Content

- Controlatom
- Megaports
- Inspections + NORM database
- Cases

Who is Controlatom?

- Vinçotte Controlatom is
  - **a recognized body for health physics inspections**
  - **" We provide protection for the population, the environment and employees against medical, industrial and natural sources of radiation ".**

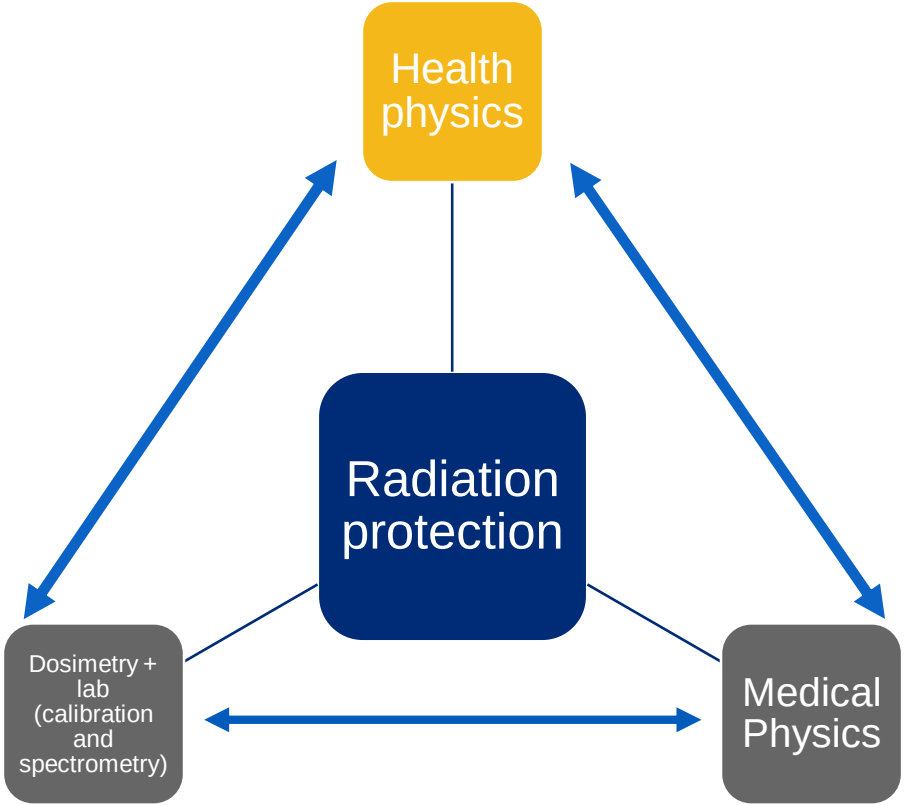
- In Belgium we are market leader in the field of
  - **Personal dosimetry**
  - **Controls (inspections) regarding radiation protection**
    - *Health physics - protection of employees and environment*
    - *Medical physics - protection of patients*
  - **& we also handle larger projects for customers (consultancy/detachment)**

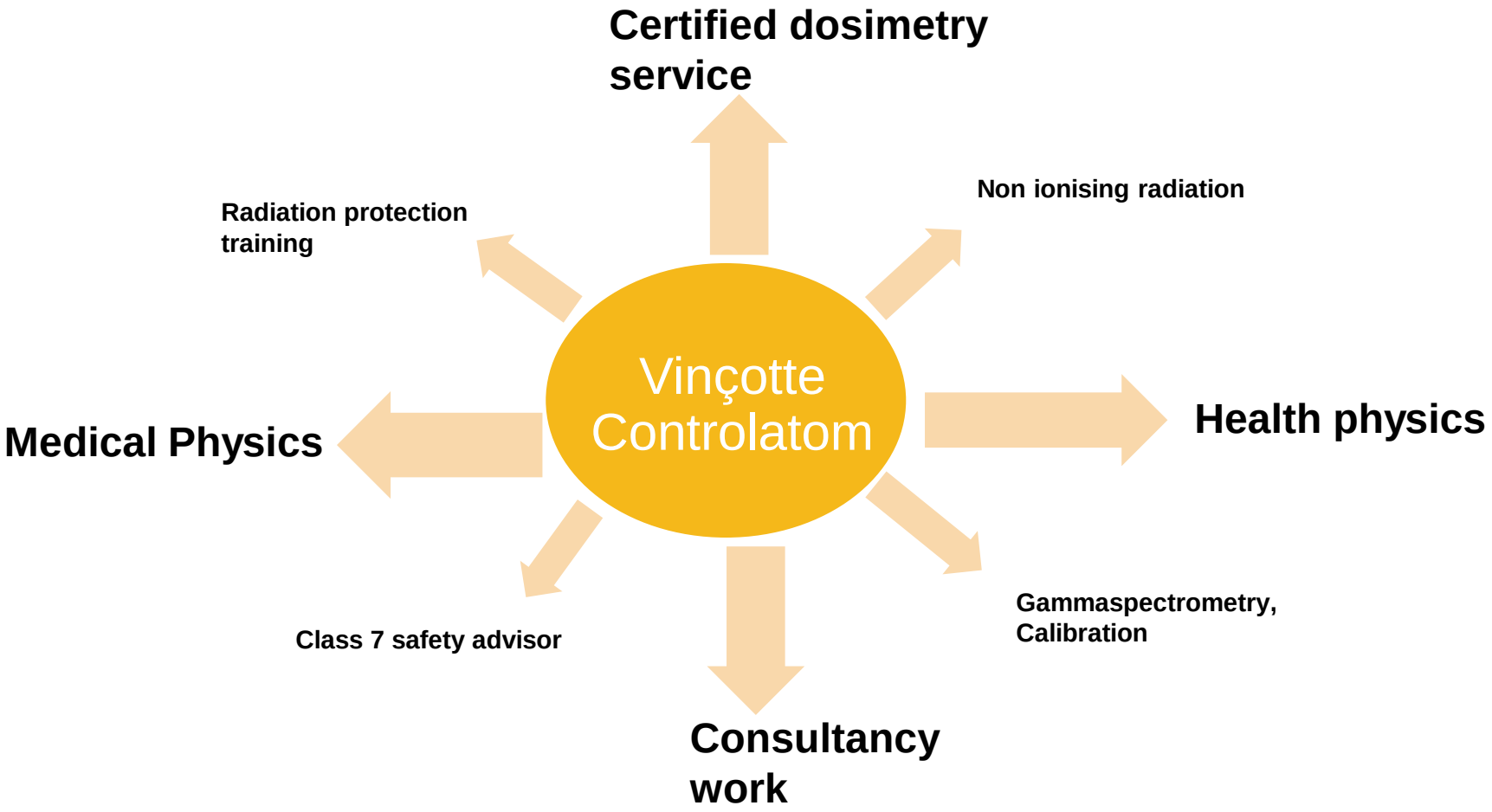
Who is Controlatom today

Our main resources are the experience & expertise of our personnel:

- **41 staff**
- **30 experts**
  - *Different background: engineer, physics, chemistry,…*
  - *Average age 43 y*
  - *Average experience 13 y*
- **Multidisciplinary approach possible**

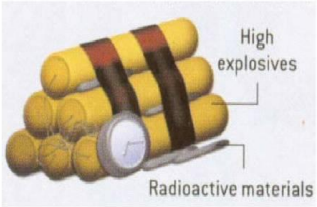
Radiation protection: integrated approach




Certified dosimetry service
Non ionising radiation
Radiation protection training
Vinçotte Controlatom
Medical Physics
Health physics
Class 7 safety advisor
Gammaspectrometry, Calibration
Consultancy work

What is Megaports Initiative (MPI)?

- Founded by National Nuclear Security Administration (NNSA)
  - **United States**
  - **2003**
  - **Twin Towers**
- Why?
  - **Main reason: Anti-terrorism**
    - *Smuggle nuclear material(Uranium and Plutonium)*
    - *Dirty bombs*
  - **Reason 2: Protection public health**
    - *Orphan sources*
    - *Contamination consumer goods*

