

THE VALDUC WASTE INCINERATION FACILITY STARTS ACTIVE OPERATIONS (IRIS PROCESS)

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ABSTRACT

The operation of the facilities at the Valduc center, which belongs to CEA's Military Applications, generates various grades of waste.

Waste compatible with near surface disposal requirements is sent to Centre de Stockage de l'Aube, operated by ANDRA, the French radioactive waste management agency. The rest is processed to reduce its volume and permits its storage in conditions that comply with the permits granted by the French Safety Authorities.

The Valduc Center asked SGN to build an incineration facility to treat the most contaminated combustible waste.

WASTE TREATED

The waste to be incinerated has the following composition by weight :

- PVC 50%
- latex and neoprene 35%
- cellulose 10%
- polyethylene 5%

It contains a high proportion of chlorinated compounds, and a significant amount of zinc oxide. These two components cause the formation of volatile metallic chlorides during combustion requiring the development of a specific off-gas treatment.

The average activity of the waste is $7.5 \cdot 10^8$ Bq/kg (0.02 Ci/kg). The waste is only contaminated by plutonium without any fission products.

The waste is conditioned in 10 to 20 l bags set in a double containment and placed in 100 l drums.

THE INCINERATION UNIT

SGN is the Prime Contractor for the project on behalf of CEA/DAM (Valduc Center), the Owner. CEA/DCC (Marcoule Center) is the Licensor and is accordingly responsible for complimentary development tests.

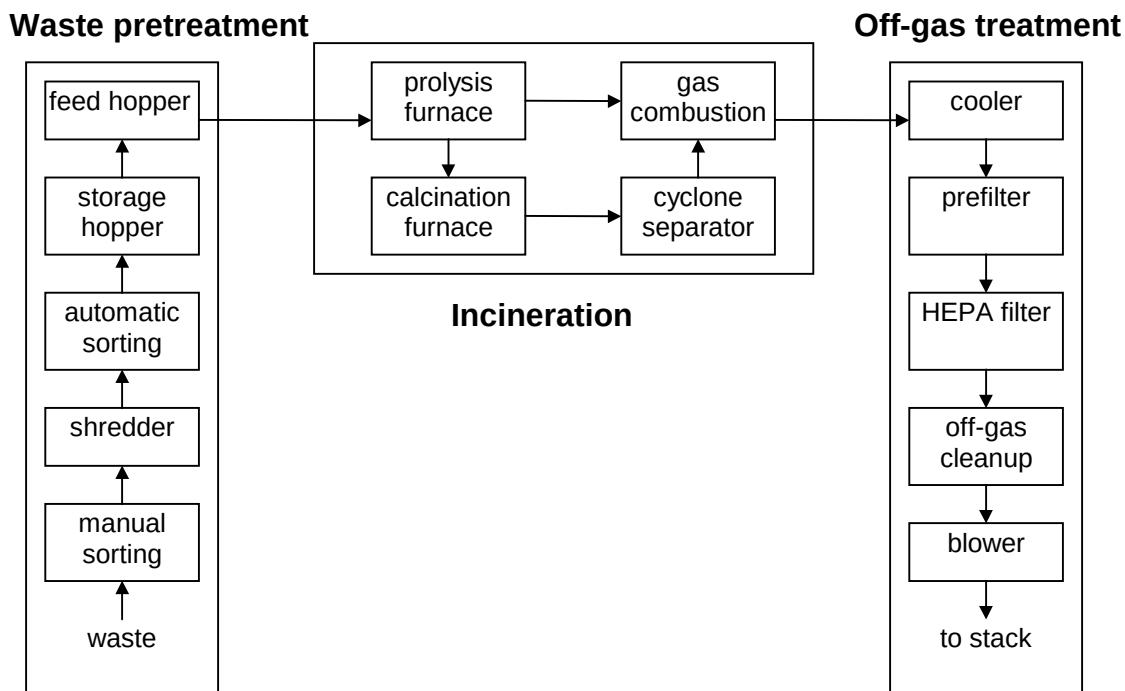
The incinerator is installed in a new three-storey building with a total volume of about 5000 m³. The Valduc facility, the first industrial application of the IRIS process (see below), will have the capacity to treat 26 t of contaminated waste per year.

THE IRIS PROCESS

The process selected was developed by the CEA at the Marcoule Research Center. It represents a cumulative 5000 h of tests on an inactive pilot facility. It was designed to meet the safety requirements for alpha waste. Incineration is carried out in two stages followed by off-gas postcombustion in small furnaces, enabling their installation in radioactive material containments.

The process also produces ash in a grade suitable for in-line vitrification, or plutonium recovery by argentic dissolution.

