Case Study II: Clearance of the Eurochemic Building

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"To Clear, or not to Clear"
BVS 11-09-2015

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- In the last decade, Belgoprocess applied the clearance practice in view of optimising the volume of radioactive waste for treatment and disposal
- Initially clearance was based on surface contamination monitoring
- On annual basis several hundreds of tons of decontaminated materials are recycled through the use of the clearance principle
- Decommissioning activities on industrial scale with special emphasis on
  - Waste minimisation
  - Intensive decontamination to unconditional release levels
  - Minimisation of D&D costs

BELGO PROCESS

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- This can be achieved in optimising commercially available technology on an industrial scale

- Specific radiological characteristics of BP installations
  - α, β contamination versus β,γ activation (power plants)
  - Protective clothing, breathing/cooling air in area's with high air contamination
  - Hands-on decommissioning, in case of low dose rates

BELGO PROCESS

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- In Belgium, Belgoprocess was a pioneer in decommissioning and the application of the principle of clearance on an industrial scale
- A pilot-project has been achieved from 1988 till 1991
  - Two storage buildings for uranyl nitrate, plutonium oxide and spent solvents were emptied and decontaminated
  - Result was restoring green field
  - About 65% of all metal material could be unconditionally released
- The clearance methodology comprised 2 successive measurements of the complete surfaces

BELGO PROCESS

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- Before demolition, core samples were taken from concrete structures for analyses
- Finally 2.350 Mg of concrete was removed to a public disposal site for inert wastes
- Health Physics department contributed for about 16% to the overall decom. costs due to the extensive monitoring (10.000 m^2 of concrete structures) for clearance purposes

BELGO PROCESS

Pilootproject

BELGO PROCESS

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- In 1989 the decommissioning of the main process building Eurochemic was started
- In view of the results obtained in the pilot project, a lot of emphasis was put in the optimisation of methods and techniques for decontamination of concrete and metal components

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

Item	Building 6A and 6B	Main process building
Contamination: - surface - in depth	- low in α, β , γ - almost none	- low to high in α, β , γ - commonly observed (e.g. due to cleaning with high pressure water jet)
Historical information	Well known	Partially known
Pipe penetrations	Easy to remove	Complex structures for shielding purpose
Dose rate	low	Low to high; presence of hot spots, mSv/h
Total concrete	2.400 Mg	28.000 Mg
Total concrete surface	5.000 m^2	55.000 m^2
Total amount of metals	47 Mg	1.500 Mg

BELGO PROCESS

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- As decommissioning activities are proceeding a strategy has to be defined relating to the final decom. phase, i.e. the demolition of the remaining concrete structures
- A final clearance methodology is set up in view of demolition of the building
- Application of the methodology applied for the storage buildings of the pilot project is too complicated for several reasons

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- The most important are:
  - The type and spread of contamination, cleaning with high pressure water jet technique, which caused in-depth penetration of contamination
  - During dismantling a lot of aerosols are generated due to the use of specific cutting techniques as plasma cutting
  - The total concrete surface is large and will require extensive manpower if all surfaces have to be monitored twice
  - Taking core samples at most contaminated areas would result in a large amount of samples for analyses
  - In the beginning pipe penetrations remained in the concrete structures
    - Afterwards the decision was taken to remove the pipe penetrations

Main lessons

- Emphasis on decontamination of:
  - Metal components
  - Concrete structures

Strategy

- Avoid any spread of contamination to the environment
- Decontamination in view of unconditional release
- Minimal volumes of radwaste
- Maximalization of recycling and opportunities for reuse of valuable components

Main data of Eurochemic

- Relevant data :
  - Length 90 m, width 27 and height 27 m
  - Volume: 56.000 m^3
  - Concrete volume : 12.500 m^3
  - Concrete surface : 55.000 m^2
  - Metal: 1.500 ton
- 7 floors, 40 large cells
- 106 cell structures

BELGO PROCESS

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- Although the application of the methodology used for the two small buildings is not rejected as such , an alternative was studied
- The alternative includes at least one complete measurement of all concrete structures and the removal of all detected residual radioactivity.
- The surface monitoring is followed by a demolition and crushing of the resulting concrete parts.
- During the crushing, metal parts are separated from the concrete and representative concrete samples are taken
- In a further step the concrete samples are milled, homogenised and a smaller fraction is sent to the laboratory for analyses
- If the concrete is released also the reinforcement bars contained in the concrete are released

BELGO PROCESS

FUNDAMENTAL PRINCIPLES OF THE BELGOPROCESS STRATEGY

- In the beginning the clearance methodology did not refer to specific clearance levels
- As far as release levels were concerned large variations may be observed among different studies about clearance practices
- Unconditional release levels are indicated in official IAEA, EC or OECD publications
- Before 2001 there was an absence of any Belgian legislation concerning clearance, practical application was based on a case-by case approach
- This implies that for each new type of material subjected to release, first the competent autorities and/or the TSO had to be consulted

Legal framework
International / EU recommendations and guidelines

IAEA guidelines and recommendations

- Safety Series No.89 (Principles for the exemption of radiation sources from regulatory control)
- IAEA TEC DOC 855 recommends a set of unconditional clearance levels(in solid material)

Council directive 96/29 EURATOM

- Had to be implemented in national legislation by mai 2000
- RP No.89: Guidance on recycling or reuse of metals
- RP No.113: Guidance for the clearance of buildings and building rubble
- RP No.122: Practical use of the concepts of clearance and exemption

CLEARANCE
Legal framework Belgium

- ARBIS: Algemeen reglement op de bescherming van de bevolking, de werknemers en het leefmilieu tegen het gevaar van de ioniserende straling (Royal Decree 20/07/2001)

BELGO PROCESS

Unconditional release of materials at Belgoprocess

Release procedures at present:

- KB-0258:” Vrijgave van materialen:algemeen”
- KB-0914:” Vrijgave van materialen d.m.v. oppervlaktebesmettingsmetingen”
- KB-0915:” Vrijgave van materialen d.m.v. de betonbemonsteringsinstallatie”
- KB-0907:” Vrijgave van (grote) oppervlakken d.m.v. muurmonitor LB 166”
- KB-1102: “ Vrijgave van elektrische kabels d.m.v. oppervlaktebesmettingsmeting met de kabelmonitor”
- KB-1176: “ Vrijgave van wapeningsstaal van het cellengedeelte van gebouw 101A”
- VGM/2005-03860: “ Vrijgave niet risico ruimten in gebouw 101A”
- KB-1155: “ Vrijgave van materialen met lage densiteit via AQ2”
- KB-1170: “ Vrijgave van betonpuin door middel van een bandmonitor: concretespec “

  These release methodologies are approved by the competent authority

BELGO PROCESS

Unconditional release of materials at Belgoprocess

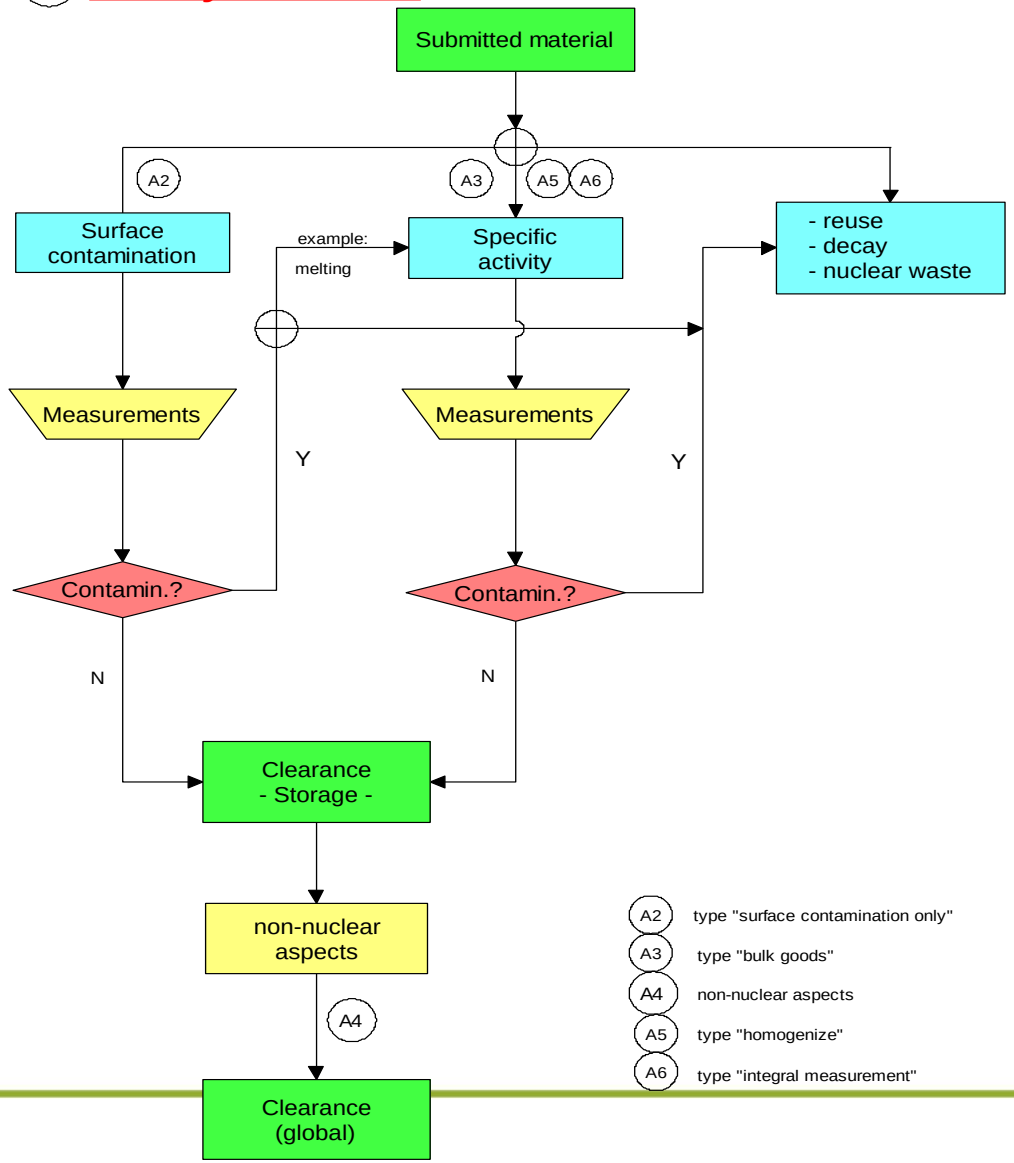
- The clearance methodology as indicated has been discussed and approved of by a working group in which the most important nuclear operators as well as AVN (now Bel V) were represented.
- The aim is to have a common and transparent methodology which is submitted to the regulatory authority. (Fanc)

Unconditional release of materials at Belgoprocess

- Currently 5 clearance types are considered, one of which covers the non nuclear aspects
- Relating to the nuclear aspects, 4 clearance types may be considered:
  - Surface contamination measurements
  - Bulk type material
  - Measurement of mat. in drums
  - Material that may be homogenised
- In practice, however, the unconditional release of materials mostly involves a combination of surface cont. measurement and mass specific activity measurements.

