

**Alpha-Contaminated Solid Waste Sorting and Conditioning at
BELGOPROCESS (Belgium): Commissioning and Lessons Learned
from the First Working Period**

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ABSTRACT

The alpha-contaminated solid waste generated in Belgium results from past activities in the fuel cycle (R & D + Reprocessing and MOX fabrication pilot plants) and mainly of present operation of BELGONUCLEAIRE's MOX fuel fabrication plant in Dessel and waste coming from the dismantling of the old EUROCHEMIC plant.

After the main steps in the management of alpha-contaminated solid waste were established, ONDRAF/NIRAS¹ (National Agency for Radioactive Waste and Enriched Fissile Materials), with the support of BELGOPROCESS² (subsidiary of ONDRAF/NIRAS in charge of the treatment and conditioning of non conditioned waste in Belgium and of the management of storage facilities) and the engineering office of BELGONUCLEAIRE, started the design, construction and realization of the treatment and conditioning ('T/C') and interim-storage facilities for this alpha waste.

The accumulated solid alpha radwaste containing a mixture of burnable and non-burnable material will be sorted and characterized. After sorting, both the accumulated and recently generated alpha waste will be compacted in the PAMELA facility and the pellets will be embedded in a cement matrix.

The commissioning of the sorting unit which includes glove boxes and the interim storage building for conditioned packages has been completed at BELGOPROCESS, in the beginning of year 2005; the commissioning of the conditioning unit (PAMELA facility) is foreseen mid 2006.

The paper describes the project environment and gives a short description of the new installation; the lessons learned from the project itself and of the first working months of the sorting unit, under hot conditions, are presented, as well.

¹ In short: O/N

² In short : BP

INTRODUCTION

Origin of the Waste

The alpha-contaminated waste generated in Belgium results from

- past activities in the fuel cycle (R & D + Reprocessing and MOX fabrication pilot plants), and
- present operation of BELGONUCLEAIRE's MOX fuel fabrication plant.

EUROCHEMIC, a pilot reprocessing plant, was operated till 1974 and generated alpha solid waste. The decommissioning program of this plant, which started after its closure, also generated alpha-solid waste.

Research and Development in the fuel cycle and the operation of a MOX fabrication pilot plant erected on the site of the Belgian Research Center (SCK•CEN) have also contributed to the production of alpha-solid waste. Presently the main producer of alpha waste is BELGONUCLEAIRE's MOX plant in operation since 1972 and back fitted in 1985 to increase the capacity to 35 tHM/year.

Form of the Waste / Evolution of the Packaging

The Pu Contaminated Solid Waste (PCSW) produced by BELGONUCLEAIRE is normally generated inside the glove boxes in which it is sorted by category and put into small packets (a few liters) packaged in welded double PVC bags.

In the past, the initial small packets obtained were packaged in 30-l cans and 220-l drums. The solid suspect alpha waste was placed in the free spaces in those containers. From 1986, the small PVC packets were packaged in a 200-l drum without adding any further suspected solid waste. The produced wastes were stored on the BELGOPROCESS site in Dessel, waiting for the final treatment and conditioning processes.

Between the beginning of solid alpha waste production (in the 70's) and the end of 1985, the way to package and to sort by type (burnable or non burnable) at the producer's site has evolved. The specifications, imposed by ONDRAF/NIRAS, have been fixed. As a result, a significant amount of waste ($\approx 231 \text{ m}^3$) generated before the end of 1985 and still stored on the BELGOPROCESS site must be re-sorted in order to meet the present specifications:

- the solid suspect alpha waste placed in the free space of the 30-l cans will be removed after inspection of the small welded packets (contaminated alpha waste), and
- the small packets in the 30-l cans and the 220-l drums will be sorted into non burnable and burnable waste.