The different steps of the IRIS process are shown in the diagram below



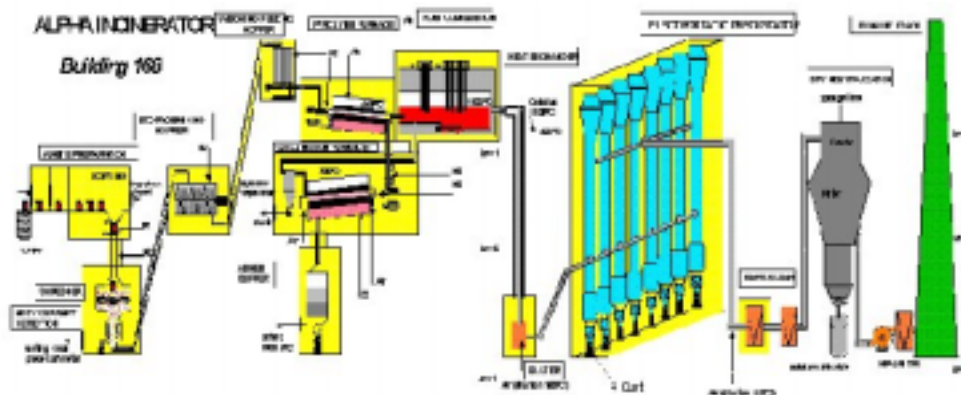


Fig. 1 : Incinerator components

Waste Preparation

This part includes the following steps :

- X-ray inspection to detect large metal parts,
- manual extraction of large metal parts if necessary,
- waste shredding,
- detection and automatic extraction of small metal parts,
- buffer storage of shredded waste.

Incineration

This part includes the following steps :

- pyrolysis furnace feed at a maximum regulated rate of 7 kg/h,
- waste pyrolysis at 550°C in reducing atmosphere, yielding a combustible gas and a solid residue called pitch essentially consisting of carbon,
- pitch calcination at 900°C in oxygen-enriched atmosphere to obtain ash suitable for possible subsequent treatment,
- combustion of pyrolysis gases at 1100°C in a post-combustion furnace to which the calcination gases are also sent.

Off-Gas Treatment

This part includes the following steps :

- gas cooling by passage through a pipe heat exchanger, followed by mixing with cold air,
- gas prefiltration in an electrofilter featuring 99.8% filtration efficient,
- HEPA filtration to meet the site release specifications,
- chemical purification of inactive gases by dry neutralization ; performance of the process takes account of the European guidelines and applicable French legislation (see table 1).

CAPACITY AND OPERATING MODE

The facility operates five days per week with :

- waste preparation during normal working hours (8 h/day),
- continuous and automated waste incineration and off-gas treatment.
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The facilities are placed on standby on weekends.

The facility has a maximum capacity of 7 kg/h.

For an annual 26 t of waste treated, it will produce about 1300 kg of ash and about 400 kg of fines per year. The ash and fines are conditioned in stainless steel pots and stored under a double vinyl containment in metal drums awaiting treatment or conditioning.

The ash obtained will contain 99% of the activity introduced with the waste, and its residual carbon content is about 1%.

THE EQUIPMENT

The waste preparation equipment is built using standard machines adapted to operate in ventilated containments and modified for minimum holdup.

The pyrolysis and calcination furnaces were developed specifically for this type of application. They are rotary furnaces (see fig. 1) consisting of a metal tube surrounded by heating shells. This design accounted for maintenance operations, and all routine operations can be performed without opening the containment barrier provided by the ventilated sealed containment.

The three furnaces (pyrolysis, calcination and post combustion) are electrically heated, simplifying the auxiliary circuits while reducing the volume of off-gases.

The pyrolysis furnace is fed at a regulated rate to allow constant flue gas discharge and temperature. Heat rejected from the furnaces is removed outside the containments partly through heat pipes, which offer the advantage of requiring no energy source. The heat exchanger used for the first gas cooling step is a water heat pipe whose two-shell evaporator surrounds the flue gas duct. The duct can easily be cleaned under containment if necessary.

The electrofilter has eight tubes in which the gas stream from the cooler is distributed. Along its centerline, each tube has a tubular stainless steel electrode raised to about 80,000 V. The geometry of the electrofilter allows cleaning by a scrapper device for zeroing of the radioactive material balance. For weekly recovery of the fines, the tubes are isolated in pairs from the gas stream, de-energized and cleared by striking. To permit fines recovery in easily unclogged powdery form, the electrofilters operate at a temperature of 165°C.

The gases are chemically purified by a dry neutralization process, since liquid releases from the Valduc Center are not authorized. The sodium bicarbonate process initially selected was abandoned because of its poor

efficiency, since the temperature was not high enough for the neutralization reaction to be significant. The neutralization facility was adjusted and operates with sponge lime at about 130°C. The measuring instruments installed in line indicate a HCl content of 1mg/m³ downstream of neutralization for an upstream content of 1g/m³. Lime consumption is about 1 kg for 400 g of hydrochloric acid.

