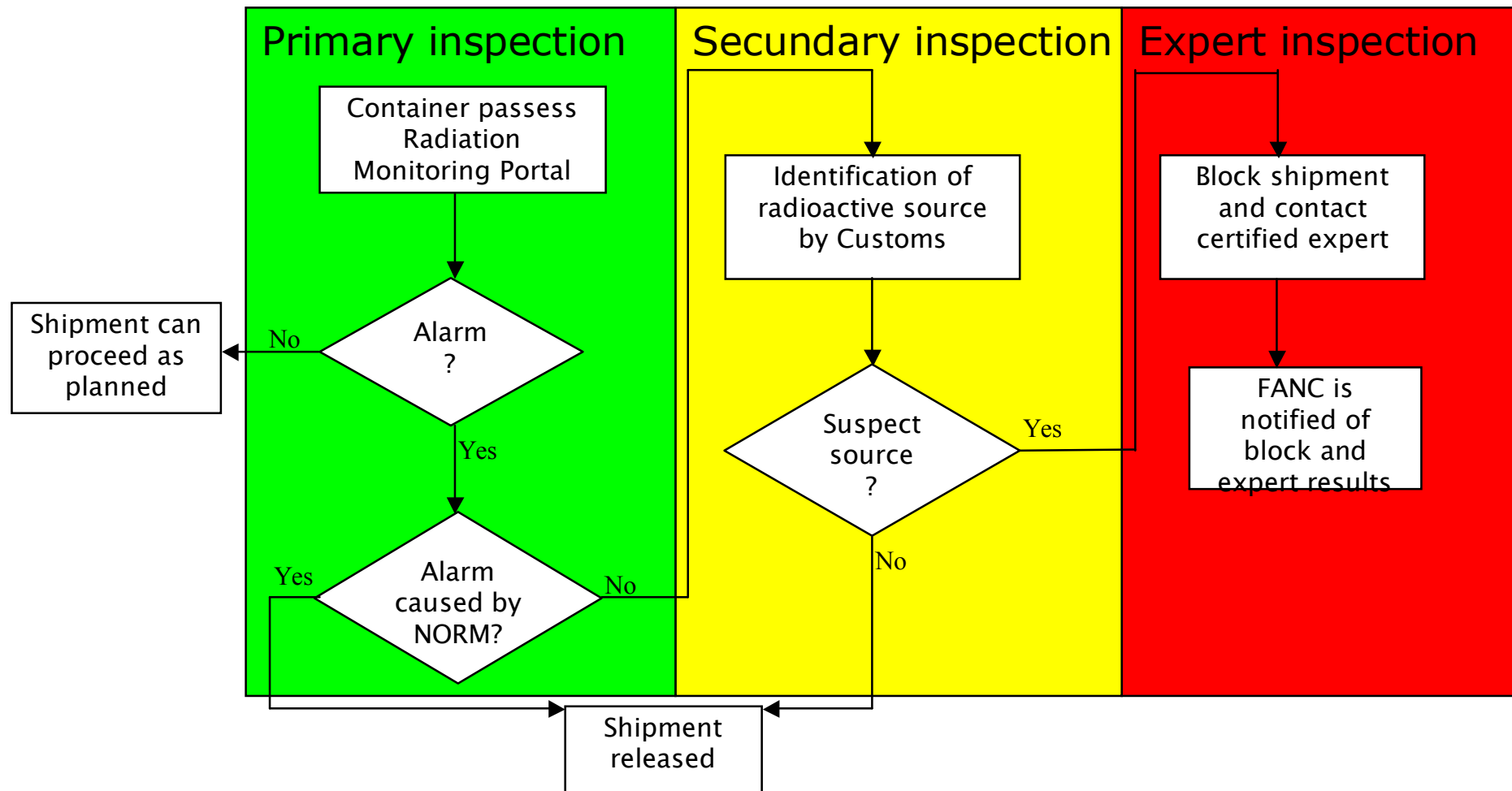


Antwerp installations

Customs owns the system and performs the inspections
1 Central alarm station
10 Local alarm stations: inspection of import shipments
2 Secondary inspection points



Standard procedure (short version)



Some stats

2011 (jan-oct)	
Occupancies	3 235 012
Alarms	46 966
Alarm rate	1,45%
Occupancies/day	15 450
Alarms/day	224