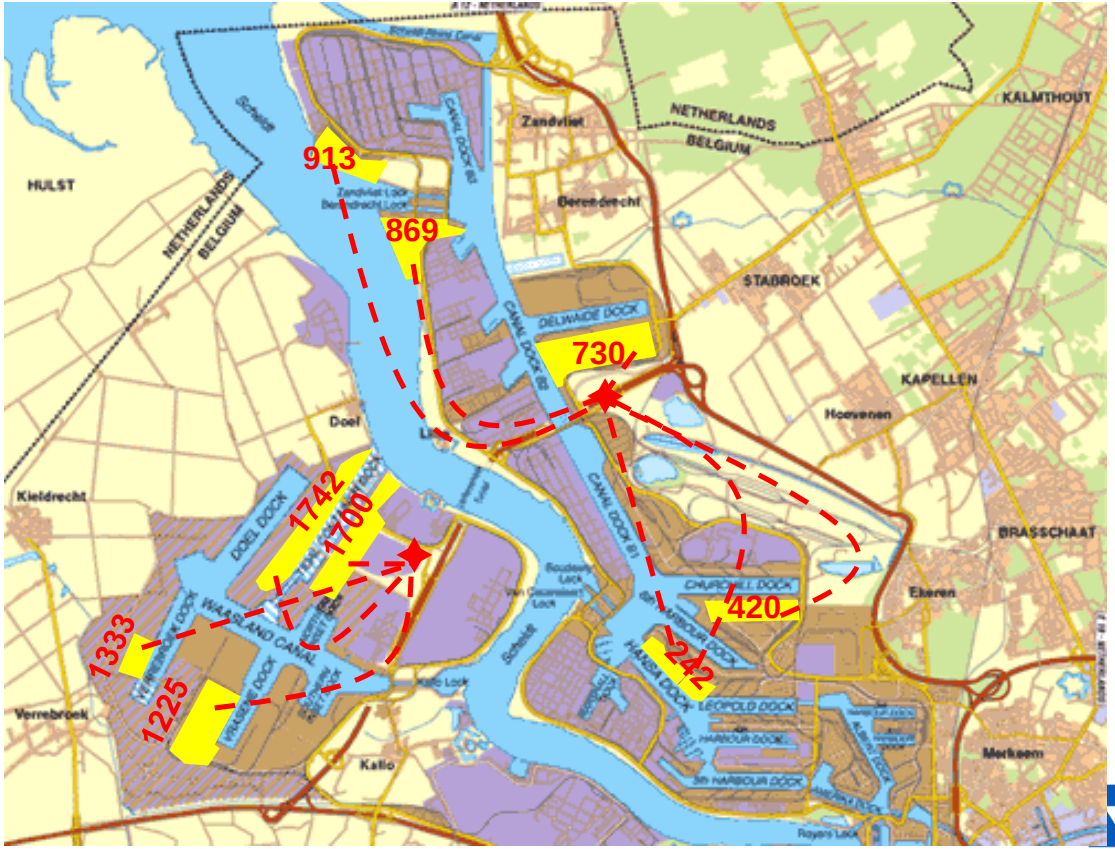


Belgian customs

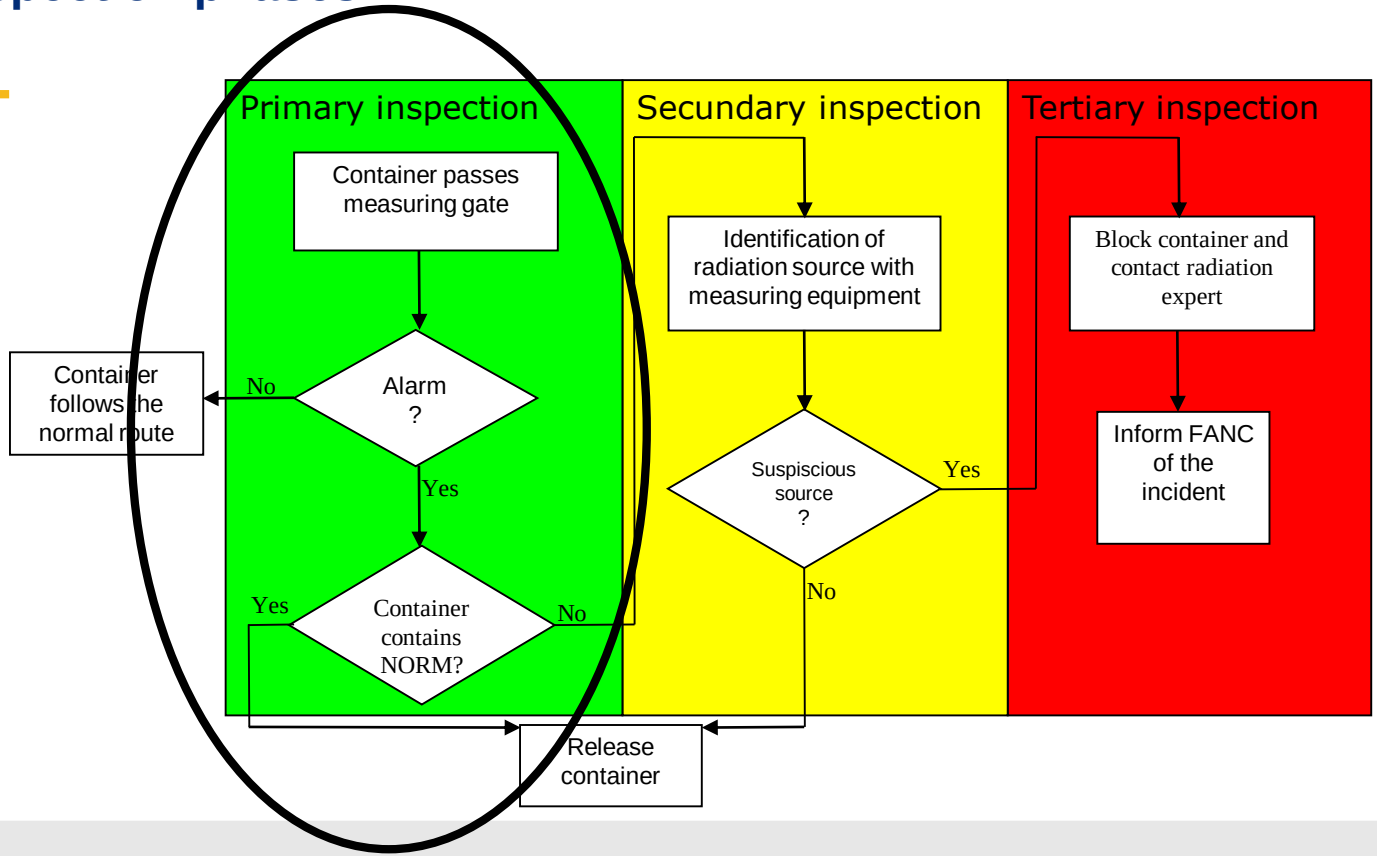
- Antwerpen
  - **Linkeroever**
  - **Rechteroever**
- Zeebrugge
- Twee inlandse terminals
  - **Willebroek**
  - **Meerhout**

Belgian customs

- Antwerpen
  - **Linkeroever**
  - **Rechteroever**
- Zeebrugge
- Twee inlandse terminals
  - **Willebroek**
  - **Meerhout**



Inspection phases



Primary inspection

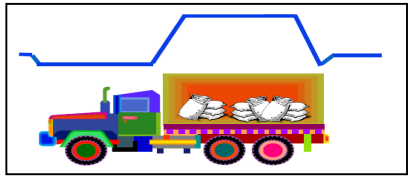
- Measuring gates are “blind”
  - **Passive measurement (does NOT radiate independently)**
  - **No recognition of the type of radiation**
    - *Natural source (NORM)*
    - *Industrial source*
    - *Medically used substance*
    - *Nuclear material (nuclear)*
- Customs declaration only additional source of information
- Large number of alarms due to NORM
  - **300/day**

Primary inspection

- Theoretical goal
  - **Inspection of all alarms**
    - *Content*
    - *Scan*
    - *Secundary + tertiary inspection*
- Nadelen
  - **Economical impact**
  - **Timeconsuming**
- Not realistic

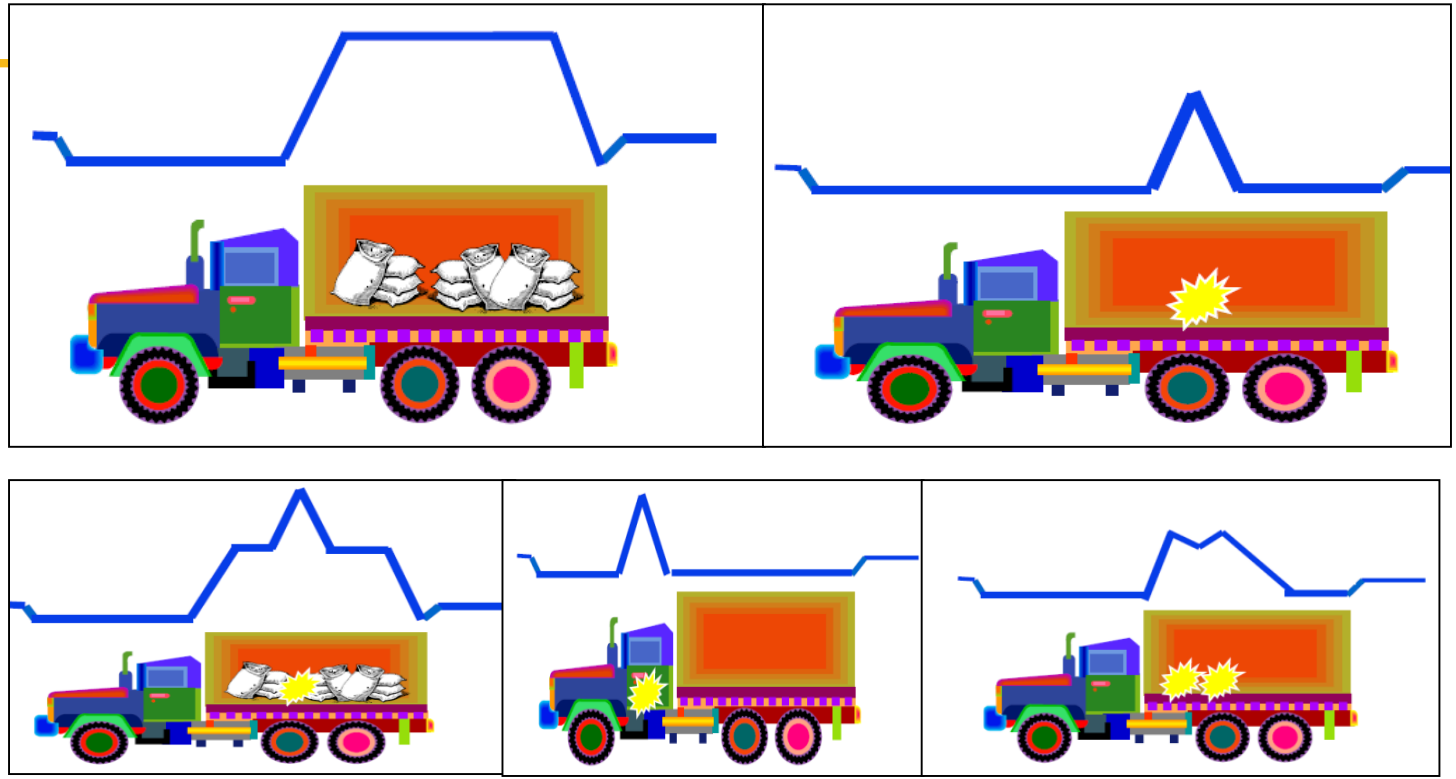
Primary inspection

- Practical goal
  - **Close incoming alarms in software in an efficiënt way**
  - **Focus on suspicious alarms**
  - **Limit impact**
- How?
- Selection criteria
  - **Radiation profile**
  - **NORM database**
  - **Customs instinct/Experience**