BELGO PROCESS

A1 Survey clearance



BELGO PROCESS

Unconditional release of materials in Belgium

- The work of the working group on the clearance of materials resulted in a FANC guideline:
- *30/04/10 Richtlijnen meetprocedures en meettechnieken vrijgaveniveaus*
  Besluit van 30 april 2010 van het Federaal Agentschap voor Nucleaire Controle houdende vaststelling van de richtlijnen voor de meetprocedures en meettechnieken om de overeenkomst na te gaan met de vrijgaveniveaus vastgelegd in bijlage IB van het koninklijk besluit van 20 juli 2001 houdende algemeen reglement op de bescherming van de bevolking, de werknemers en het leefmilieu tegen de gevaren van de ioniserende stralingen of bepaald in de vergunningen verleend met toepassing van artikel 18 van hetzelfde koninklijk besluit

BELGO PROCESS

Clearance procedures Belgoprocess

- KB-0258 general guidelines
  - Certificate of origin:
    - Origin
    - Historical data
    - Contaminationlevels
    - Type of decontamination technique used
      - Waiting period
    - Paint
    - Internal parts
  - Measurements
    - Surface contamination
    - Masscontamination
    - Non-nuclear aspects

BELGO PROCESS

Clearance procedures Belgoprocess

- Evaluation
  - Evaluation by head of Health Physics department
  - Consult TSO (Bel V)
    - Facultative
  - Consult the authority (Fanc)
    - Facultative
  - Release YES/NO
- Destination
  - Nuclear waste
  - Nuclear reuse
  - Unconditional Release

BELGO PROCESS

Clearance procedures
Surface contamination

- KB-0914 surface-contamination monitoring
  - Flat clean surfaces
  - Surface measured 2 times with 2 distinct handheld monitors and by 2 distinct RP officers
  - Release measurement procedure is based on:
    - ISO 11932: “Activity measurement of solid materials considered for recycling, re-use, or disposal as non-radioactive waste”
    - ISO 7503: “ Evaluation of surface contamination”
  - Measurements are performed by radiation protection officers
  - Specially assigned measuring instruments
  - After decon. delay time of 3 months between 2 measurements

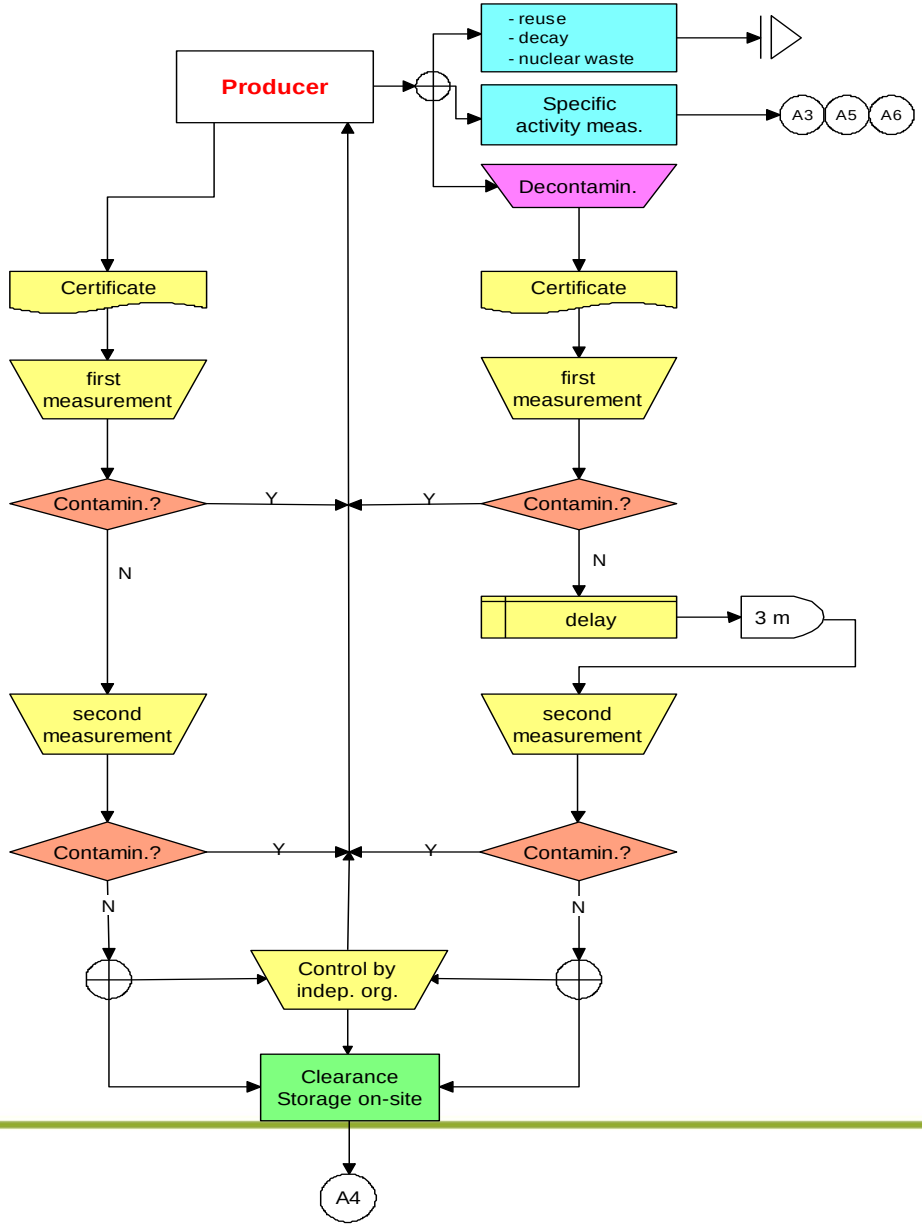
BELGO PROCESS

Clearance procedure surface contamination

- Criteria
  - 0,04 Bq/cm² α
  - 0,4 Bq/cm² β
- Conditions
  - Low background
    β < 4 cps (50 cm²)
    α < 0,1 cps
  - Surface
    not poreous, dry, grease-free
    measuring distance < 5 mm; v = 1m/min
  - Verification measuring equipment
    - On a daily base
    - Calibration

BELGO PROCESS

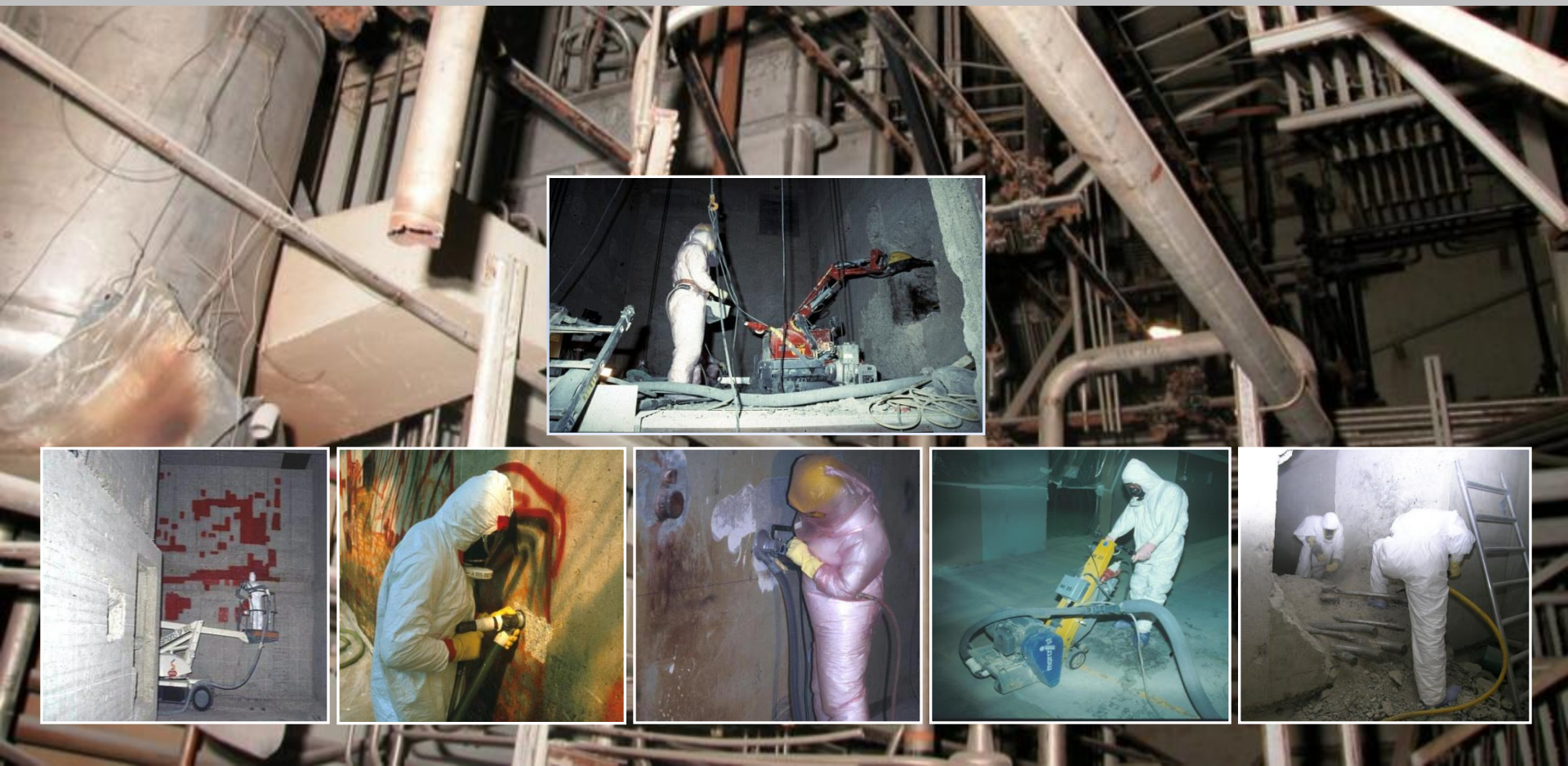
A2 Type "surface contamination measurement only"