T/C Processes/ Evolution of the Options

Up to the 90's, the produced wastes were stored on the BELGOPROCESS site, waiting for a decision about the final T/C options. At the begin of the 90's, O/N started with the inventory and management of the waste and with the development of a programme for T/C, interim storage of the conditioned waste and their perspectives for final disposal. For the T/C, the retained solutions to be implemented included

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- immobilization for the non burnable waste, and
- incineration (pyrolysis) for the burnable ones.

On this basis, it was necessary to re-sort the stored non-conditioned waste and, as a result, to build a new sorting installation, called 'A3X sorting installation'; this installation was planned for commissioning in 2003.

In 2000, the project had to be reoriented once again, due to financial reasons (investment cost for the pyrolysis installation not justifiable with regards to the small quantities of burnable waste, coming from the Belgian program, to be treated). This conclusion was reinforced by the fact that there was no hope to import waste coming from foreign countries.

For the T/C, the final solutions to be implemented for the still stored non conditioned waste included

- sorting and physico-chemical characterization of historical mixed waste, the sorted waste being placed in a 200-l drum (special designed for alpha waste and called ALDRUM), and
- volume reduction (compaction) followed by cementation.

As a consequence, it was necessary to reorient the 'A3X installation' project; this new sorting installation has been commissioned in March 2005.

DESCRIPTION OF THE PROJECT

The 'A3X' project

A small part of the "nuclear past" alpha waste kept in stock on site 2 of BP is being covered by a "HRA-Solarium" project. Processing and conditioning of these waste, mainly originating from SCK•CEN, is sorted in the HRA-Solarium facilities on BP site 2 and conditioning and interim storage has been planned on BP site 1 (T/C facility PAMELA and storage facility B155).

The main part of non-conditioned alpha waste produced until 1985 according to the former O/N specifications is made of 655 220-l drums and 3013 30-l cans which are kept in stock on BP site 1. The "A3X" sorting installation has been set up to ensure the management of those wastes (that is to say approximately 221 m³).

Furthermore, the BELGONUCLEAIRE's MOX plant continues to produce from 1985 approximately 20 m³ of non-conditioned waste in 200-l drums each year; it must be noted that a large number of drums will be generated when dismantling the plant later. Those wastes will be directly treated and conditioned in the refurbished 'Pamela' facility on the BP site.

Originally, the burnable contaminated waste (A31) had been planned for treatment by pyrolysis but, despite the attractive VRF (Volume Reduction Factor), the investment required for a relatively small waste volume was considered excessive and it was decided to treat all alpha waste by super-compaction in the "Pamela" facilities on BP site 1, just like the non-burnable waste (A34).

As a result of this reorientation of the project, the "A3X sorting facility" has been designed to meet the following objectives for what concerns the non-conditioned alpha waste stored on the BP site:

- Waste inventory using the waste tracking system of the BP facilities and the transfer sheets filled in the 80's when transporting the alpha-waste from the producer to BP;
- Waste transportation in a sorting glove box (HK) (through the HK1 air lock for the 30-l cans and through the HK3 drum tipper for the 220-l drums);

- Separation of the A2X (alpha activity: burnable $< 400 \text{ MBq/m}^3$; non burnable $< 1 \text{ GBq/m}^3$ if $d < 0.3$ and $< 4 \text{ GBq/m}^3$ if $d > 0.6$) and A3X (alpha activity $>$ limits A2X) waste;
- Preparation (the burnable wastes in PVC bags and the non burnable ones in 220-l drums) and transportation of the A2X waste for final conditioning in CILVA (facility on the BP site for T/C of LLW);
- Physical and chemical characterization of the A3X waste and transportation in 200-l drum for characterization and measurement of the drum's isotopic content and final conditioning by supercompaction followed by embedding in concrete of the pellets in 400-l-drums in Pamela.

The Waste Inventory

The existing amount of waste is known through transportation worksheets from the producer to SCK•CEN until 1980, then to O/N afterwards.