Measurements on NORM in step 2

1. Gammaspectroscopy

NORM = K-40, Ra-226, Th-232

Suspect but probably NORM = U-238

2. Dose rate

< 5 $\mu\text{Sv/h}$: no (urgent) need for dangerous goods transport

> 5 $\mu\text{Sv/h}$: possibly a dangerous goods transport (average dose rate and activity concentration need to be determined)

3. Activity concentration

Calibrated HP Ge detector (samples)

Measurements of big bags, boxes, ... (technique NuTeC)

Rough estimate based on previous measurements and radiation portal monitor data

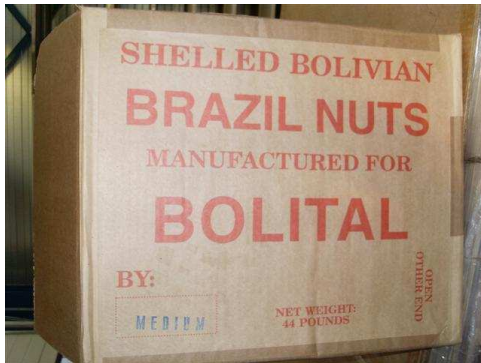
Standard of operations for NORM shipments

- Step 1: recognition of NORM materials based on cargo description by shipper/designee/consignee/...
 - NORM database with thresholds
 - Experience of operators and experts
 - Internet search engines
 - Spectroscopic gammadetectors
 - Physical inspection of cargo



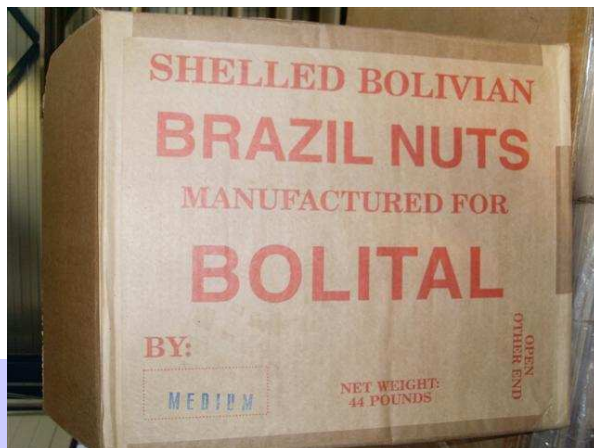
Hoofdcategorieën	Limiet in slgms	Oorsprong activiteit + nietlijn	Andere benamingen
Abrasiet	45	Straalgrit, glasachtig residu van steenkoolcentrales, opconcentratie van NORM	
Acrylpolymereën	35	Kaliumzouten van (poly)acrylaat	Laquasorb, Hydrosorb, Polymethylacrylaat
Actieve kool	55	Bewerkte steenkool (soms ook turf, cocos, ...): ontgast en gezuiverd, hierdoor opconcentratie van NORM	Norit, Activated Carbon/Charcoal
Alumina - aluminiumoxide	140	Bewerkte vorm van aluminiumerts (meestal bauxiet)	"Aluminium oxide" (engels)
Alumina stenen en cement	85	Bewerkte vorm van aluminiumerts (meestal bauxiet)	Alumina brick, Alumina cement, alumina bricks, kullundite (soort plasten anderen)
Alumina zirconia	150	Bevat zowel aluminiumoxide als zirkoniumoxide	Zirconia alumina
Aluminium houdende materialen	50	Mij divers, meestal ertsen, in sommige gevallen kaliumzouten van aluminaat	Aluminiumerts, aluminates, aluminate, aluminaat
Aluminiumsilicaat	40	Bereid op basis van ertsen, lagere limiet dan alumina (reden: geen bauxiet gebruikt en andere bereiding)	Aluminium silicate, aluminum silicate, phonosorb 555 ®
Ammoniumzouten	50	Typisch zijn deze zouten in zuivere vorm niet radioactief. Vaak in mengvorm aanwezig in meststoffen, de hierbij aanwezig kaliumzouten zorgen voor de activiteit	ammonia, ammonium, ammoniumnitraat, ammoniumfosfaat, ammonium nitrate, ammonium phosphate
Asfalt - bitumen	20	Asfalt bestaat uit minerale aggregaten (NORM) en bitumen. Bitumen is een bindmiddel dat gewonnen wordt uit aardolie (zwaar).	Asphalt
Assen en slakken - grit	35	Residuo's van productieprocessen (zie ook abrasiet, casitos en belagrit), typisch zitten hier nog beperkte NORM fracties bij. Concentratie hangt sterk samen met de gebruikte beginproducten.	Cenospheres, microspheres, glass beads, straalgrit, blasting grit

To NORM or not to NORM ...