BELGO PROCESS

Intensive decontamination

New technologies, ergonomic tools



Intensive decontamination

METAALSTRAALINSTALLATIE *ABRASIVE BLASTING INSTALLATION*

1

LAADEENHEID VAN DE STRAALINSTALLATIE
CHARGING DEVICE OF THE BLASTING INSTALLATION

3

GESLOTEN STRAALTROMMEL
CLOSED BLASTING CHAMBER

5

ONTLADEN VAN DE STRAALTROMMEL
DISCHARGE OF THE BLASTING CHAMBER

2

GEOPENDE STRAALTROMMEL MET TE STRALEN METAAL
OPENED BLASTING CHAMBER WITH METALS TO BE DECONTAMINATEED

4

BEDIENING VAN DE STRAALINSTALLATIE
OPERATION OF THE BLASTING INSTALLATION

GLOBAAL BEELD VAN DE STRAALINSTALLATIE
OVERVIEW OF THE BLASTING INSTALLATION

6

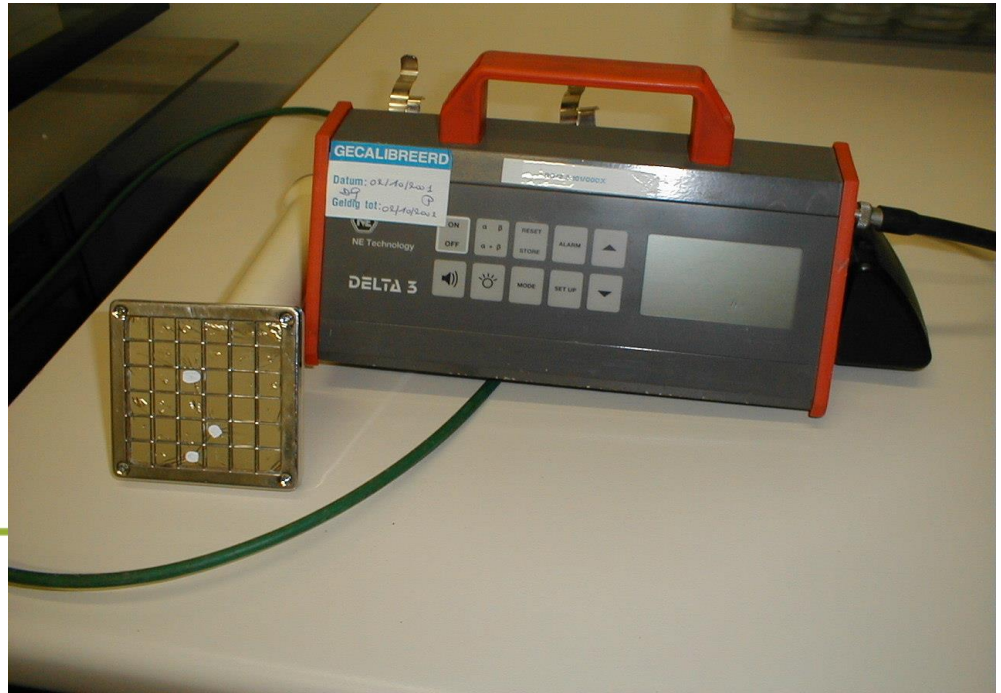
GESTRAALD METAAL
BLASTED METAL

BELGO PROCESS

Clearance procedures
Surface contamination

- Portable contamination monitor
- Type ELECTRA with dual probe DP/2R – DP 6

  - α → ZnS (Ag) on perspex
  - β → plastic scintillator Anthraceen on perspex



BELGO PROCESS

Clearance procedures
Surface contamination

BELGO PROCESS

Clearance procedures
Surface contamination

BELGO PROCESS

Removal of cables from the corridors

BELGO PROCESS

Clearance procedures
Surface contamination

BELGO PROCESS

Clearance procedures
Surface contamination

2 000 cm² surface contamination monitor

BELGO PROCESS

Clearance procedures
Surface contamination

BELGO PROCESS

Clearance procedures
Surface contamination

BELGO PROCESS

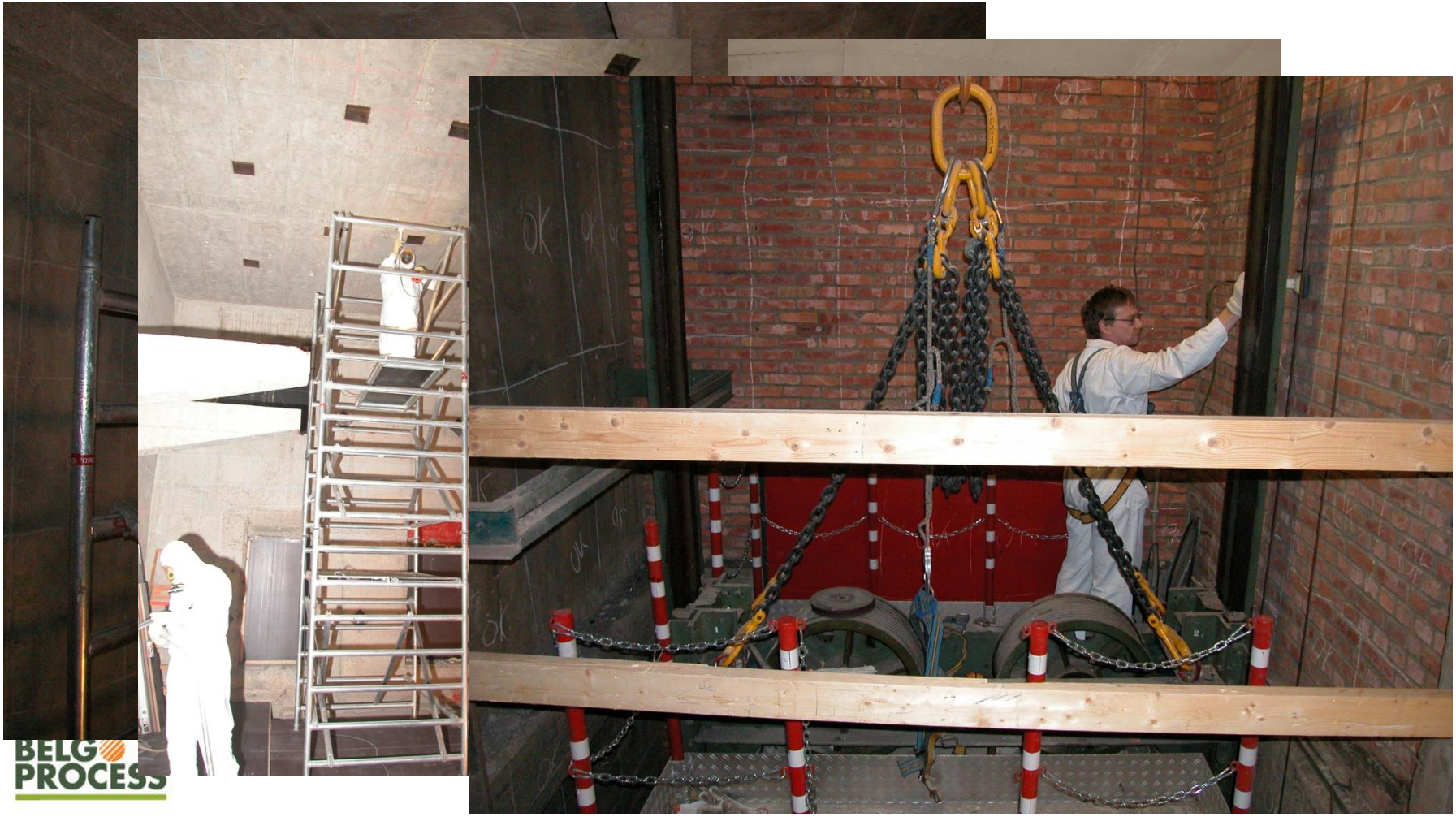
Clearance procedures
Surface contamination

BELGO PROCESS

Clearance procedures
Surface contamination

BELGO PROCESS

Surface measurement



Released cells

Free release of metal componants Deco shop

- Location for (pre)treatment of objects
  - Variety of tools available
    - (Plasma) cutting, …
  - High flexibility for non-standard objects

BELGO PROCESS

Abrasive blasting

- Decontamination of metal components (and concrete blocks)