Furthermore, measurement campaigns at random have provided a better knowledge of the package typical contents. The outcome is the following inventory:

- 3013 30-l cans (90 m^3) with an estimated content of 70 m^3 of A2X and 30 m^3 of A3X, and an average Pu content of 1 gr Pu/can (Fig. 1. shows the contents of an opened 30-l can),



Fig. 1. A typical 30-l can

- 655 220-l drums (131 m^3) with a maximum Pu content of 39 gr Pu/drum .

Besides this historical inventory, the production of “new” A3X waste, related to the BELGONUCLEAIRE's MOX plant operation from 1985, reaches approximately $20 \text{ m}^3/\text{year}$ of

200-l waste drums, each containing max. 39 gr of Pu, and the waste generation related to the upcoming dismantling of this plant.

Some 250 m³ of non conditioned waste has also been produced by the dismantling activities at the BELGOPROCESS sites.

As these “new” wastes have been characterized and sorted at source by BELGONUCLEAIRE and the other producers according to O/N specifications, these drums of new waste will directly be super-compacted in Pamela, without any pre-treatment in the A3X sorting facilities. Fig. 2. illustrates the waste streams.

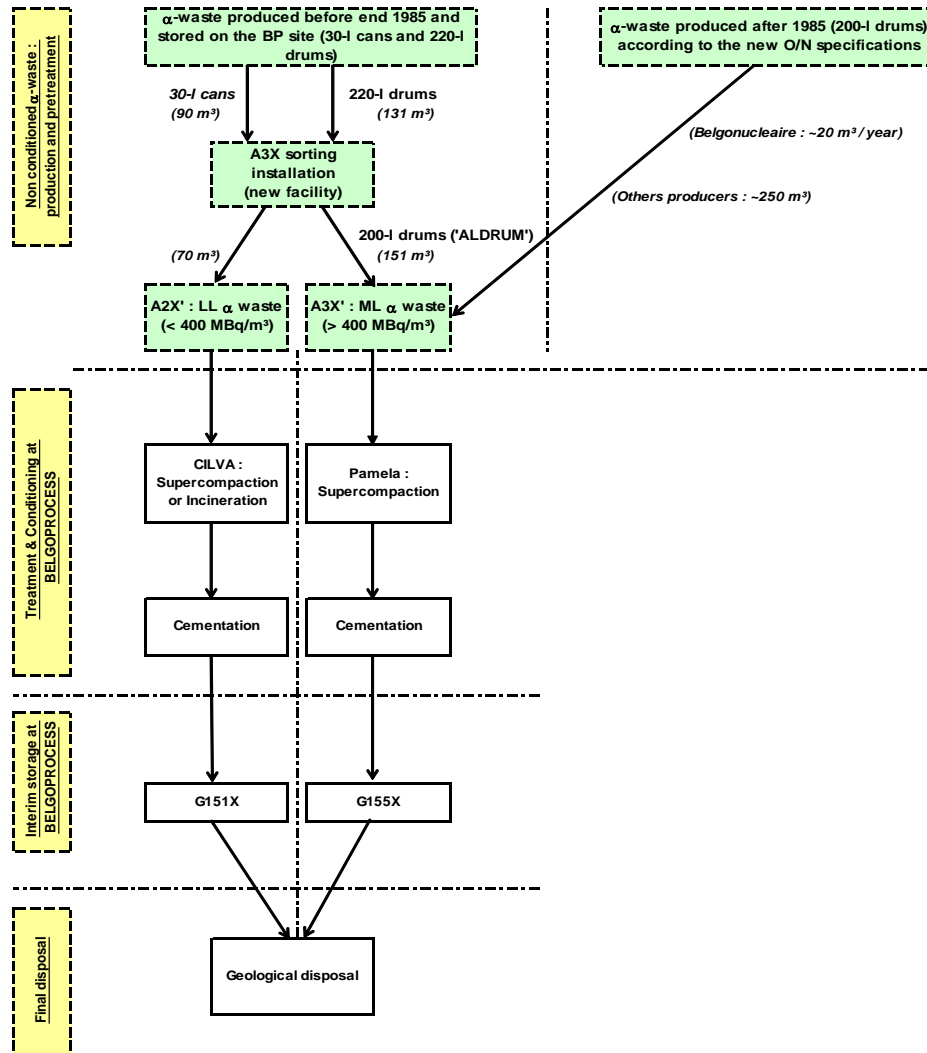


Fig. 2. Waste streams

DESCRIPTION OF THE PRETREATMENT FACILITY

The 'A3X' Sorting Facility

The A3X sorting facility includes four main glove boxes linked to each other by tunnels. This facility is located in room 102 of building 110 on BP site 1.