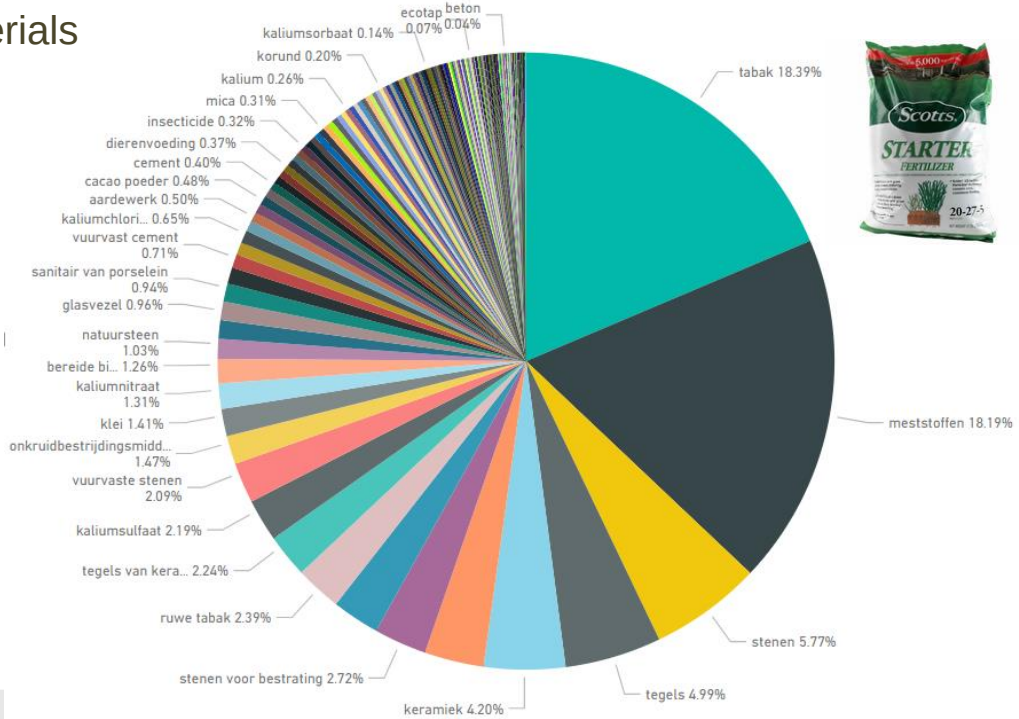
Algemene naam	Waarschuwingsdrempel	Gemiddelde	Stddev	Aantal
tegels van keramiek	81	37	22	320
tegels van porselein	111	59	26	16
terracotta	47	26	14	19
titaniumdioxide	95	65	15	6
titaniumerts	93	75	9	35
ultramarijn	30	17	6	23
vaatwerk	111	51	30	34
vaatwerk van gres	107	59	24	30
vaatwerk van keramiek	120	56	32	17
vaatwerk van porselein	142	54	44	6
veldspaat	54	33	11	5
verglaasbare samenstellingen	58	23	18	120
vermiculiet	60	19	20	16
vlas	16	10	3	13
voedingsadditieven	61	28	17	7
vuurvast beton	152	63	44	9
vuurvast cement	111	51	30	327
vuurvaste keramiek	244	149	48	64
vuurvaste klei	321	146	88	30

Radiation profile



Primary inspection: NORM Database

- Naturally Occuring Radioactive Materials
  - **Potassium, Radium, Thorium, Uranium**



Primary inspection: NORM database

- There is no general list with materials that can be considered NORM
  - **Creation of a list of all alarms with NORM in the port of Antwerp**
  - **Now more than 200.000 alarms in the database**
- 300 types of NORM in the list
- Used for alarm filtration
- Suspect if:
  - **Materials are not found in the list**
  - **Materials exceeding a radiation level indicated in the list**
  - **Not a homogenous profile**

How do I prepare a NORM database?

- STEP 1: Define materials by their names
  - **Make sure that these are as specific as possible!**
    - *E.g. Big difference between potassium chloride and a potassium chloride solution*
    - *Not all fertilizers have the same potassium levels*
    - *Big difference between refractory ceramics and ordinary ceramics*
    - *Stones: sandstone, bricks, firebricks, cobblestones, etc*

How do I prepare a NORM database?

New NORM materials added after:

- **Phase 2 inspection**
- **Presence of natural forms of K/Ra/Th/U established**
- **Physical verification of the content and possible sampling for analysis in a lab**
- **Expert seeks online info on the composition of material (wikipedia, google, MSDS,…)**

How do I prepare a NORM database?

- STEP 2: Maintain a list of past alarms for each name
  - **Preferably note additional details for each alarm such as the producer or sender, or a brand name/chemical composition…**
  - **Remember to take note of the gamma value**

How do I prepare a NORM database?

- STEP 3: Define alarm levels for each name based on statistical data from each list
  - **Average value and Standard deviation**
  - **Alarm limit = average+ 3 standard deviation**
  - **If the deviation is too large: name is not specific enough or there is a very small number of alarms**

How do I prepare a NORM database?

- Extract info from the SLD server (sql)
- Use Access as database,
  - **Easy to query**
  - **Calculate average, std. dev. & nr of alarms**
  - **Export to excel as a list**
- Excel list for vehicle and rail
  - **Name material**
  - **Limit**
  - **Average**
  - **Standard deviation**
  - **Number of alarms**
  - **To Do’s**
  - **Synonyms**

Vehicle

Materiaal	Limiet	To Do	Gemiddeld	Stddev	Aantal	Synoniemen
aardewerk	56		22	11	642	earthen ware
abragrit	54		32	7	377	
absorptiekorrels	45		11	11	19	
acrylpolymeren	29		9	7	14	Laquasorb, Hydrosorb, Polymethylacrylaat
Actieve kool	40		12	9	525	Norit, Activated Carbon/Charcoal
Alumina	227	altijd bedrijf en docnummer toevoegen	110	39	69	
Aluminiumcement	115	altijd bedrijf en docnummer toevoegen	48	22	12	Alumina brick, Alumina cement, alumina bricks, kellundite (soort plasterwanden)
Aluminiumerts	239	altijd bedrijf en docnummer toevoegen	55	61	14	aluminates, aluminate, aluminaat
aluminiumoxide	213	altijd bedrijf en docnummer toevoegen	69	48	213	Aluminium oxide
amaril	103		32	24	48	
Ansilex	28		17	4	36	
Aquagel	34	indien mogelijk bedrijf toevoegen	13	7	31	
arduin	44		17	9	25	
Asfalt	32		10	7	37	bitumen, asphalt
Assen en residuen	891	altijd bedrijf en docnummer toevoegen	119	257	8	
Assen en slakken	67	altijd bedrijf en docnummer toevoegen	27	13	11	
Auto onderdelen	31	detail opvragen: over welke onderdelen gaat	10	7	24	
baddeleyiet	486	altijd bedrijf en docnummer toevoegen	164	107	20	Baddeleyite
bauxiet	321	altijd bedrijf en docnummer toevoegen	91	77	103	Bauxite
beef extract	14		8	2	26	Rund extract
bentoniet	44		19	8	588	Bentonite, hydrocol
bereide bindmiddelen voor gietvorme	74		24	17	350	Bindmiddelen gietvormen