May contain nuts

- Brasil nuts (paranoten)
 - Literature and measurements: 0,03 Bq/g ^{226}Ra
0,04 Bq/g ^{232}Th
 - About 1000 times higher concentration than in other foodstuffs
 - Well known phenomenon and no risk for health (if consumption stays below a few kgs per day)



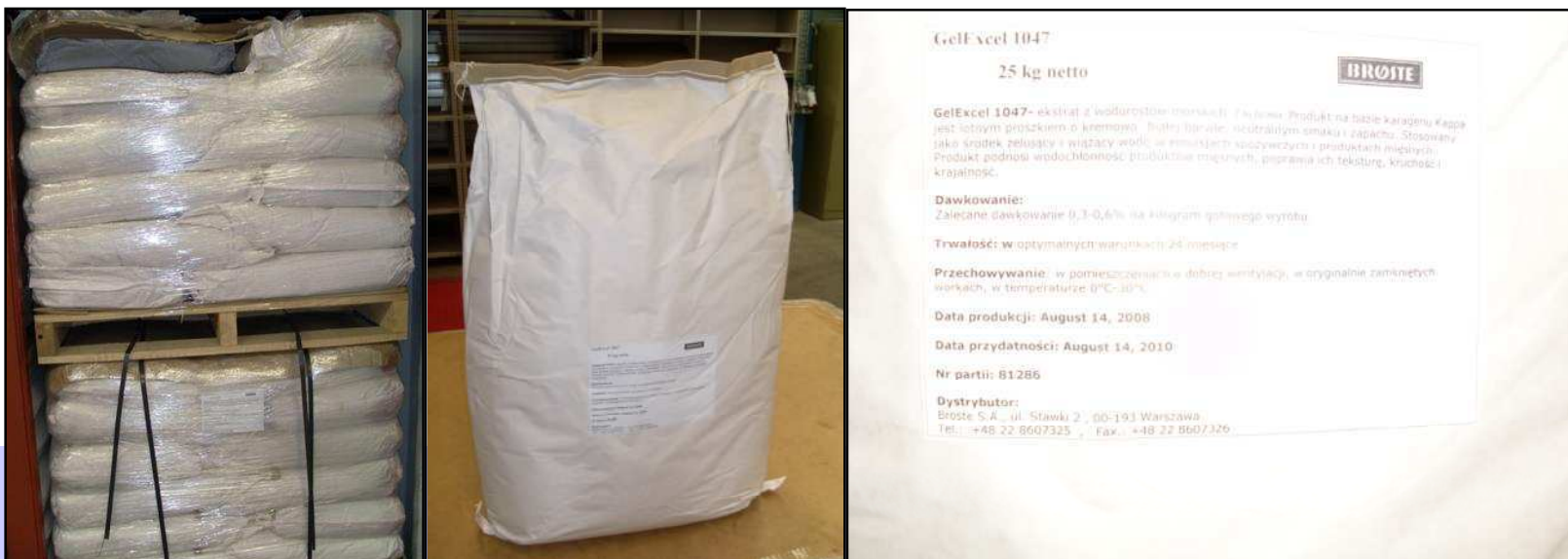
Electrical insulators

- Manifest info: steel products ???
- After physical examination: ceramic parts = NORM = release



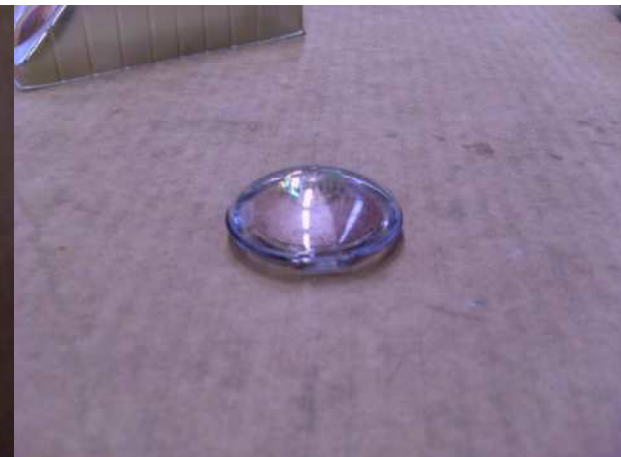
Sausages

- Aquagel
 - Gel excel 1047 for preparing saugages
 - Potassium-40, about 0,2 $\mu\text{Sv/h}$ in contact