BELGO PROCESS

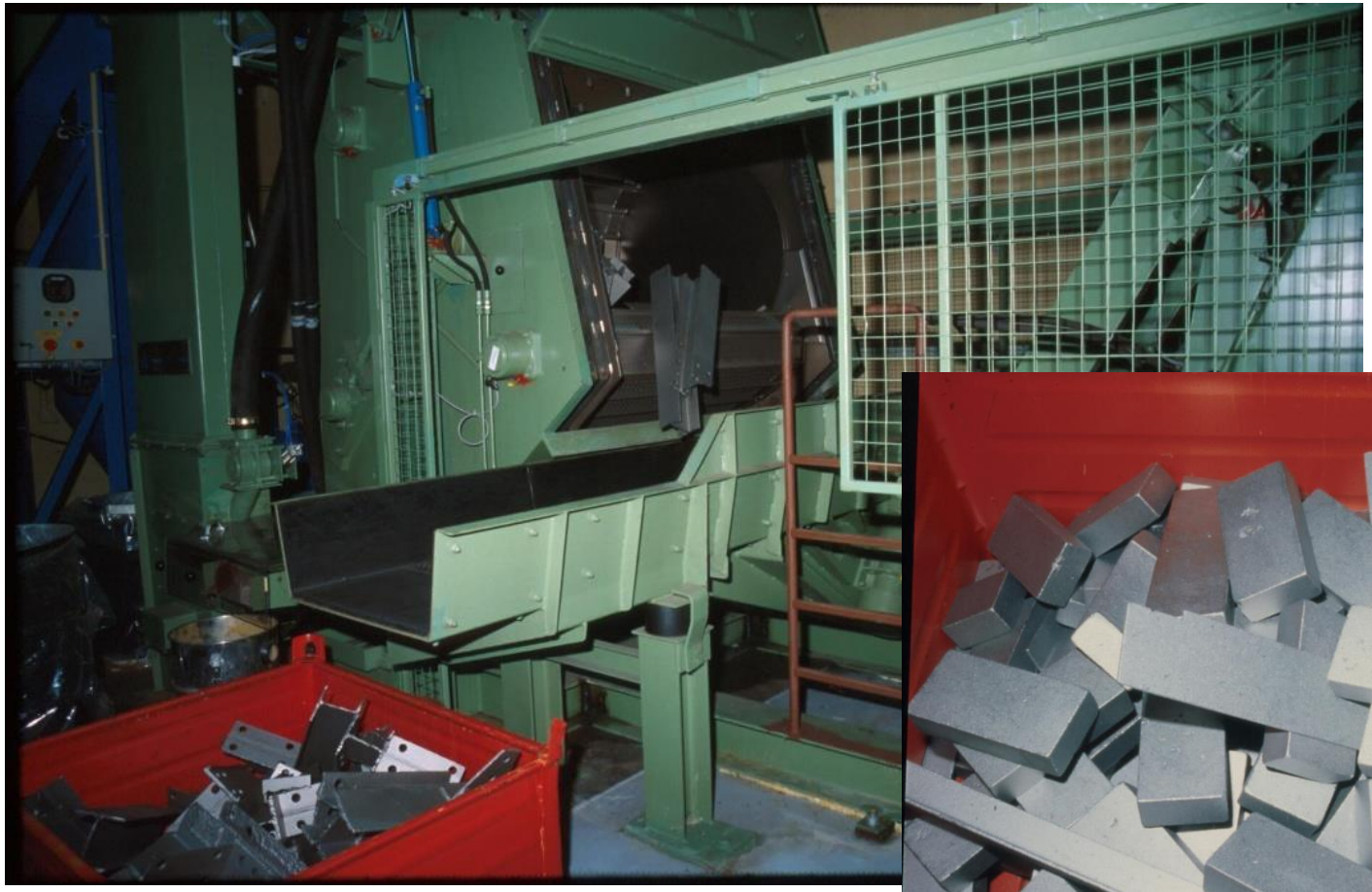
Abrasive blasting

BELGO PROCESS

Abrasive blasting

BELGO PROCESS

Abrasive blasting



BELGO PROCESS

Nuclear smelting furnace (abroad S, GE, US)

- Output of abrasive blasting
  - Nuclear contaminated part is separated in the slags

BELGO PROCESS

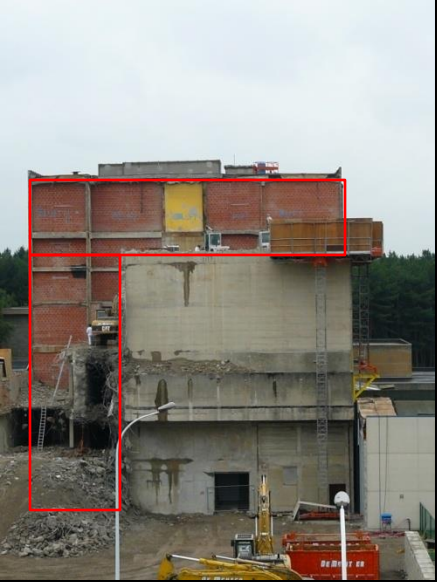
Free release of concrete

- 3 types of concrete
  1. Corridors, 5th and 6th floor
  2. Thick walled cells
  3. Piping penetrations
- Different release strategies for free release
  - Surface measurement
  - Sampling

BELGO PROCESS

Samples of the corridors

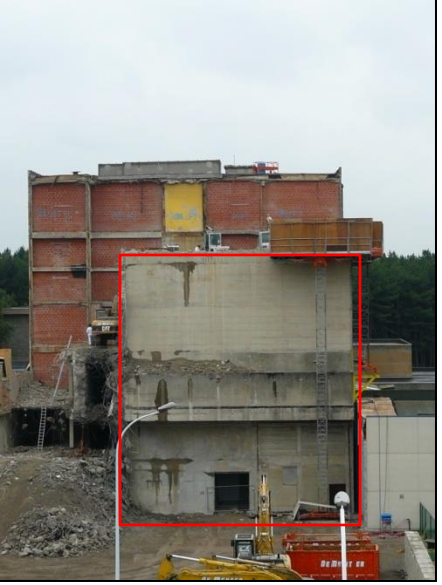
BELGO PROCESS



Concrete from corridors, fifth and sixth floor:

"Removed" from site 1 after in situ sampling of surface

BELGO PROCESS



Concrete from thick walled cells

"Release" from site 2 after representative samples from 12 T batches

BELGO PROCESS

Concrete debris from removal of pipe penetrations:

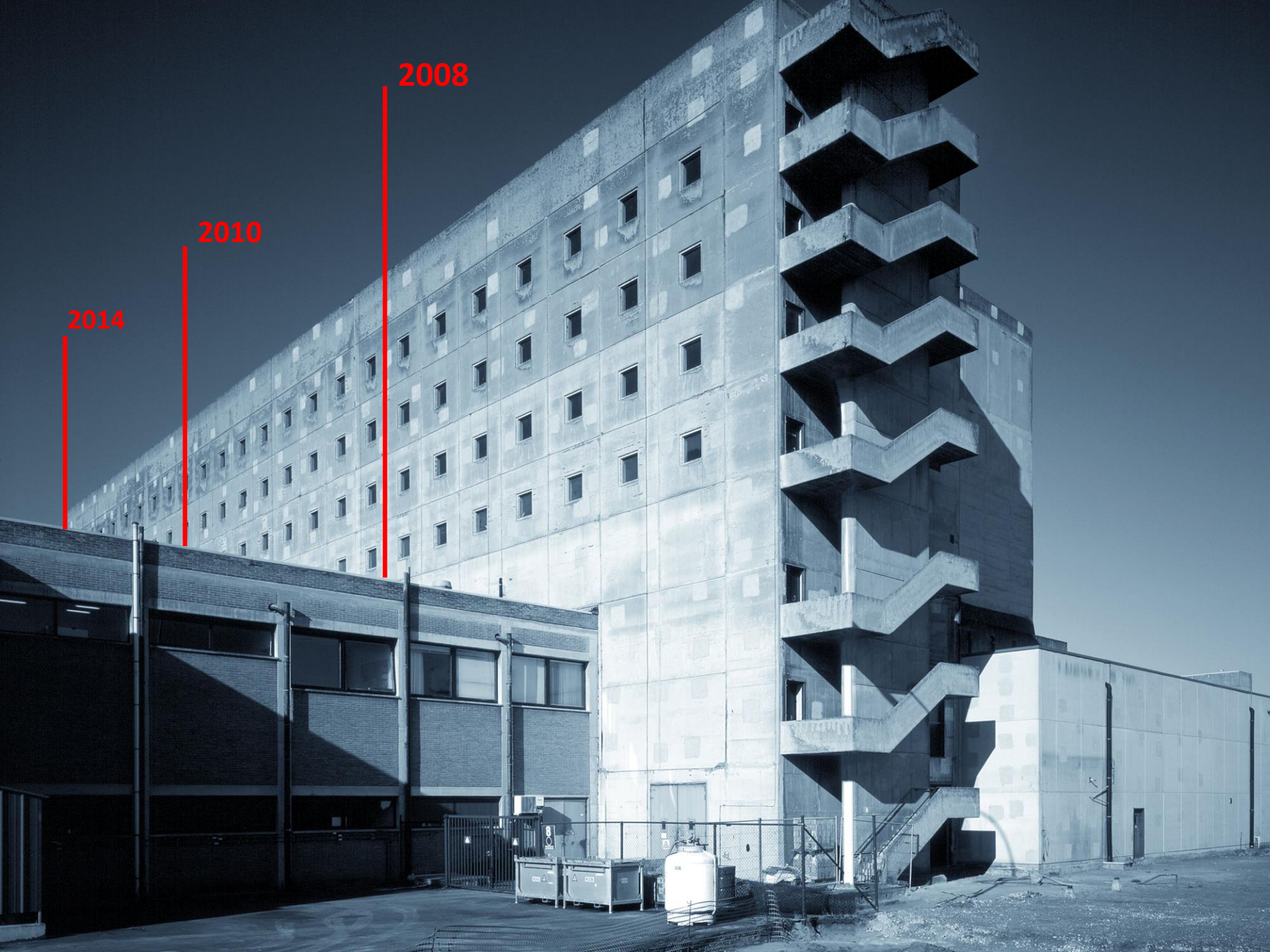
BELGO PROCESS

Removal of pipe penetrations

BELGO PROCESS

Removal of pipe penetrations : after

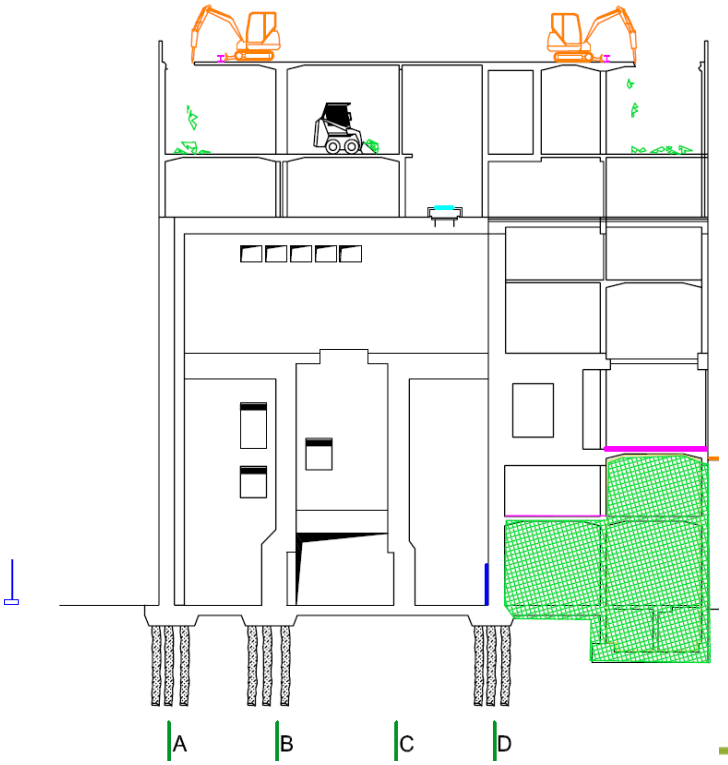
BELGO PROCESS


2008
2010
2014

Demolition

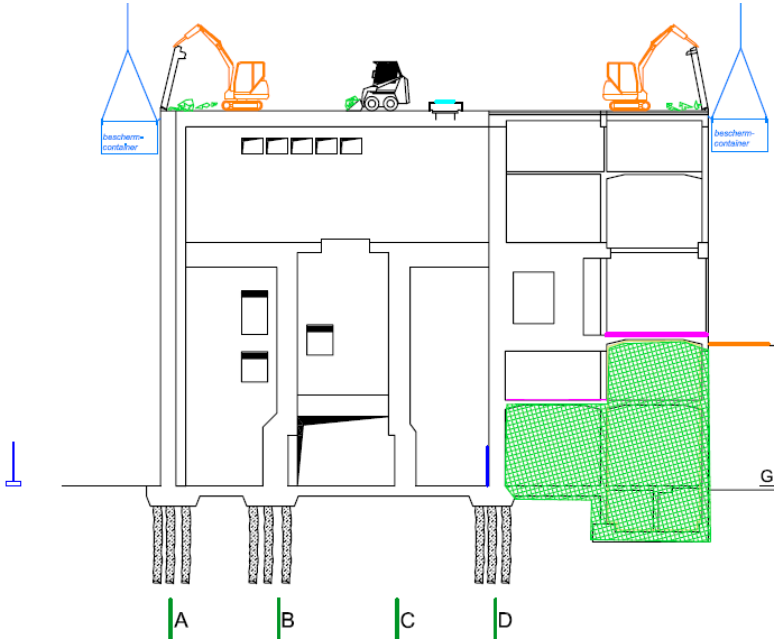
WEST : 2014

Demolition

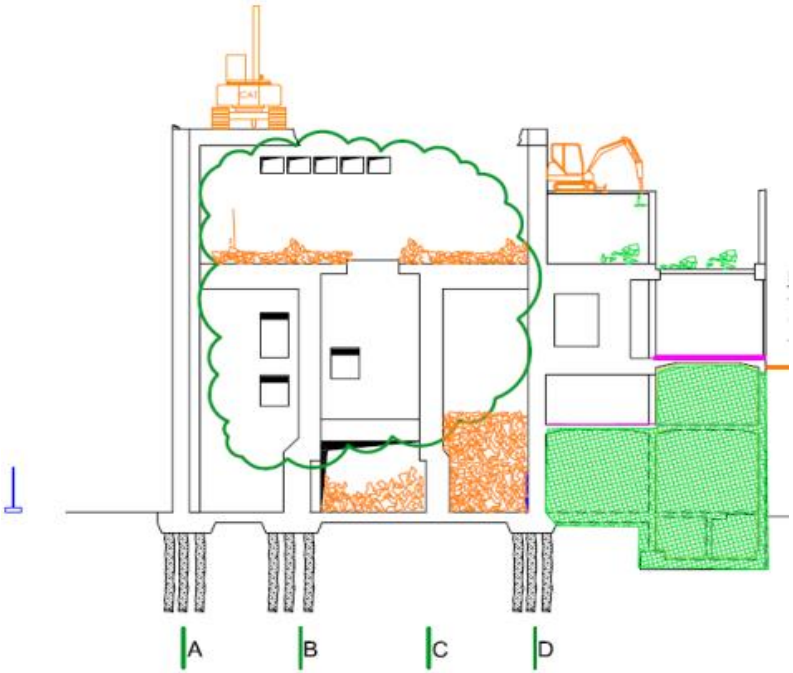


Demolition

De Meuter
De Meuter


bascherm-
container
bescherm-
container
G
A
B
C
D

Demolition



DE MEUTER
CAT
DE MEUTER
DE MEUTER
PC 800 LC

Clearance procedures
Concrete crushing and sampling

- KB-0915

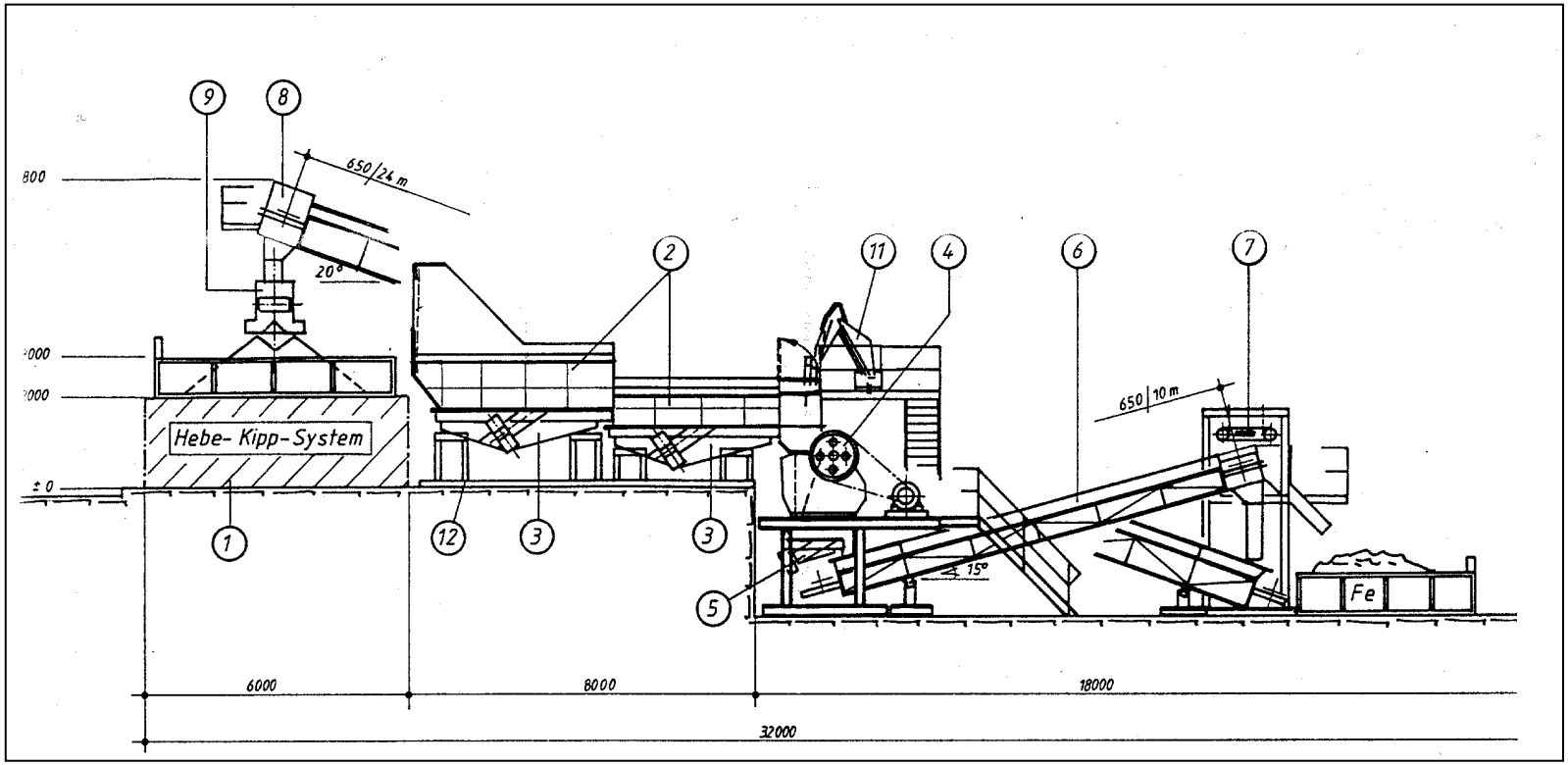
  When application of 2 surface measurements on concrete structures and the analyses of core samples is complicated and unfeasable (cracks, …) we use concrete crushing
  - All surfaces are monitored by hand held instruments
  - Concrete structures are crushed
  - Taking representative samples
  - Milling and homogenising these samples
  - Analysing a smaller fraction in laboratory environment