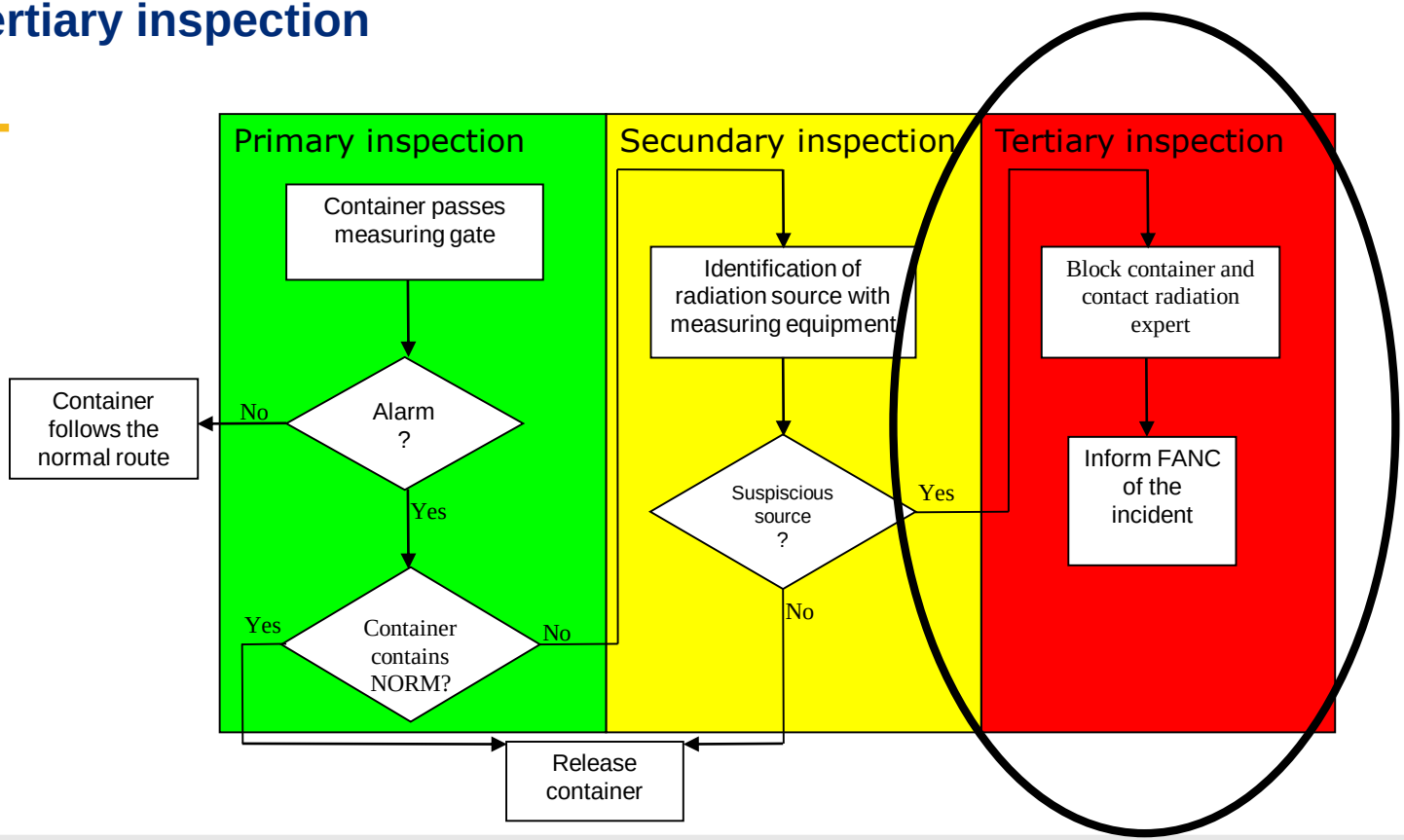
Rail

Materiaal	Limiet	To Do	Gemiddeld	Stddev	Aantal
Actieve kool	105		27	26	16
badkuipen	42		24	6	22
bentoniet	87		33	18	60
bereide bindmiddelen voor gietvormen	56		17	13	37
cacaopoeder	21		10	4	7
cement	93		34	20	15
Corrosief	179	altijd bedrijf en docnummer toevoegen	55	41	8
Dakpannen	36		20	6	8
email	170	altijd bedrijf en docnummer toevoegen	68	34	12
gietpoeder	139	altijd bedrijf en docnummer toevoegen	30	36	62
Glasvezel	36		9	9	11
graniet	64		25	13	57
Hout	29	altijd bedrijf en docnummer toevoegen LET OP! Typisch wordt het alarm niet veroorzaakt door het hout zelf, maar door een ander deel van de vracht. Vb. houten meubelen aangegeven, terwijl er ook marmeren tafelbladen aanwezig zijn. Boven de limiet MOET de packing list worden opgevraagd.	12	6	13
isolatiemateriaal	86		16	23	34
Kaliumcarbonaat	320	altijd bedrijf en docnummer toevoegen	163	52	9
kaolien	79		19	20	8

Company

Firma	Materiaal	Limiet	To Do	Gemiddel	Std. Dev	Aantal
acs bvba	Stenen	18		12	2	3
agfa-gevaert	Fotografisch materiaal	17		5	4	17
albert vd braembussche & zonen	werken van steen	11		7	1	3
allibert benelux	sanitair	38		33	2	4
algemeen ceramiek verkoopkantoor	tegels	55		28	9	22
aniserco	Kattenbakvulling	19		19	0	6
anorel	kaliumcarbonaat (meststoffen)	169		164	2	9
argex	Klei - Geëxpandeerde klei	28		19	3	22
arma	leisteen	12		7	2	8
asia stone import	tegels	26		18	3	4
ATRIO	TEGELS	22		15	2	9
august de wandeleer	Stenen	31		12	6	7
Avi-Agri bvba uit Gavere	meststoffen	65		52	4	3
b&s international	sanitair	19		15	1	3
BAKU OIL REFINERY	katalysatoren	9		7	1	4
barney stones & tiles	tegels en keramische tegels	44		22	7	73

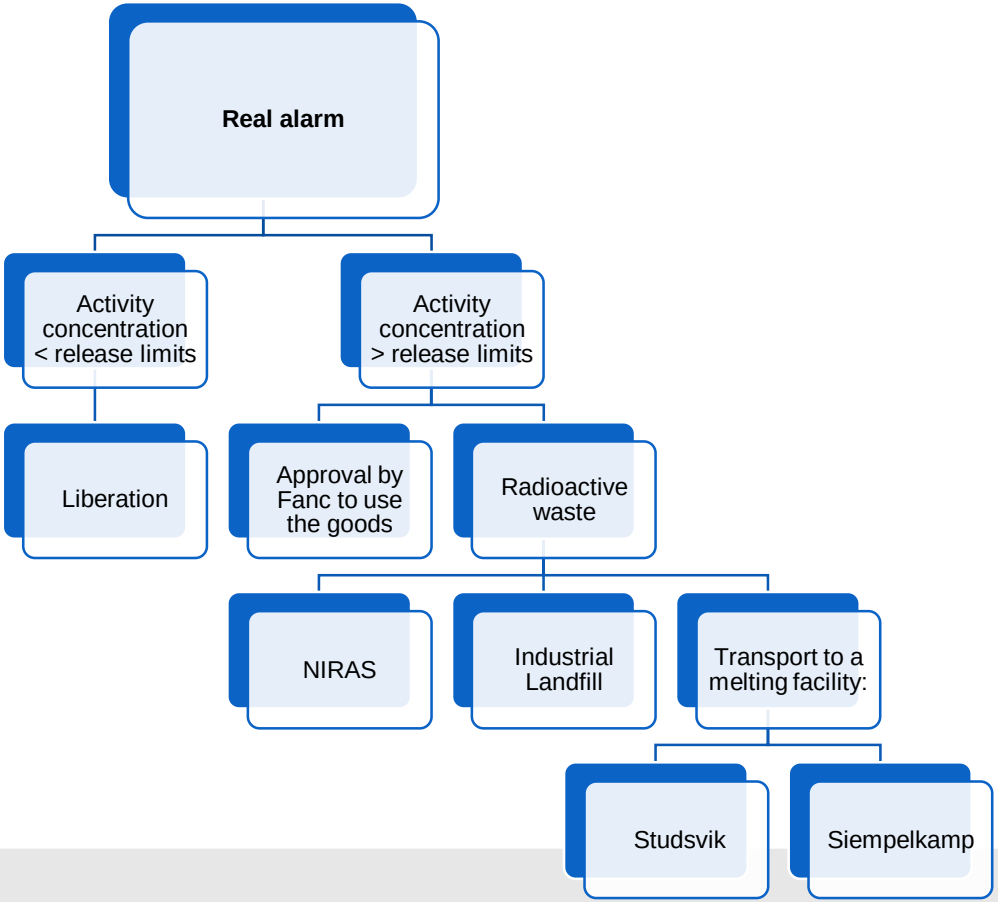
Tertiary inspection



Tertiary inspection: Involved parties

- Customs
- Vinçotte Controlatom
- Fanc: Federal agency nuclear Control
  - **2 SPOC's assigned to MPI (single person of contact**
  - **All communication passes by them**
- NIRAS: National Institute for Radioactive waste