Eye shade

- Contains mica (thin layered structure)
- Ra-226, Th-232, K-40
- $< 0,1 \mu\text{Sv/h}$ in contact with cargo



Standard of operations for NORM shipments

- Step 2: If NORM, any further action needed?
 - If above 1 Bq/g : Customs document or equivalent information is transferred to expert, who informs FANC on a regular basis off all these shipments
 - If above dangerous goods limits: container is blocked and licensed transport needs to be organised
 - If point source (typically in waste shipments): block and isolate source



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Rough estimate based on previous measurements and radiation portal monitor data

> 1 Bq/g

- Very typical materials
 - Zirconium ores and salts
 - Refractory materials
 - TENORM (in most cases residuals of metal production): silica fumes, Fe/Sn granulates, ...

Material	Sigma	Activity concentration (Bq/g)	Decision
Silica fumes	1000	7.4 Ra-226 - 1 Th-232	Release
Zirblast	33 (point)	2.8 Ra-226	Release
Garnets	324	0.25 Ra-226 - 1.9 Th-232	Release
Copper cake	5 (point)	6.5 U-238	Release
SnFe cake (hardheads)	360	5	Release

Dangerous goods issues

- If the material has to be classified as dangerous goods class 7 (radioactive) the problems start
 - Most shippers reply: no class 7 on my ship
 - Most consignees reply: I will not or cannot pay the bill for the shipment



Result?

Goods are blocked for months.

Extra costs for shipment.

Abandoned goods.

1 extreme case: NORM is treated as industrial waste although it is a start material for a paint



Point sources

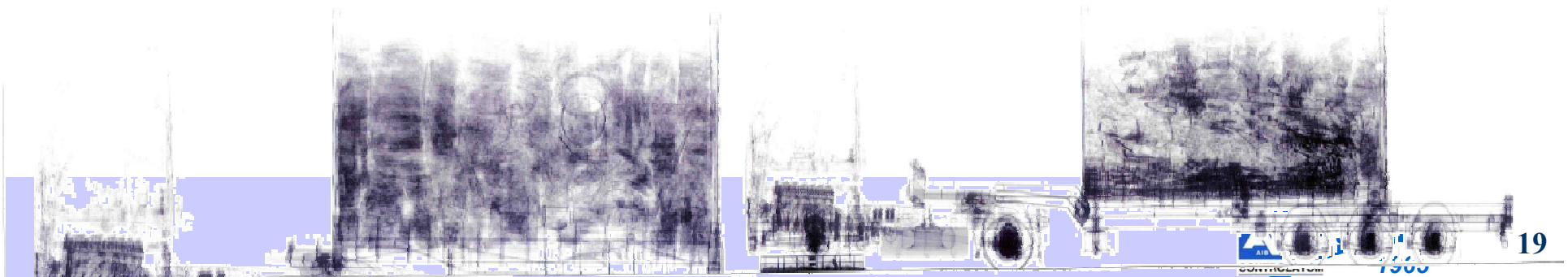
- Typically in scrap containers
- Sources:
 - Scaling in decommissioned installations
 - Radium sources: paint on instruments, lightning rods, ...
 - Thorium magnesium alloys
- Sources need to be isolated and treated as rad waste



Radium sources in scrap

2 containers with Radium –226

- 1,2 & 4 uSv/h, ^{226}Ra
- Destination: scrap yard with portals in the Netherlands
- Special arrangement between FANC (Belgium), VROM (Netherlands) and scap company: containers transported under ADR class 7 to scrap yard



Radium pain(t)