Activity specific measurement

- Combination of surface contamination and mass measurement
- Concrete sampling installation
  - Representative sample in accordance with standard
  - Gamma spectroscopy measurement
    sample of 2,5 l (> 6h)
  - $\alpha + \beta$ total measurement
    double tape technique
  - Release criteria, annex 1B of ARBIS
- Melting of metals (steel, …) at Studsvik
  - Release in Sweden

BELGO PROCESS

BBI: Concrete crushing and sampling installation



~Length 48 m, width 10 m, height 9 m

~Current nominal capacity set at **240 Mg per week**

BELG PROCESS

BBI: Concrete crushing and sampling installation

BELGO PROCESS

Representative sampling unit

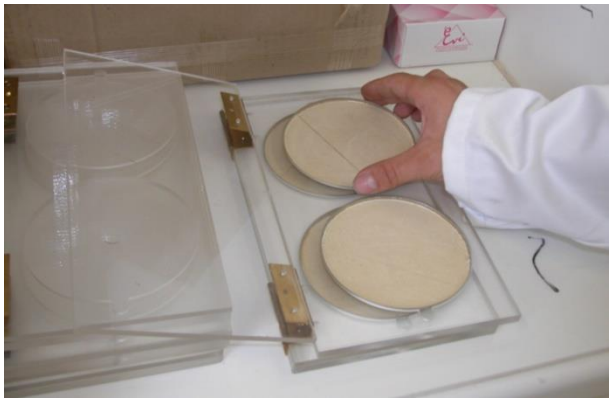
- The sampling frequency meets the prevailing standards (based on the mineral processing industry)
- Sampling principle:
  - 2% per processed batch of 12 Mg is taken as representative sample (sum of partial samples)
  - This quantity (240 kg) is milled, homogenised by a crusher and miller to bring the granulate dimensions to the requested level for measurement
  - A representative part (4.5 litres) is sent to the laboratory for analysis

Containers waiting for release

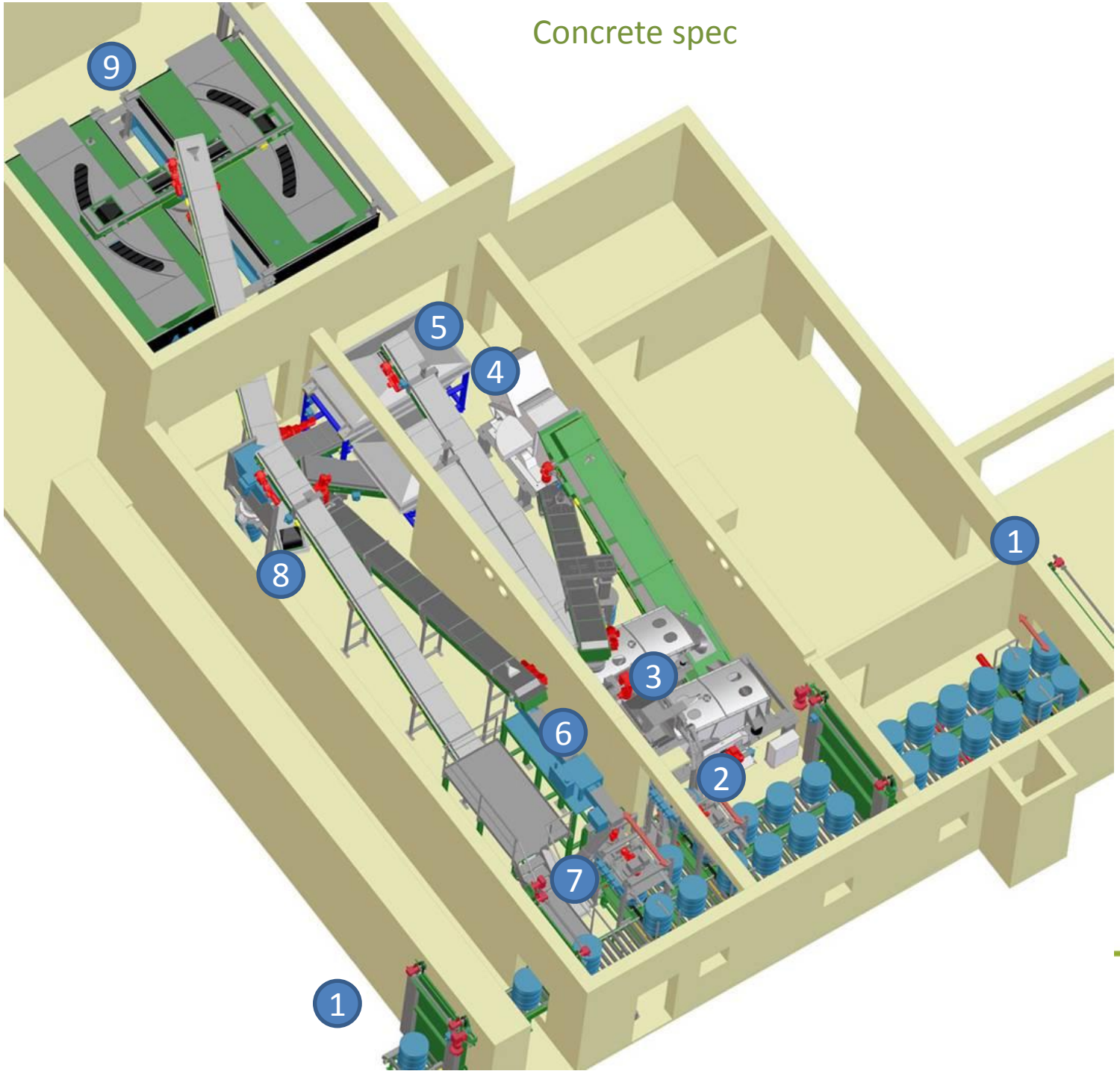
BELGO PROCESS

Lab analysis

- Total α- and β-activity
  - Adhesive tape with 100mg dust
  - 6 samples
- Gamma-spectrometry
  - Marinelli beaker (min 2,5 kg)



Concrete spec



1 • Aanvoer vaten

2 • Vatenkantelaar

3 • Zeef

4 • Breker

5 • Bunker

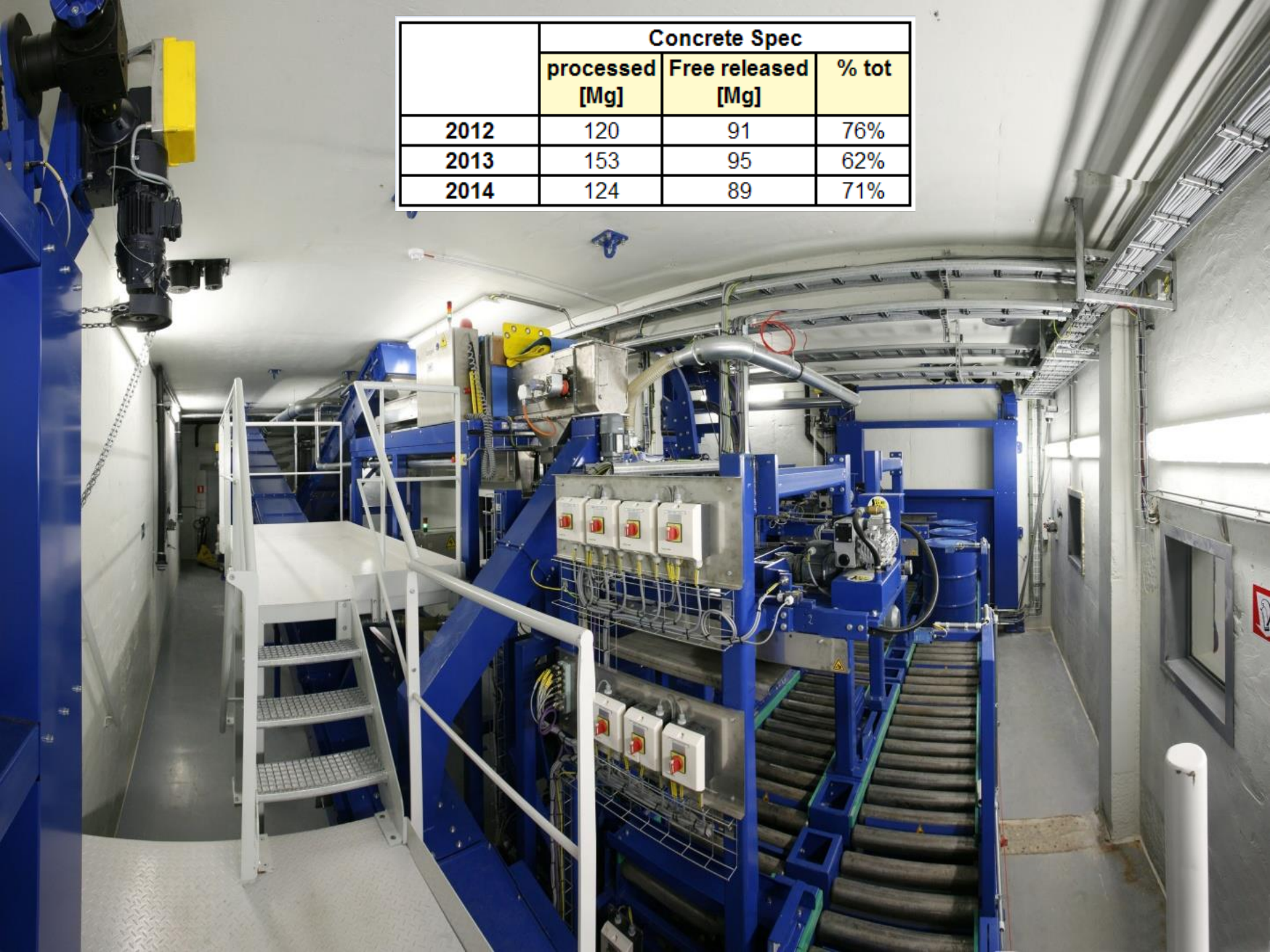
6 • Meettoestel

7 • Sorteerklep

8 • Monstername

9 • Granulaatcontainers

	Concrete Spec		
	processed [Mg]	Free released [Mg]	% tot
2012	120	91	76%
2013	153	95	62%
2014	124	89	71%