Tertiary inspection

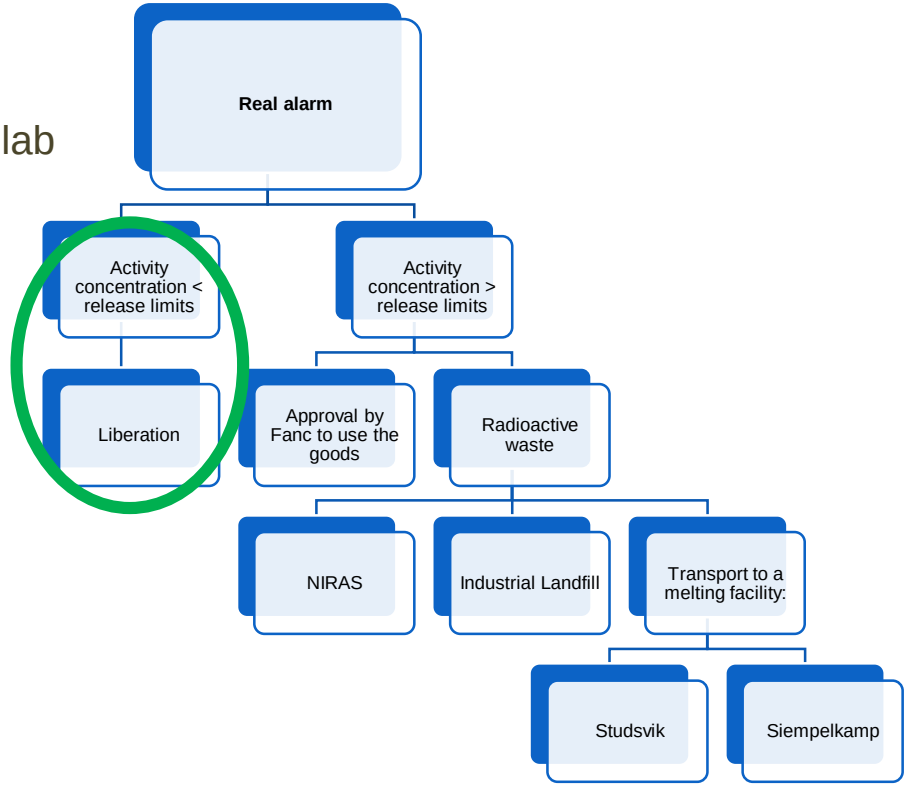


Typical cases in a tertiary

- NORM cases:
  - **Doubt as to whether or not it is NORM**
  - **Too high activity to release**
  - **Industrial use of NORM materials**
- NOT NORM
  - **Contaminations**
  - **« actual » radioactive sources**

NORM?

- Gammaspectrometric analysis in our lab
- Communication with FANC
- Liberation of the material



NORM?

- Brazil nuts
  - **0,03 Bq/g 226Ra - 0,04 Bq/g 232Th**
  - **Low concentration of 226Ra**
  - **But 1000x higher then other food products**
  - **Release**

NORM?

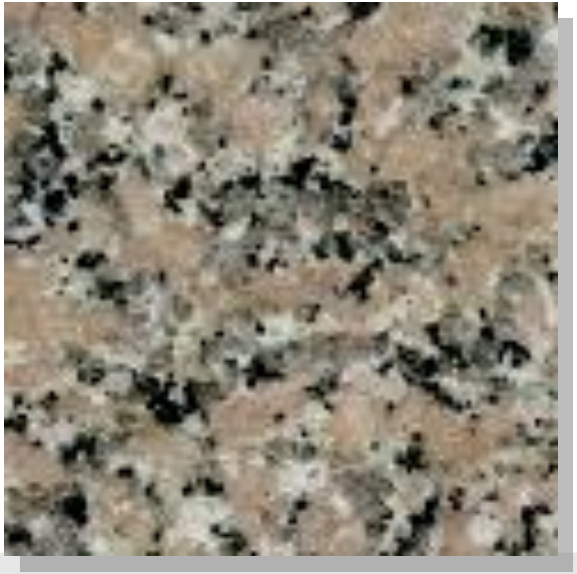
- Eye shadow
  - **Ra/Th/K**
  - **Contained Mica (clay)**
  - **Release**

NORM?

- Ultramarine
  - **Blue pigment**
  - **Contains lots of Na**
  - **Na and K: chemically very similar**
  - **Contains also K**

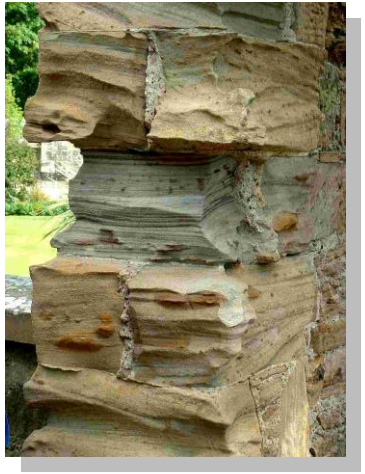
NORM?

- Granite
  - **Solidified magma from the liquid part of the Earth's mantle**
  - **Contains potassiumoxide**



NORM?

- Thin layers of clay minerals
  - **Between these layers, impurities such as water, potassium compounds, traces of uranium/radium/thorium, etc. are deposited.**
- Different types of clay in nature
  - **kaolin, feldspars, mica, ...**

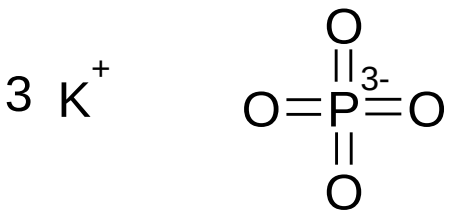


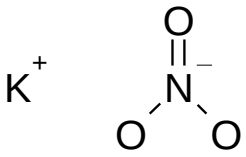
NORM?

- Marble
  - **Metamorphosed limestone consisting of very pure calcium carbonate.**
  - **The colour of the marble depends on the type of impurities it contains: Clay, sand, iron oxides...**

NORM?

- Potassium salts





kalium	152
kaliumbicarbonaat	178
kaliumbromide	81
kaliumcarbonaat	276
kaliumchloride	236
kaliumcitraat	138
kaliumcyanide	229
kaliumfluorosilicaat	33
kaliumformaat	135
kaliumfosfaat	182
kaliumhydroxide	291
kaliummethylaat	152
kaliumnitraat	187
kaliumsilicaat	69
kaliumsorbaat	107
kaliumsulfaat	206
kaliumsulfiet	128
kaliumtripolyfosfaat	177

NORM?

- Ceramics
  - **Collective name for earthenware, porcelain, faience, ...**
  - **The higher the concentration of NORM in the raw material, the higher the concentration in the ceramic**
  - **e.g. with uranium glassware the radioactivity can be measured per piece (raw material: uranium ore)**
  - **with "classic" porcelain (plates, ...) this is not or hardly the case (raw material: clay)**

NORM or not NORM?

- Transformer
  - **Ceramic insulator**
  - **Release**

NORM or not NORM?

- Plastic toys
  - **Also contained ceramics**
  - **Release**

High activity NORM

- Is it acceptable or not ?
  - **Activity(concentration) basis for decision**
  - **Transport legislation (ADR) in the EU**
    - *Limit 10 Bq/g (40K : 100 Bq/g)*
  - **Health prevention: expert analysis and rapport to FANC in all cases**

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

High activity NORM

- Tourmaline powder:
  - **25Bq/g 232Th & 5Bq/g 226Ra**
  - **Dose rate of up to 20µSv/h**
  - **Container was blocked and ADR shipping was necessary**

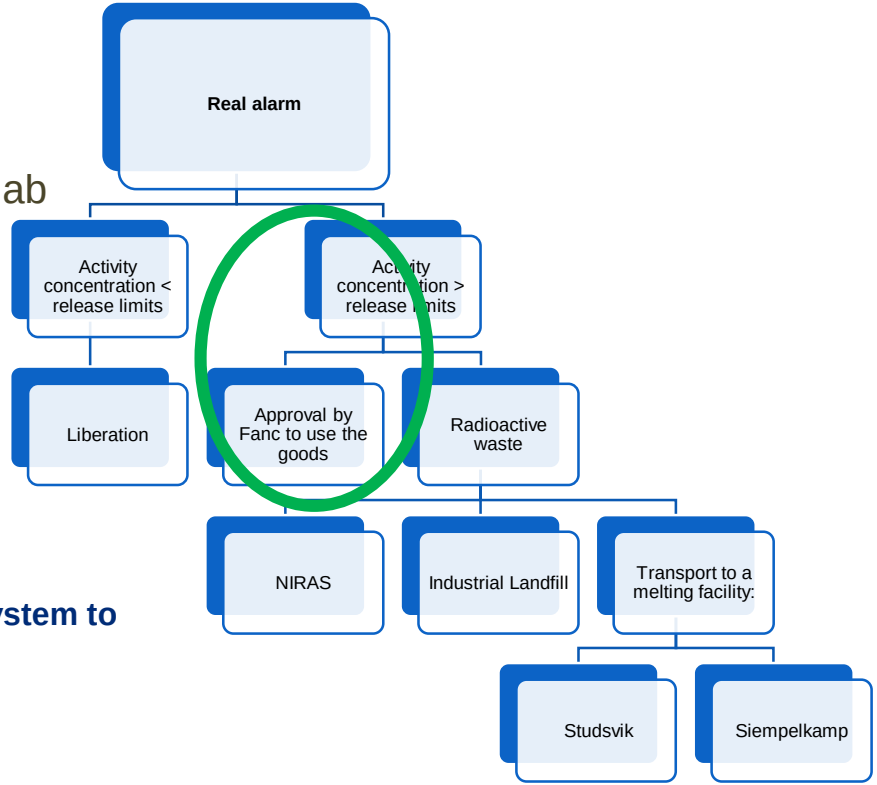
- Tourmaline applications:
  - **(Ion) Combs/hairbrushes**
  - **Clothing**
  - **High 232Th concentration**
  - **Dose rate up to 2µSv/h**
- It is forbidden to add radioactive substances to consumer goods