The following table shows the concentrations of pollutants determined by destructive analyses in November 1997 for samples taken just after dry neutralization process and before dilution by air coming from the general ventilation of the building. All the measured concentrations are far below the French law of 10/10/1996 (which is also the European regulation) dealing with municipal incinerator. The analyses were performed by INERIS, an official French organism.

Pollutants	French law 10/10/1996	Measured values during November 1997
Total dust (mg/m ³)	10	0.1
VOTC (mg/m ³)	10	3.5
CO (mg/m ³)	50	6
SO ₂ (mg/m ³)	50	0.8
HCl (mg/m ³)	10	2.5
(Cd, Tl) (mg/m ³)	0.05	0.04
Hg (mg/m ³)	0.05	0.0002
(Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn, Se, Te) (mg/m ³)	0.5	0.013
(Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn, Se, Te) + Zn (mg/m ³)	5	0.014
Dioxines and furanes (ng/m ³)	0.1	0.008

Table 1 : Measured values of pollutant concentrations in off-gases

CRITICALITY SAFETY

Criticality risk prevention is based on limiting the mass of active material undergoing treatment in the facility. A balance is compiled continuously by calculating the difference between the mass of active material entering the facility and the mass leaving it. These masses are evaluated by the activity measurements performed on qualified measurement circuits.

Due to measurement uncertainty, the absence of holdup in the components must be checked periodically. The operator has conducted tests with calibrated radioactive sources to qualify the systems for measuring holdup from outside the equipment. Measurement are taken chiefly by gamma spectrometry, allowing overall or targeted measurement with the collimator, and, for the post-combustion, by passive neutron counting. The instruments used are mobile, since no continuous holdup measurement is carried out. If

necessary, gamma detectors will be introduced into the components to locate any holdup. Holdup can also be visualized by endoscopy.

The balance is zeroed periodically by cleaning and drainage of all the equipment. Equipment located downstream of the furnaces (cooler, electrofilter) is in tubular form, selected to facilitate the recovery of fines by scraper devices.

During the first active waste incineration campaigns, each run will be followed by drainage and complete cleaning of the facility to obtain feedback on the distribution of active material holdup in the facility.

ZINC PHOSPHATIZING

The combustion of waste containing high proportions of chlorine and metallic oxides leads to the formation of volatile metallic chlorides. Zinc chloride in particular is a very hygroscopic product which becomes highly corrosive after absorbing moisture. To prevent the absorption of moisture, all the flue gas equipment is kept at temperature by electrical heating. This heating is necessary in operation, and also during shutdowns. Maintenance operations must be conducted in a dry atmosphere.

The Marcoule Research Center, the Licensors, has developed a process in which phosphorus is injected into the incineration process in organic form to promote fines phosphatization reactions to the detriment of chloride formation. In fact, zinc phosphate is a much more stable compound than zinc chloride. It is not hygroscopic, not corrosive at ambient temperature, is virtually insoluble in water, can be vitrified and melted to reduce its volume. This phosphatizing process has been selected by CEA for the Valduc Research Center.

The phosphatizing of zinc fines during the inactive chlorinated waste incineration test runs was achieved by selecting waste containing the amount of phosphate needed to run the phosphatizing reaction. Inspections performed after these incineration runs revealed the complete absence of corrosion in the equipment. In the first incineration runs, reducing the operating temperature of the electrofilters to about 160 °C was observed to improve recovery of the fines in powder form. To optimally control the quantity of phosphorous injected in the line with the zinc content of the waste to be incinerated, the Valduc Center proposes to conduct waste management upstream of incineration, and adjusting the feed to obtain the right ratio between the phosphorous and zinc contents.

WASTE ACCEPTABILITY RANGE

Incineration campaigns were conducted at Valduc by varying the type of waste in order to validate the acceptance range for the different types of waste produced at the Center. These campaigns have shown that the process

is flexible and that, for the standard composition considered, PVC can be replaced by ethylvinylacetate up to 25% of the total waste content.

CONCLUSION

Inactive waste incineration campaigns were run in 1996, 1997 and 1998. The system measuring holdup of active material from outside the equipment was qualified by tests performed by calibrated sources. The Marcoule Research Center, the Licenser, developed a process in which phosphorus is injected into the process in organic form to promote fines phosphatization reactions to the detriment of chloride formation. The phosphatizing of zinc fines during the inactive chlorinated waste incineration test runs was achieved by selecting waste containing the amount of phosphate needed to run the phosphatizing reaction. Inspections performed after these incineration runs revealed the complete absence of corrosion in the equipment. This phosphatizing process was selected by CEA for the Valduc Research Center. Active commissioning of the facility is scheduled for early 1999. The Valduc incinerator is the first industrial application of the IRIS process.

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