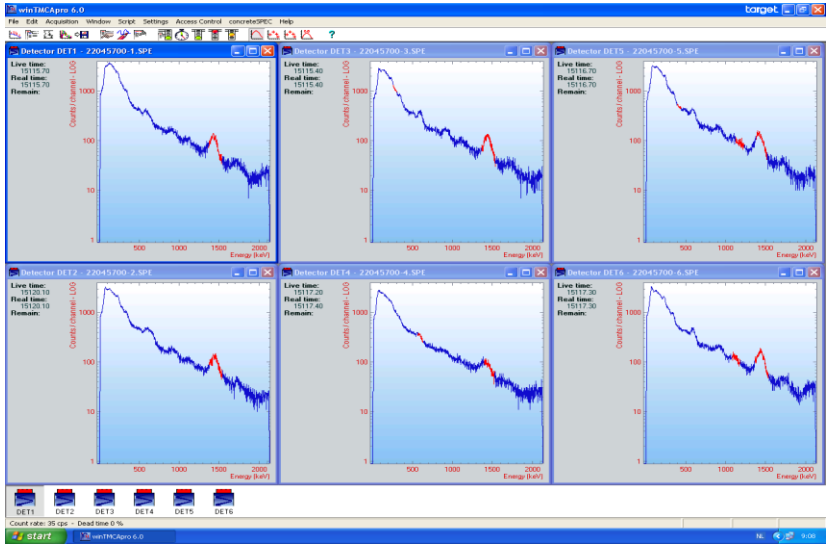
Measurement principle

- Continuous mode
  - ‘Reference’ in cps (BG)
  - Natural activity, mainly of K-40
  - K-40 levels in concrete
  - Alarm

BELGO PROCESS

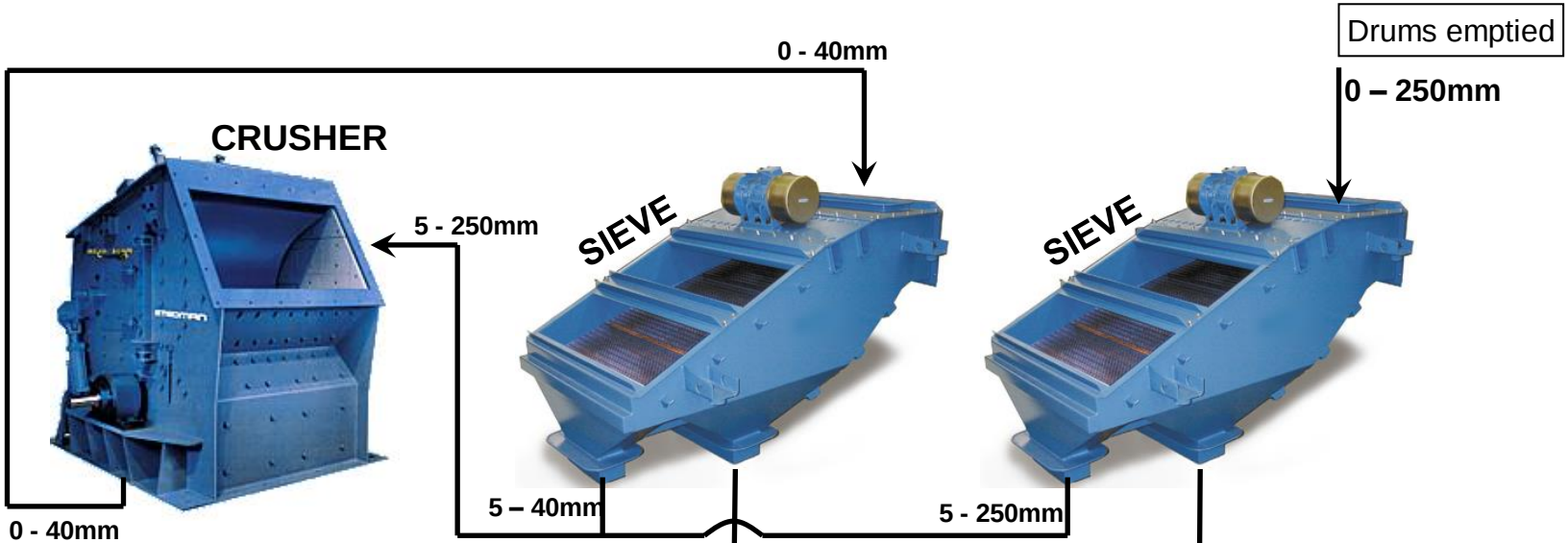
Measurement principle

- Step by step mode
  - Gamma spectrum for isotopes
    - Cs-137, Co-60 and Am-241
  - Detection limits in Bq/kg at 90 sec. counting time
    - Cs-137 : 22 Bq/kg
    - Co-60 : 17 Bq/kg
    - Am-241 : 35 Bq/kg
  - Contam. if > alarm level
    - Cs-137 : 200 Bq/kg
    - Co-60 : 35 Bq/kg
    - Am-241 : 35 Bq/kg