High activity NORM

- Natural Uranium ore
  - **Stone of natural uranium ore, 2µSv/h container wall, 500µSv/h in contact**
- Household goods container (the owner was geologist).
  - **The owner of the site where the stone was removed refused to store it on his site.**
- Stored on MPI site in Antwerp for 8 years
  - **Transported to NIRAS November 2017**
  - **Paid by funds for Orphan sources**

Detection of combs

- Gammaspectrometric analysis in our lab
- Communication with FANC
- Approval of Fanc for commercial use
  - **distributor had to implement a quality system to control the activity concentration**



Detection of combs, some times later

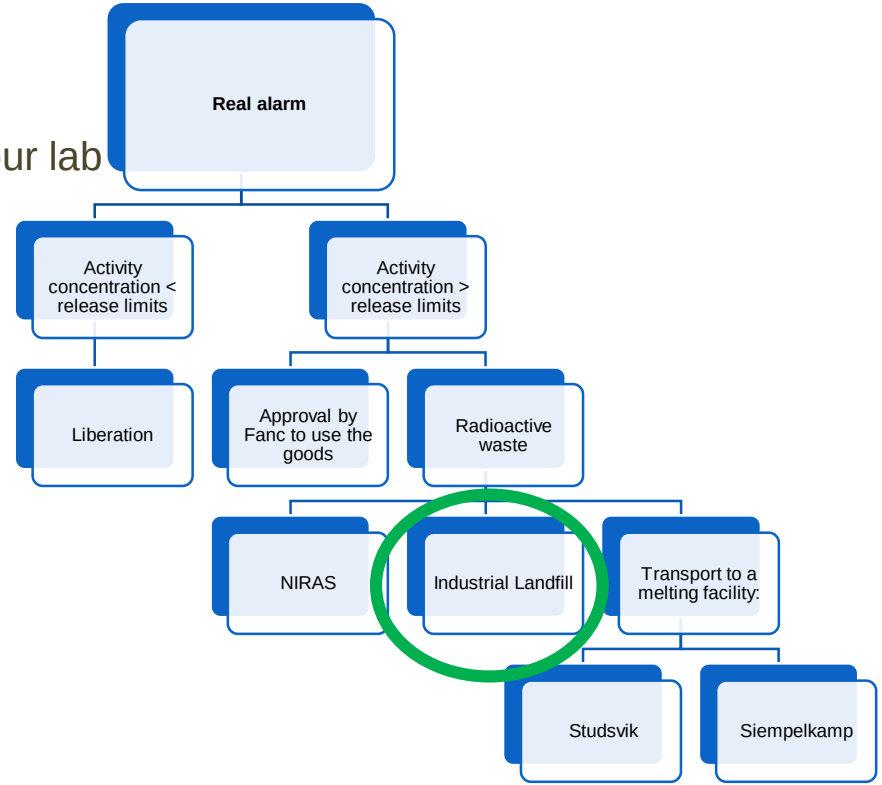
- Gammaspectrometric analysis in our lab
  - **Similar results**

- Communication with FANC
  - **Approval status is still under review**
- Upgrade of their quality system is mandatory
  - **They have bought contamination monitors**
    - *measure the radiation level of the combs before shipping them*
    - *Measure radiation level of the components*

NORM to landfill

Gammaspectrometric analysis in our lab

Communication with FANC



NORM to landfill

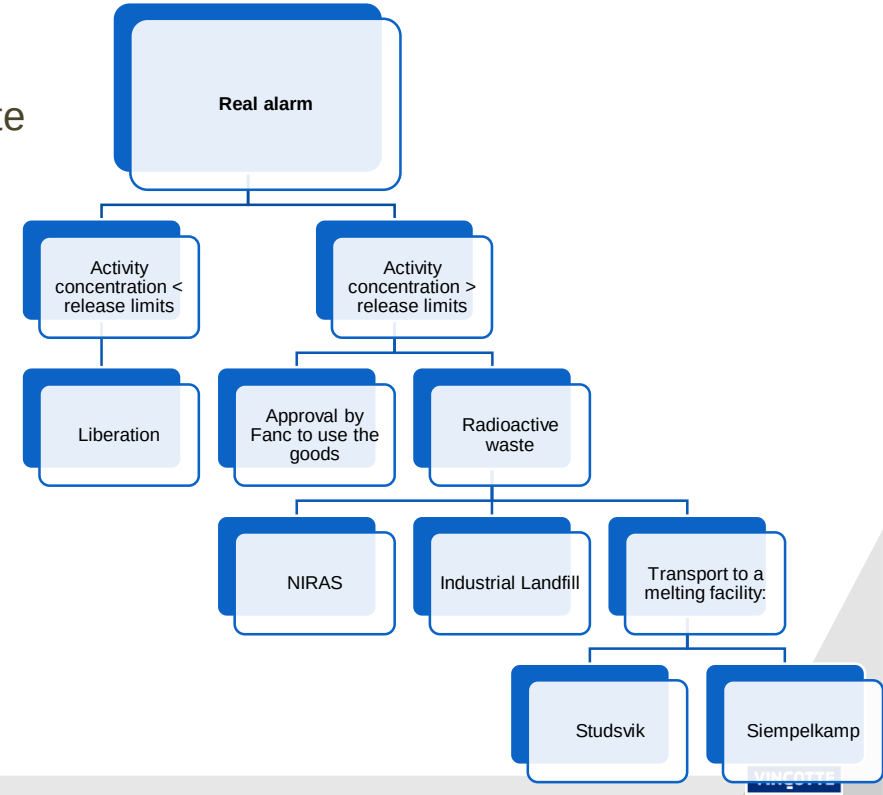
- 2 containers with Cobalt ores
  - **10 µSv/h, U-natural**
  - **Activity concentration between 1 – 40 Bq/g U-Nat**
- No use for the ores
- This type of waste can be processed by a licensed industrial landfill
  - **Activity concentration < 50 Bq/g**
  - **Only for NORM-material**

NORM in waste/scrap

- NORM section was concentrated for the application:
  - **Examples: radium paint, uranium counterweights**
- If the NORM section was accidentally present:
  - **Caking/scaling of NORM in industrial installations such as drilling rigs for oil, processing of ores, …**

NORM in waste/scrap

- Determination of the activity based on dose rate
- Communication with FANC
- Different waste processing scenarios possible
- Who’s going to pay for it???



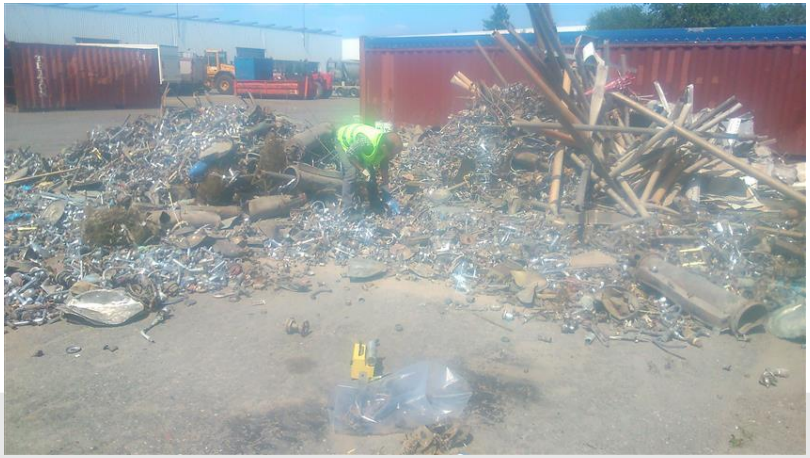
NORM in waste/scrap

- Aircraft
  - **1-130µSv/h, 226Ra**
  - **24 parts of aircraft**
  - **Presumably created and used in the period preceding WOII.**
  - **Parts were treated with radium paint.**
  - **Transported to NIRAS November 2017**
  - **Paid by funds for Orphan sources**

Beschrijving	*Dosistempo in contact met het voorwerp (in µSv/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*
	50
	130

NORM in waste/scrap

- Brass scrap
  - **1 – 20 µSv/h, 226Ra**

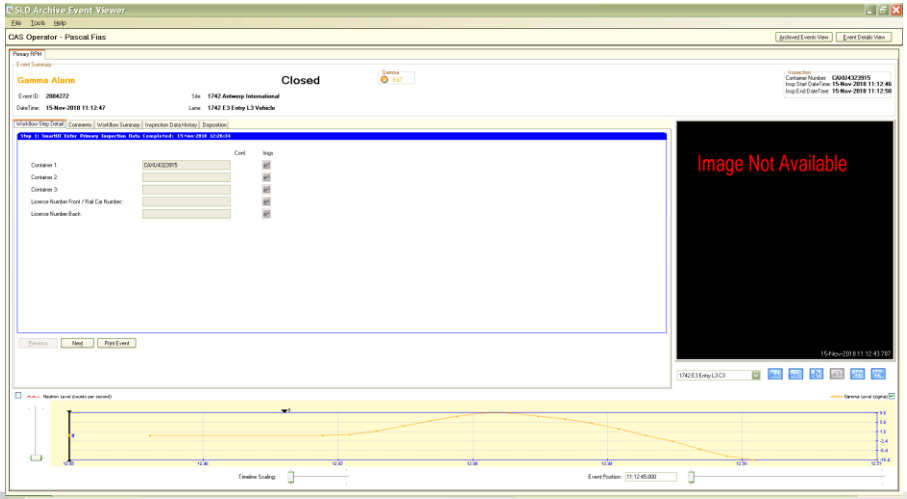


NORM in waste/scrap

- Brass scrap
  - **1 – 20 µSv/h, 226Ra**
    - *226Ra scaling*
    - *226Ra paint*
  - **Sent to NIRAS: paid by the owner**