In contact with parts 0 - 130uSv/h,
²²⁶Ra

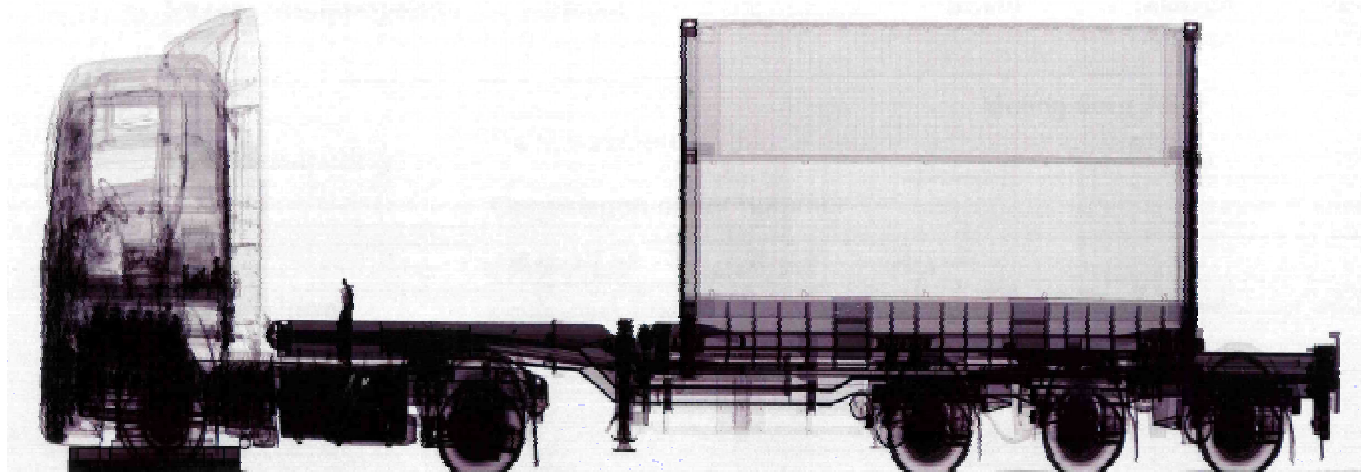
- 24 parts of WO II fighter planes
- Owned by an old American couple, husband was WO II pilot
- Low contaminated parts were released, rest helas confiscated

Beschrijving	Dosistempo in contact met het voorwerp (in $\mu\text{Sv/h}$)
"Direction"	7
"De-icer"	10
"Temp"	1
"mph"	30
Groot stuk	40
Volledig paneel (1 stuk in paneel)	30
"Air speed"	80
"Radio compass"	30
"Temp/oil/fuel"	40
"Freeair temp"	5
"Blinker"	20
"Temp/oil/fuel"	40
Waterpas	120
"Nose Wheel"	1
"Temp"	40
"Bendix Radio"	20
Waterpas	1
"Man"	50
"RPM"	15
"Radio Compass"	10
"Temp/oil/fuel"	20
"Fuel"	70
Bomrichter	50
Kompas in houten doos	130



The empty container ...

- Radiation alarm + Th-232 found with portable HP Ge detector



The empty container

- Wooden floor was contaminated by a NORM product
 - Samples <1 Bq/g ^{232}Th
 - 1,9 $\mu\text{Sv/h}$ on hot spots
 - Wooden floor was replaced and treated as normal waste (average concentration well below clearance levels for waste)



Conclusion

- Nuclear inspections in ports
 - Cause problems
 - Dangerous goods transport
 - Shipment is sometimes refused
 - Causes extra costs and efforts
 - Help to improve the radiation protection of the public
 - Detection of radioactive contaminations (NORM, Co-60 in steel, Cs-137 after nuclear incidents, ...) and orphan sources
 - Awareness of the use or existence of (new) NORM materials

NORM regulations in Belgium

List of “work activities” subjected to notification:

- Phosphate industry;
- Zircon industry;
- Extraction of rare earths;
- Tin foundries;
- Production of thoriated welding electrodes.

+ transport regulations (see TS-R-1, exemption if
[U-238sec] < 10 Bq/g
[Th-232sec] < 10 Bq/g)

Follow up Megaports data

4 objectives:

- Application of **transport regulations**
- ⇒ few cases where exemption levels were exceeded: tin-lead blocks with [Pb-210] > 100 Bq/g, tourmaline powder with [Th-232sec] = 25 Bq/g,...
- **Identification** (Belgian) companies subject to notification;
- **Control data** of notification files;
- **Identification new NORM sectors/products**
(e.g. tourmaline - used in consumer products: washing balls, clothes, jewels,...)

Overview Megaports NORM detections

Between 01/01/2010 and 20/01/2011:

<i># detections</i>	<i># companies</i>	<i># Belgian companies</i>
114	36	15

<i># companies subject to notification</i>	
7	2 : unknown companies
	5 : notification OK or in preparation