The main features of these glove boxes (HK) are:

- HK1: transfer of the 30-l cans through an air lock ; this transfer is followed by the sorting of the A2X and A3X after non-contamination control of the primary packages,
- HK2: transfer of the A2X in a 220-l drum (non burnable waste) docked by a airtight system and compaction of the emptied cans; the burnable wastes are evacuated in PVC bags,
- HK3: docking transfer and airtight tipping of the 220-l drums of A3X waste,
- HK3_{bis}: the sorting program which started in April 2005 applies only to 30-l cans during the first two years. Therefore, it has been decided to carry out a small HK3 bis transportation compartment allowing the transfer of A3X waste from HK1 to HK6 without any contamination risk of the residual HK3,
- Tunnel from HK3 lies to HK6: metal detection, and
- HK6: weighing, physical and chemical characterization of the A3X waste; separated transfer of A31 and A34 waste in 2 200-l ALDRUM drums docked by a device with weldable shell.

A series of growing depressions from HK2 and the HK1 air lock to HK6 is ensured by the ventilation.

The transfer between HK, the compaction, the tipping of the A3X 220-l drum and the docking of the A2X drum are managed by PLC and with two OP37 switchboards located on HK2 and HK3. The global layout of the sorting facility is shown in Fig. 2.

The Sorting Scenario for the 30-l Cans

The 30-l cans stored in building 110 are put in a 1 m³ container (each containing 20 cans) which is transferred to the sorting room. Each can is weighed when unloading the container in the sorting room. The can is put into the HK1 air lock. Then, it is transferred to HK1 and opened. The A3X waste contained in that can is normally covered by a double plastic envelope with intermediate protection by bubble plastic for scrap metal. Before being closed, these 30-l cans have been filled up with A2X secondary waste, in order to optimise the filling rate. Therefore, as soon as the can is opened, a smear test is carried out on the primary packaging and on the inside of the can in order to verify the non alpha contamination. This smear test is controlled outside the HK1 glove box using the classical 'BAGin-BAGout' technique. (If there is a contamination, the can is closed with its content and directly transferred in the A34 ALDRUM drum to HK6. Decontamination of HK1 is carried out if necessary).

The A3X wastes are transferred into HK3bis. The primary A3X waste packages are transferred one by one to HK6 through the HK3-HK6 tunnel, surrounded by a metal detector which detects the presence of metal with a sensitivity of approximately 10 g.

In HK6, the A3X packages are weighed, characterized chemically and physically by visual inspection, then set into the A31 ALDRUM for the burnable and into the A34 ALDRUM for the non burnable. When one of the ALDRUM is full, it is docked away, its shell is welded and its cover is hooped. The drum is then placed in an interim storage room before being processed by super-compaction in the Pamela facility.

The A2X wastes are treated as follows:

- the non burnable wastes (A27) and the emptied cans are transferred into HK2, where they are put into the 220-l drum (after compaction of the 30-l can). When a A2X 220-l drum is full, its cover is reset via the airtight docking system and, after a control procedure, the drum is evacuated in order to be processed by supercompaction and embedding in concrete of the pellets in a 400-l drum in the CILVA facilities;
- the burnable wastes (A21) are transferred to HK2, evacuated through plastic bags and transferred for incineration to the CILVA facilities.

Fig. 3 shows the sorting facility itself and the waste stream from 30-l cans.