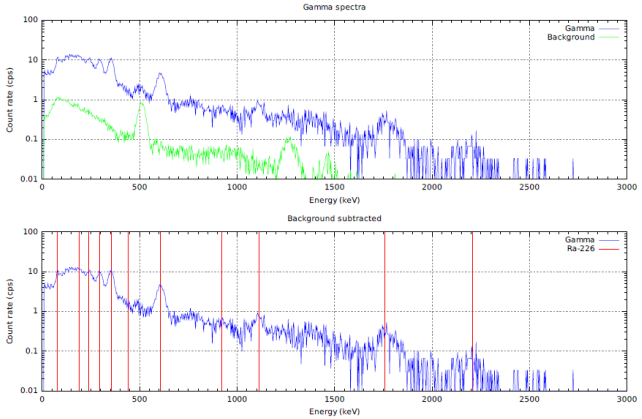
NORM in waste/scrap

- Ra-226
- Part of a lightning rod



Identification results

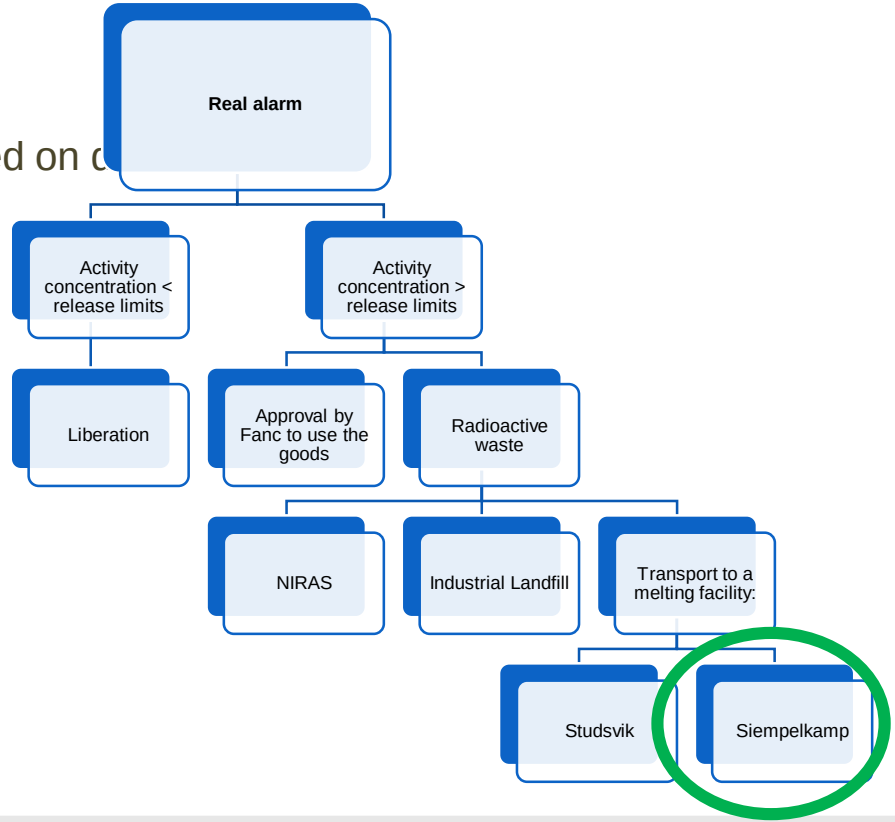
Nuclide	Category	Threat	Certainty
Ra-226	NORM	Innocent	High (97%)



NORM in waste/scrap

- Determination of the activity based on c

- Communication with FANC

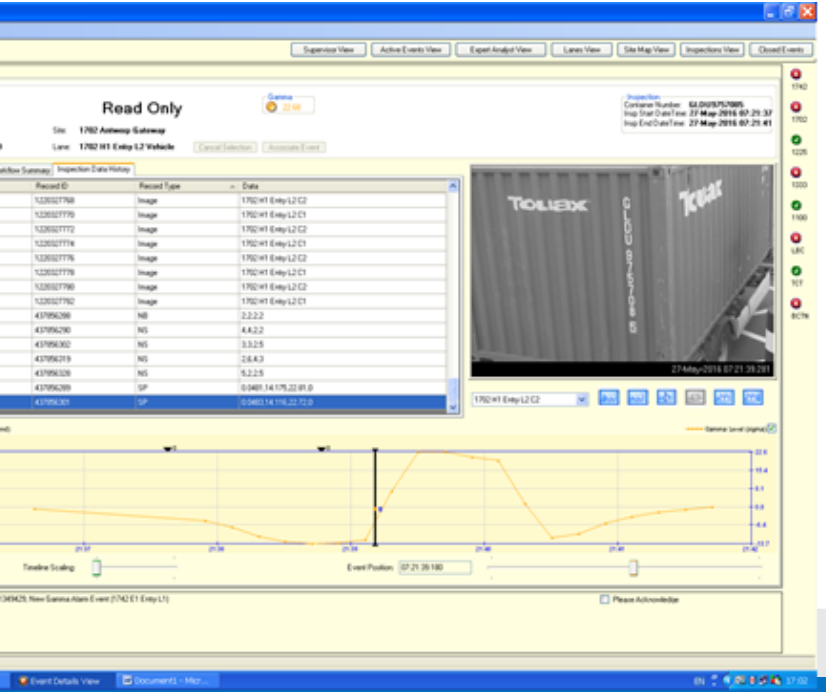


NORM in waste/scrap

- Radium scaling
  - **17 µSv/h, 226Ra**
  - **Point source in scrap**
  - **Pipe with scaling on the inside**
  - **Treatment as radioactive waste for NIRAS would have been very expensive because of the weight**
  - **Transported to and processed by Siempelkamp**

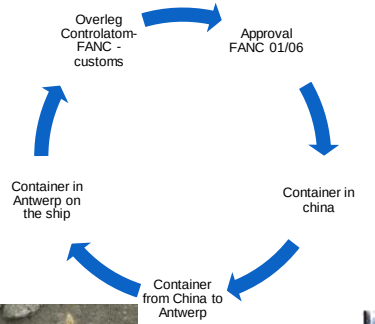
Actual sources in scrap

- Waste of iron, cast iron, steel



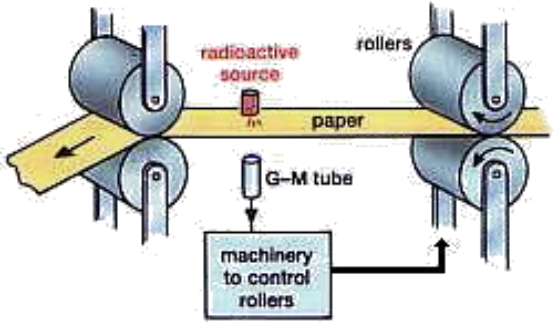
Actual sources in scrap

27 mei: alarm



Unload ontainer: 19/08

Source to NIRAS: 15/11



Actual sources in scrap

- Sr-90

Position (cm)	mSv/h
	β+ x
contact	700
5	280
10	100
15	70
20	40
30	16

Activity 80 MBq

Actual sources in scrap

- Sr-90

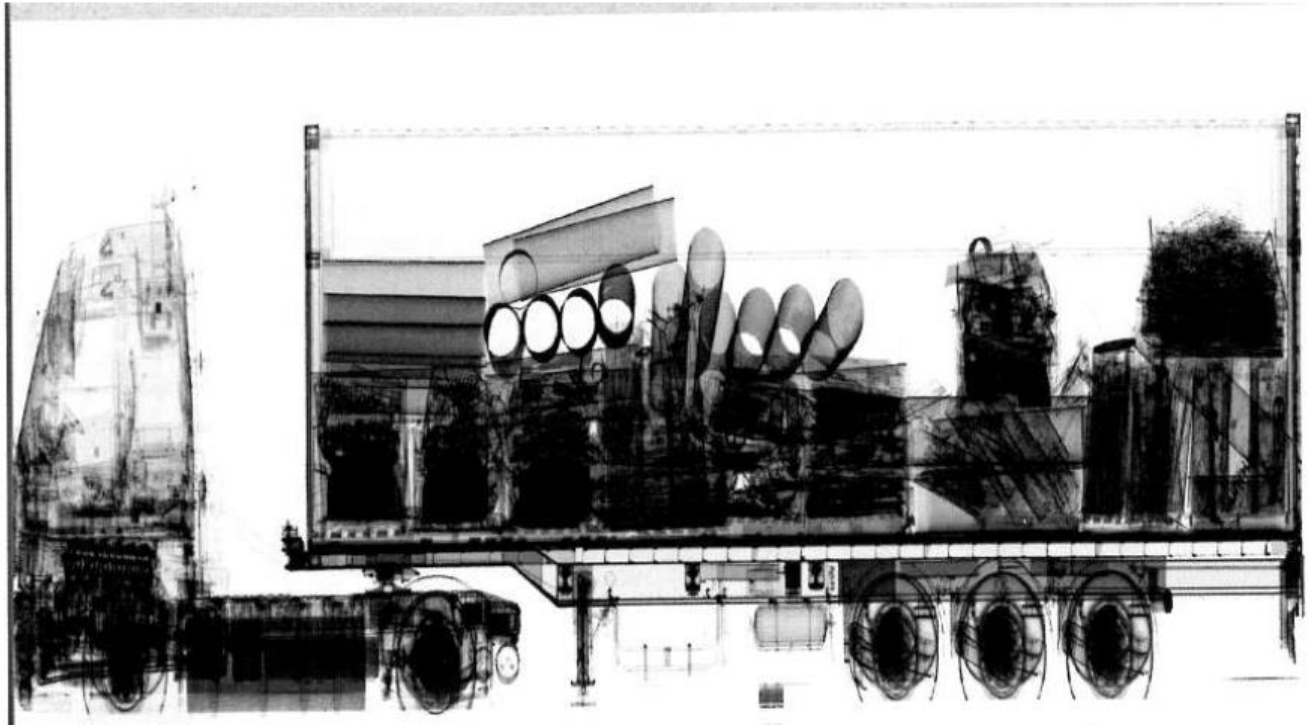
Lead

Plastic

Actual sources in scrap

- In Netherlands
- 3 Co 60 sources
  - **Activity: 50GBq**
  - **Dose rate: 15 Sv/u in contact**
- Old Radiotherapy device

Case of smuggling?