BELGO PROCESS

Installation: pre-treatment debris 250mm ➔ 5mm



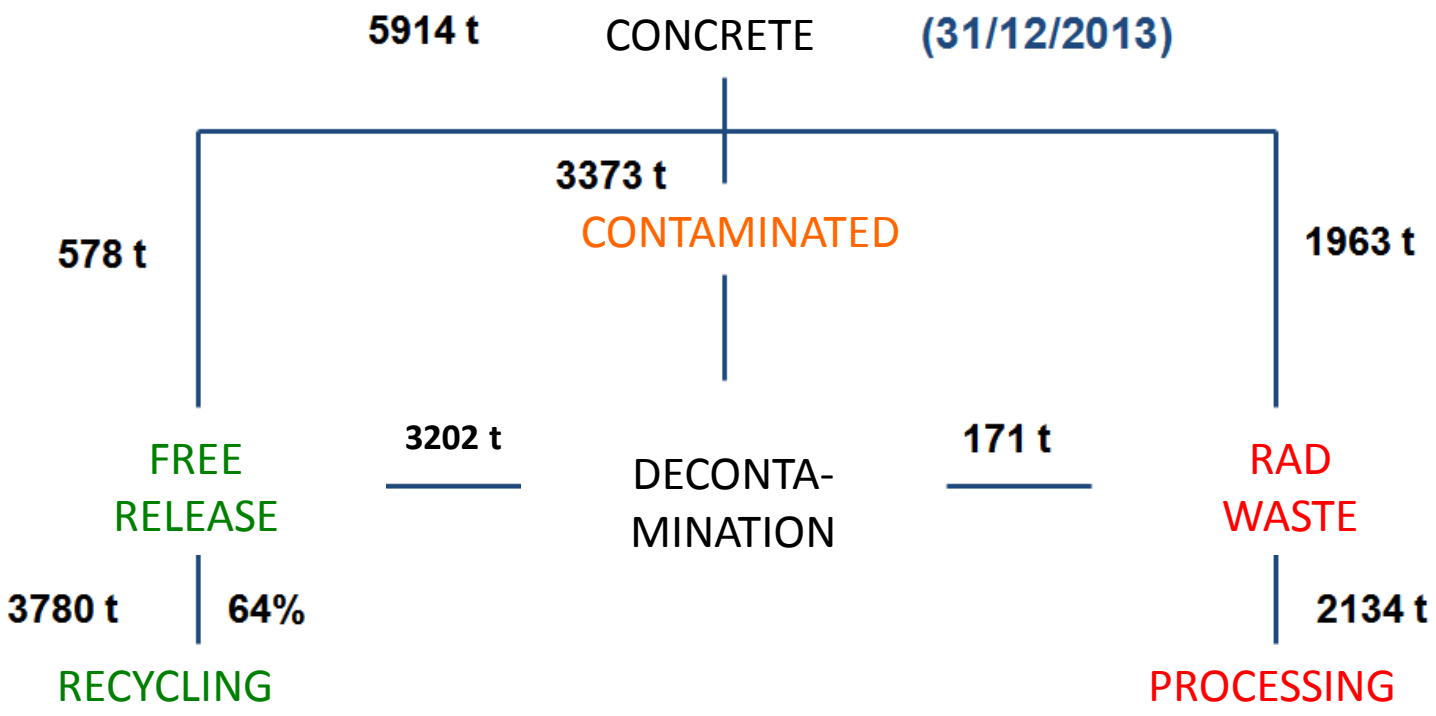
Results

- Production quantities
- Planning (man.years)
- Budget & costs

BELGO PROCESS

Production volumes for concrete

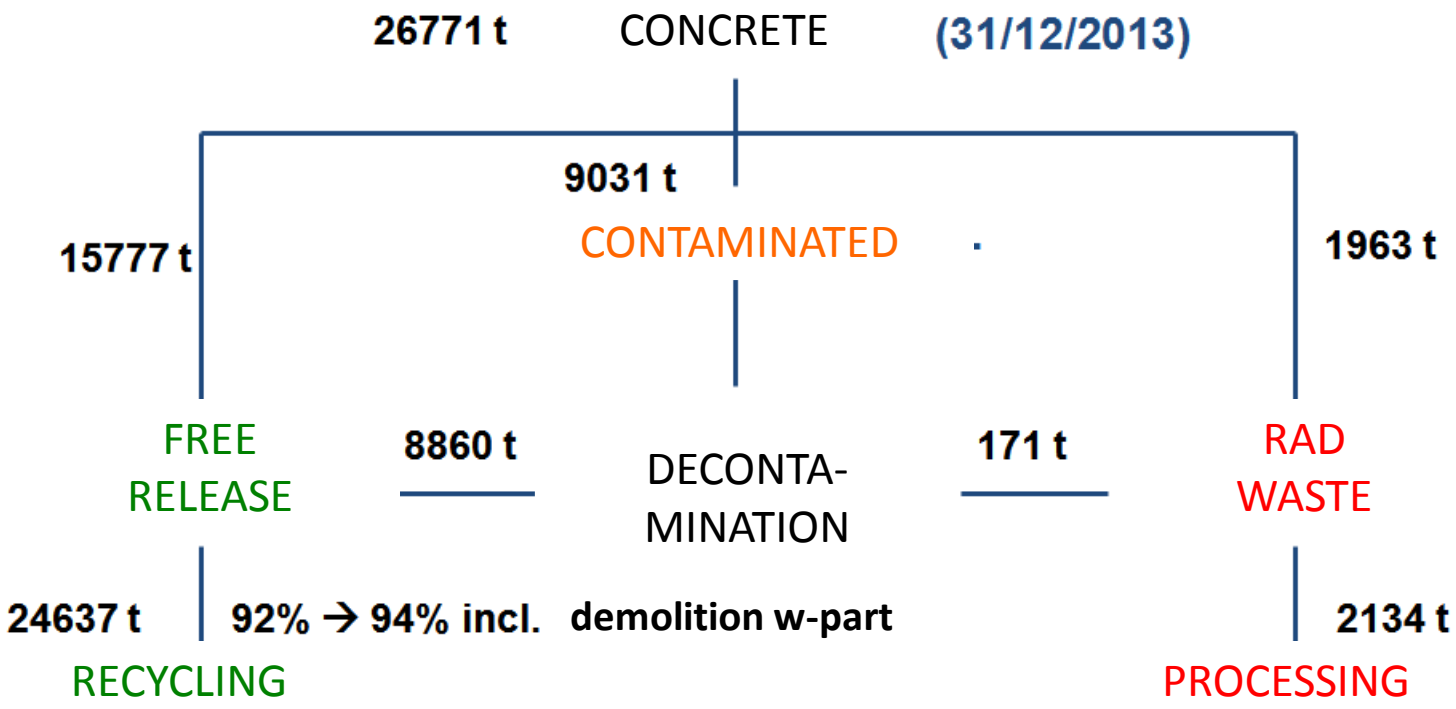
- *Demolition excluded*



BELG PROCESS

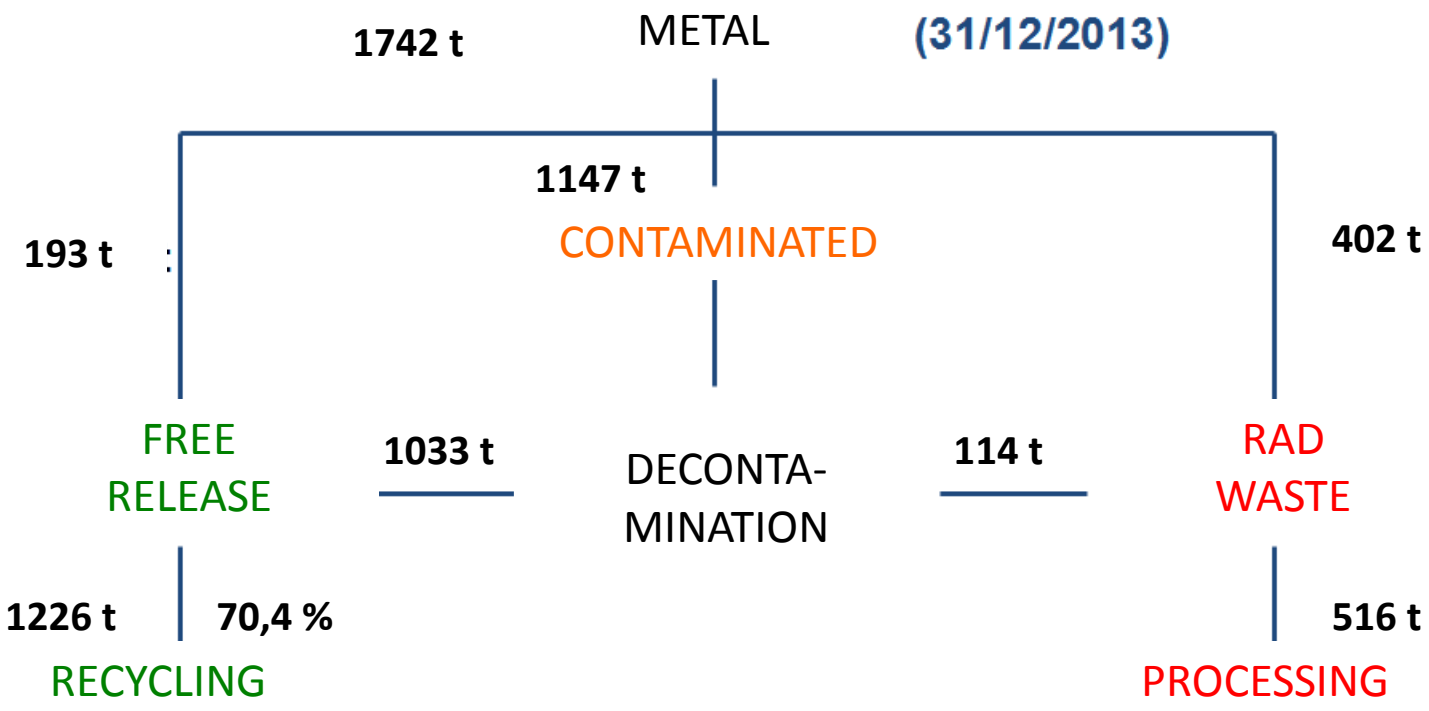
Production quantities for concrete

- *Demolition included*



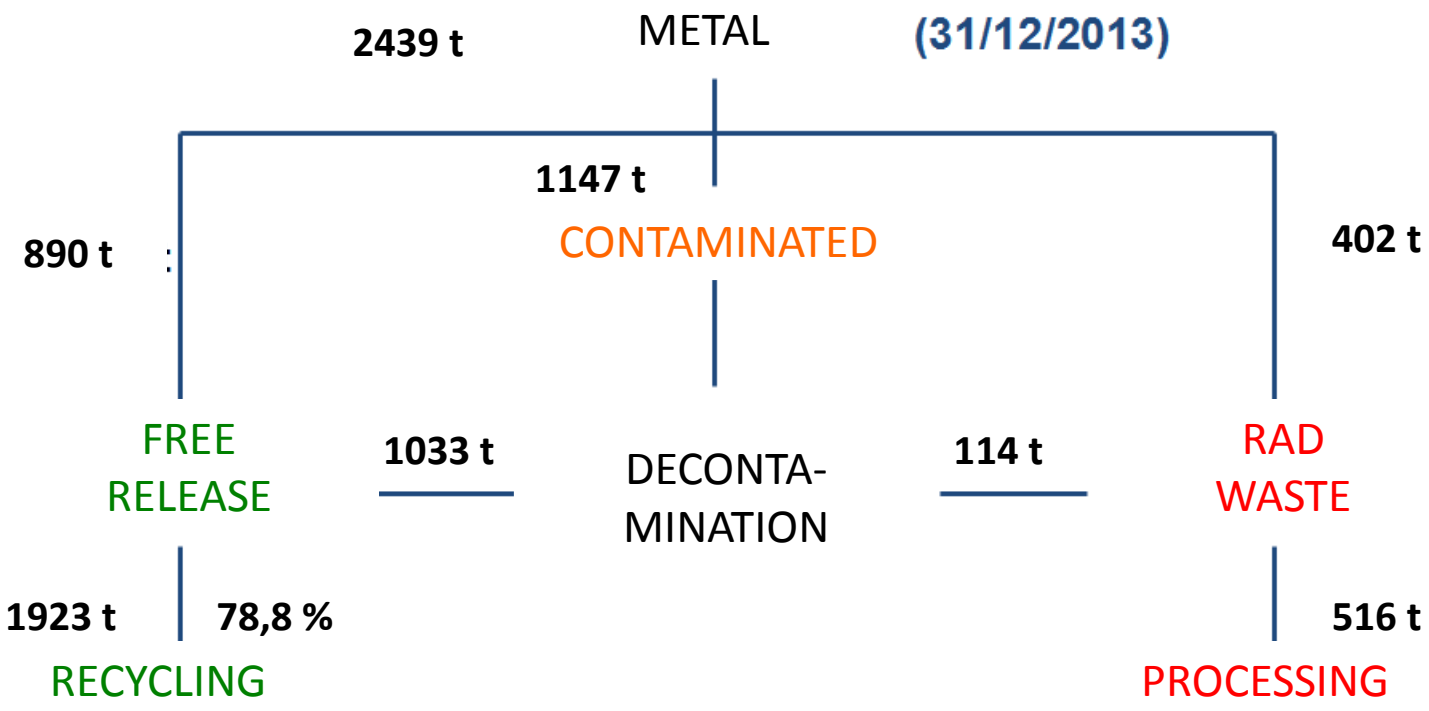
Production quantities for metal

- *Demolition excluded*



Production quantities for metal

- *Demolition included*



Results: man.year

- Initial estimation: **400 man.year**
- Final result: **570 man.year**

- Why? :
  - Inventory differences
  - Decontamination in view of free release
  - Labour intensive release measurements and stringent release procedures

BELGO PROCESS

Results: budget, costs

decon in view of release

	Initial estimation M€1992	Initial estimation M€2013	1990 – 2014 M€2013	Ratio
Decom. Costs	54,80	82,56	166,18	**2,01**
Radwaste Costs (2008)	68,70	103,45	44,12	**0,43**
Total	**123,50**	**186,01**	**210,30**	**1,13**

Smaller radwaste volumes

End result

BELGO PROCESS

Conclusions

- *Belgoprocess has mastered the complex work of the decommissioning of a reprocessing plant*
- *During 25 years a lot of knowledge and experience has been acquired in the areas of D&D technology, planning, budget and human dynamics. This will help Belgoprocess in future projects.*

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