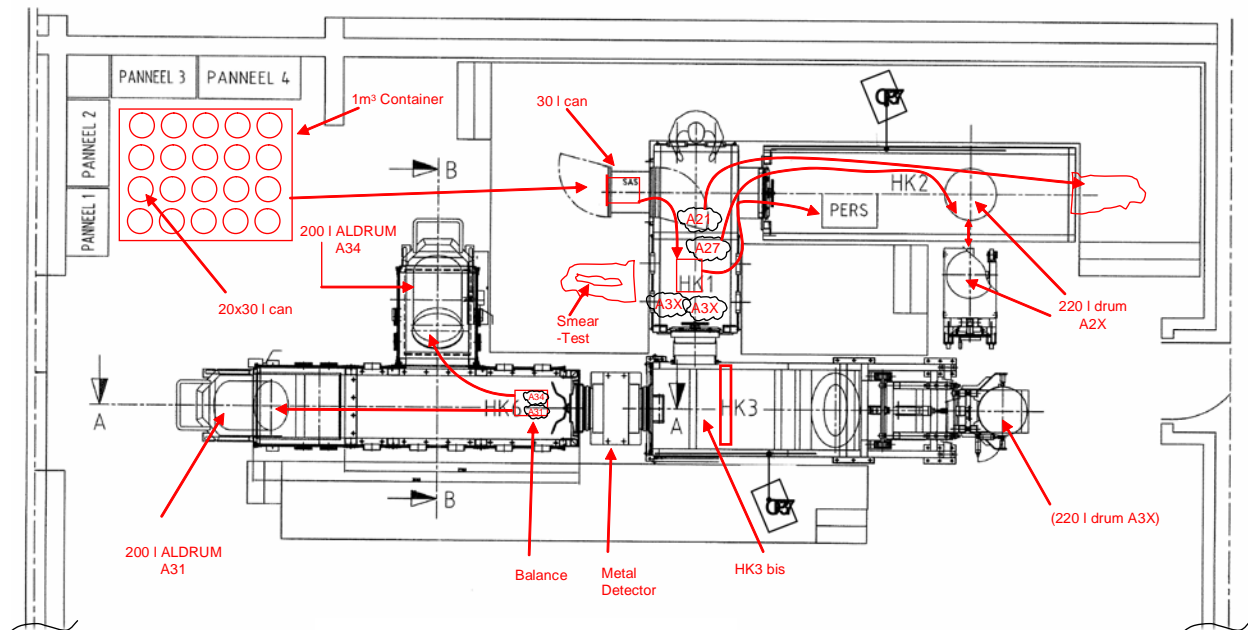


Fig. 3. Scenario for 30-l cans

The Sorting Scenario for the 220-l Drums

The 220-l drums will be sorted and treated once the sorting campaign of the 30-l cans has been achieved.

The sorting scenario of the 220-l drums is similar to that of the 30-l cans. It will imply the later disassembly of the HK3bis compartment before the start of the campaign.

A 220 l-drum is put on the HK3 drum tipper and its cover strapping is withdrawn.

The drum is tipped by 135 and docked on the cover airtight gripper system which, when it is swivelled, allows the discharge of the drum content into HK3. After an alpha non-contamination control, the empty drum is docked away, closed and sent for super-compaction in CILVA.

Afterwards, the wastes are transferred to HK1, where the control and sorting process is identical as that of the 30-l cans.

DESCRIPTION OF THE PAMELA CONDITIONING FACILITY AND OF THE INTERIM STORAGE FACILITY

PAMELA is a former vitrification facility for high active liquid waste resulting from the reprocessing plant EUROCHEMIC; it is made of shielded cells which BP is reconverting in order to carry out the treatment and the conditioning of waste (e.g. medium active 'historic waste', A3X, alpha contaminated glove boxes,...). This installation is presently being adapted.