Case of smuggling?

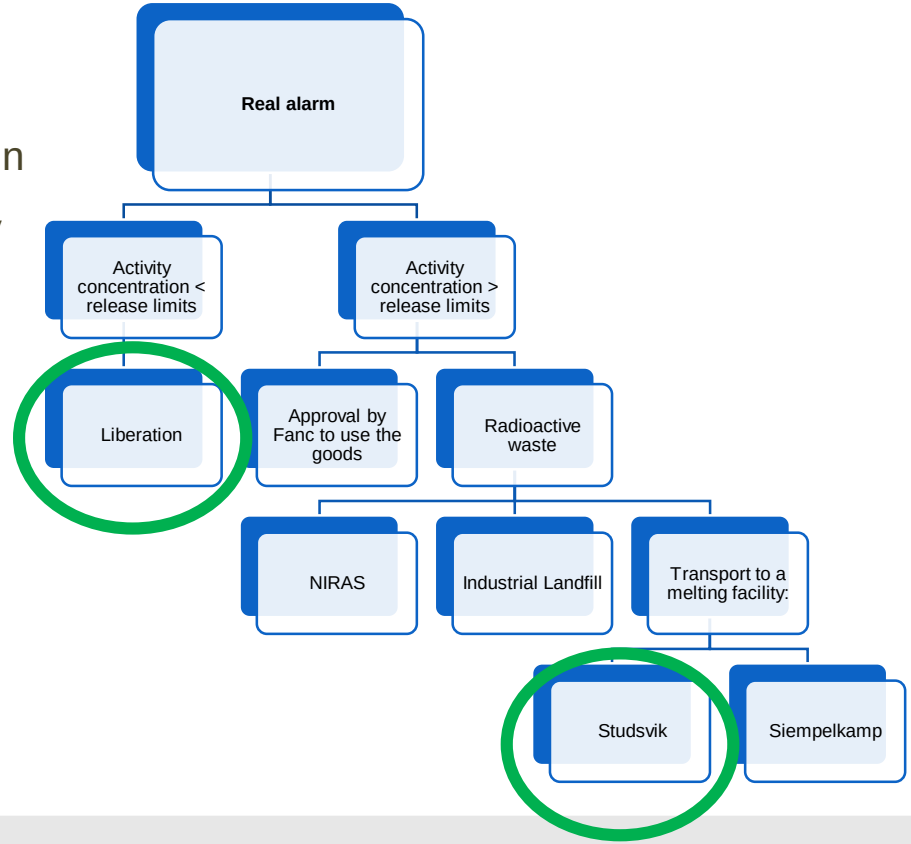
Contaminations

- Is it acceptable or not ?
  - **Activity(concentration) basis for decision**
  - **Lower limits than for NORM (around 0.1-1 Bq/g)**
  - **Food: EU limits after Chernobyl: 137Cs 0.6 Bq/g**
  - **Always require permission from FANC for release**
  - **Often return to country of origin**

- Typically
  - **Either a source melted in an oven, where all material in the oven is contaminated**
  - **Or large quantities of radioactive dust/gas is released during an incident (Chernobyl, nuclear tests, …) where everything in the vicinity is contaminated**

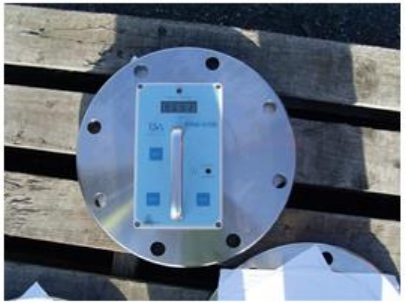
Contaminations

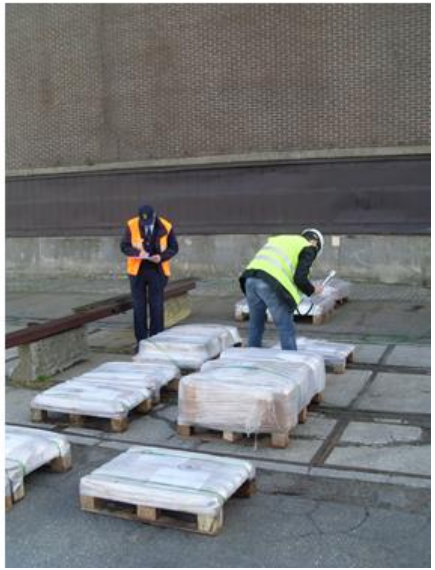
- Gammaspectrometric analysis in our lab or determination activity based on dose rate
- Communication with FANC
- Liberation, melting facility or back to the country of origin



Contaminations

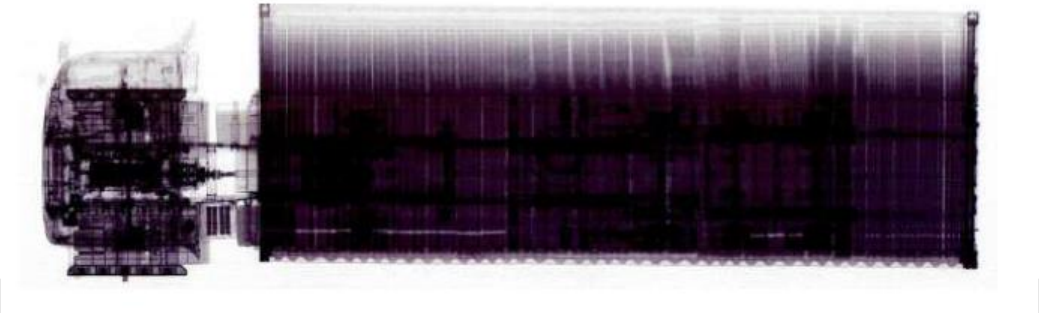
- Steel flanges
  - **10 Bq/g 60Co, 17 µSv/h**
  - **2 pallets of contaminated steel flanges**
  - **Concentration was higher than the legal limit**
  - **Detained and sent back to India**





Contaminations

- Black tea
  - **0.1 Bq/g 137Cs, 0.1 µSv/h**
  - **137Cs contamination of black tea**
  - **It was found that the activity concentration was below the EU directive for 137Cs contamination (0.6Bq/g).**

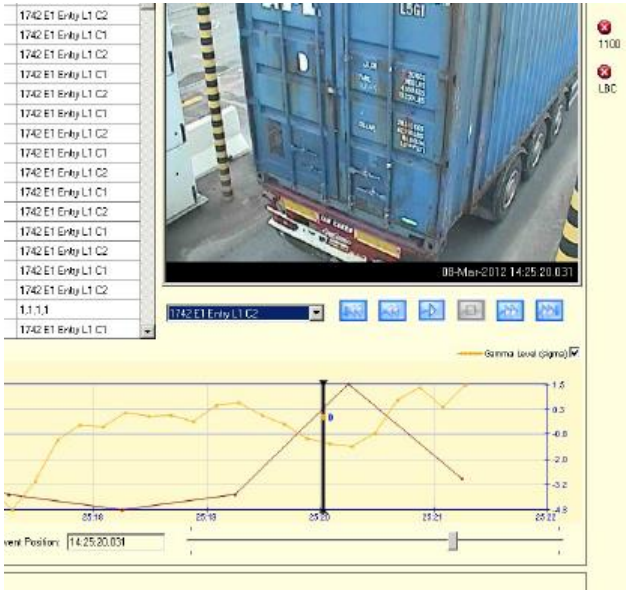


Contaminations

- Blueberry concentrate
  - **0.4 Bq/g 137Cs, 0.1 µSv/h**
  - **Concentration below the legal limit, but with food , one must always be careful**
  - **Released**

Contaminations

- Plants (ferns)
  - **<0.1 Bq/g 137Cs**
  - **Concentration was lower than the legal limit**
  - **Not for consumption but decorative**
  - **Released**

Contaminations

- Fukushima Container(s)
  - **5 Bq/cm2 137Cs**
  - **Contamination on top of the container.**
  - **Mainly on spots with rust**
  - **Probably from the Fukushima accident**
  - **Container was cleaned by specialized firm.**
  - **After cleaning the contamination could no longer be rubbed off and was reduced to around 0.4Bq/cm2.**
  - **Released**