The 200-l ALDRUM from the A3X sorting facility and those produced after 1985 will be directly introduced in the PAMELA cells through a ventilated air lock. Then, they will be super-compacted and the resulting pellets will be piled up in a 400-l drum where they will be embedded in cement. The full 400-l drums are then docked away by a double lid system and closed. Control of both the radiation/contamination level is carried out.

Afterwards, the controlled drums are transferred to the interim storage building B155 on BP site 1.

The 400-l drums will be stored in this building until the final disposal facility (geological option) will be available in Belgium.

PLANNING

The planning of the different phases of the 'A3X' project, including the different reorientation above mentioned, can be summarized as follows:

- 1994 – 1998: selection of the main options including inventory of the waste;
- 1999 – 2000: study of the A3X sorting system;
- 2000 – 2003: setting up of the A3X sorting facilities (pyrolysis option is withdrawn during the project);
- 2003: selection of the ALDRUM drum for evacuation of the sorted waste;
- 2004 : decision of the new reference solution for T/C (compaction instead of pyrolysis);
- 2005: commissioning of the sorting facility;
- April 2005: start of Industrial Start-up;
- 2005 – 2007: sorting of the ~3000 30-l cans;
- 2005: testing of Pamela adaptations leading to a commissioning mid 2006;

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- 2006: conditioning of the 200-l drums in Pamela;
- 2006: interim storage of the conditioned 400-l drums.

CONCLUSIONS: LESSONS LEARNED

From the Project Phase

The following positive lessons learned have been experienced in the initial design and construction phase of this project:

- It is justified to invest, during the feasibility analysis phase, in a waste inventory, with detailed identification of the primary containers and mapping:
 - Identification of the containers;
 - What is in the primary package, container?
 - In which position in the package or container?
 - Estimation of the risk of error and of the precision of the methodology.
- On basis of the inventory, it is justified to perform, as well, a detailed ALARA study in order to facilitate the works on existing storage site or facilities.
- HAZOP (ALARA) studies have been performed in order to minimize the risks of failure during operation, with the main objective to avoid or to reduce to a strict minimum the human intervention in an active area; appropriate retrieval measurements have been developed.
- Building a mock-up, for some critical handling cases, or validation by test campaigns of retained process solutions has been helpful during the design phase.
- The design of the new facility and of the adaptation of existing ones must be based on proven equipment and devices, in order to avoid later surprises during operation (use of prototypes to be avoided).
- During operation of T/C of such historical waste, the role of the operators must remain essential even in remote control of the process.

Negative lessons have been learned during that project, as well; they are mainly linked to aspects having consequences and/or impact on the planning, such as:

- Do not hesitate to hold a project once a fundamental strategic option (e.g. 'pyrolysis option for burnable waste) could be reconsidered by one of the parties, and
- In the case of a 'multi partners' project: some strategic decisions are difficult to be taken: a project leader or coordinator with a 'strong personality or profile' and real decision power is necessary to avoid endless discussions.

From the first working months of the A3X sorting facility

The sorting operations record until early December 2005 is as follows:

- 4 operators and one supervisor are foreseen;
- the first 18 cans have been processed using a special plastic bag which allows an evaluation of the inner contamination risks ; among the first 18 cans, one has been found lightly contaminated;

- the cans are more corroded as expected; the rust of the corroded cans is problematic, as it spreads over the entire glove boxes (HK1 and HK2). The position of the ventilation inlets had to be adapted;
- the docking time is longer than expected;
- processing capacity – reminder of the objective: 7 to 8 cans a day, at the beginning: ~7 cans a day, the “8 cans a day” objective should be reached;
- number of contamination cases of the gloveboxes (HK1) due to damages of the PVC bags contained in the 30-l cans: ~3%; decontamination of HK1 was relatively easy and quick (max. 4 hours);
- the major advantage of the sorting operations is a better knowledge of the waste content, in view of its later disposal; based on the first sorted cans, the physico-chemical composition of the resulting A3X wastes can be summarized as follows (Table I); in that frame, it was decided to separate the cellulose components from the other wastes and to concentrate them in a limited number of drums.

Table I. Physico-chemical Composition of A3X Waste (all values in %)

	'Burnable' outlet (A31)	'Non burnable' outlet (A37)
Burnable (< 150 kg/m ³)	21.77	0.48
Burnable (> 150 kg/m ³)	34.50	0.38
Polymers	0.51	0.00
PVC	41.71	5.67
Burnable parts of motors, fans, ..	0.00	0.83
Glass	0.00	0.65
Wood (< 150 kg/m ³)	0.29	0.00
Total burnable	98.80	8.00
Steel (undefined)	0.53	75.04
Lead	0.12	0.85
Aluminium	0.49	7.90
Stainless steel	0.00	4.48
Carbon steel	0.04	0.19
Miscellaneous	0.04	3.54
Total non burnable	1.20	92.0
Vol. % cellulose	14	0.1

- On December 1st, 2005, 830 cans had been processed. This processing has resulted in 84 A3X drums and 36 A2X drums. Fig. 4 illustrates the evolution of the sorting phase within the time.

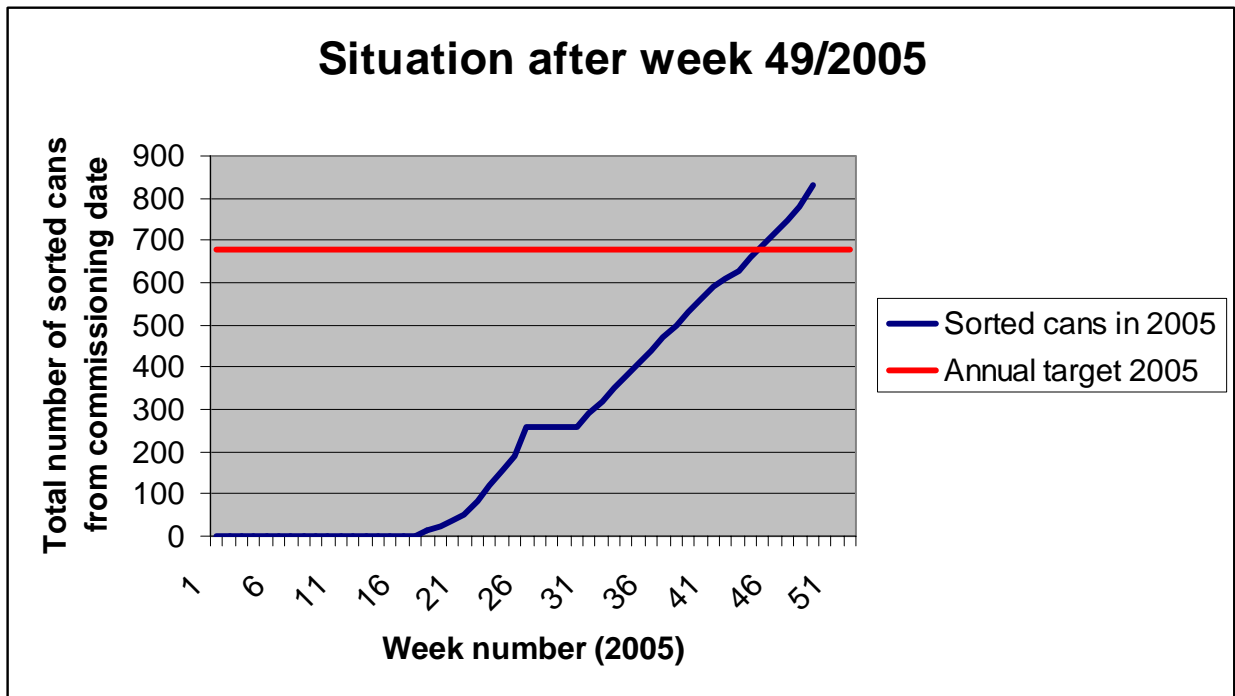


Fig. 4. Progress of sorting operations (30-1 cans)