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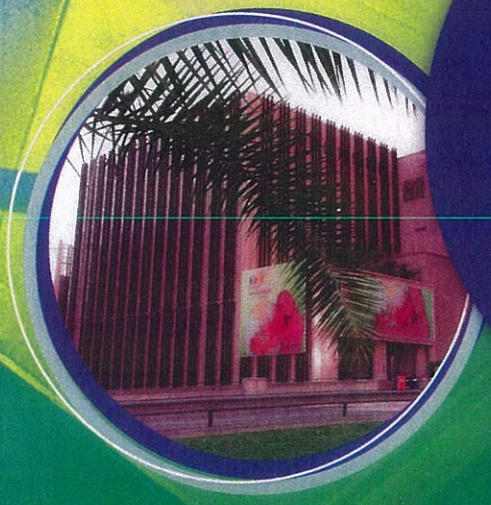

THE MONACO WASTE RECOVERY FACILITY: A MODEL FOR THE URBAN ENVIRONMENT

SOCIÉTÉ MONÉGASQUE D'ASSAINISSEMENT

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un enjeu pour
nos enfants
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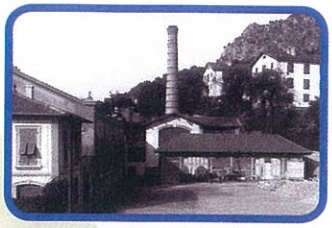
HISTORY OF WASTE TREATMENT AND RECOVERY IN MONACO

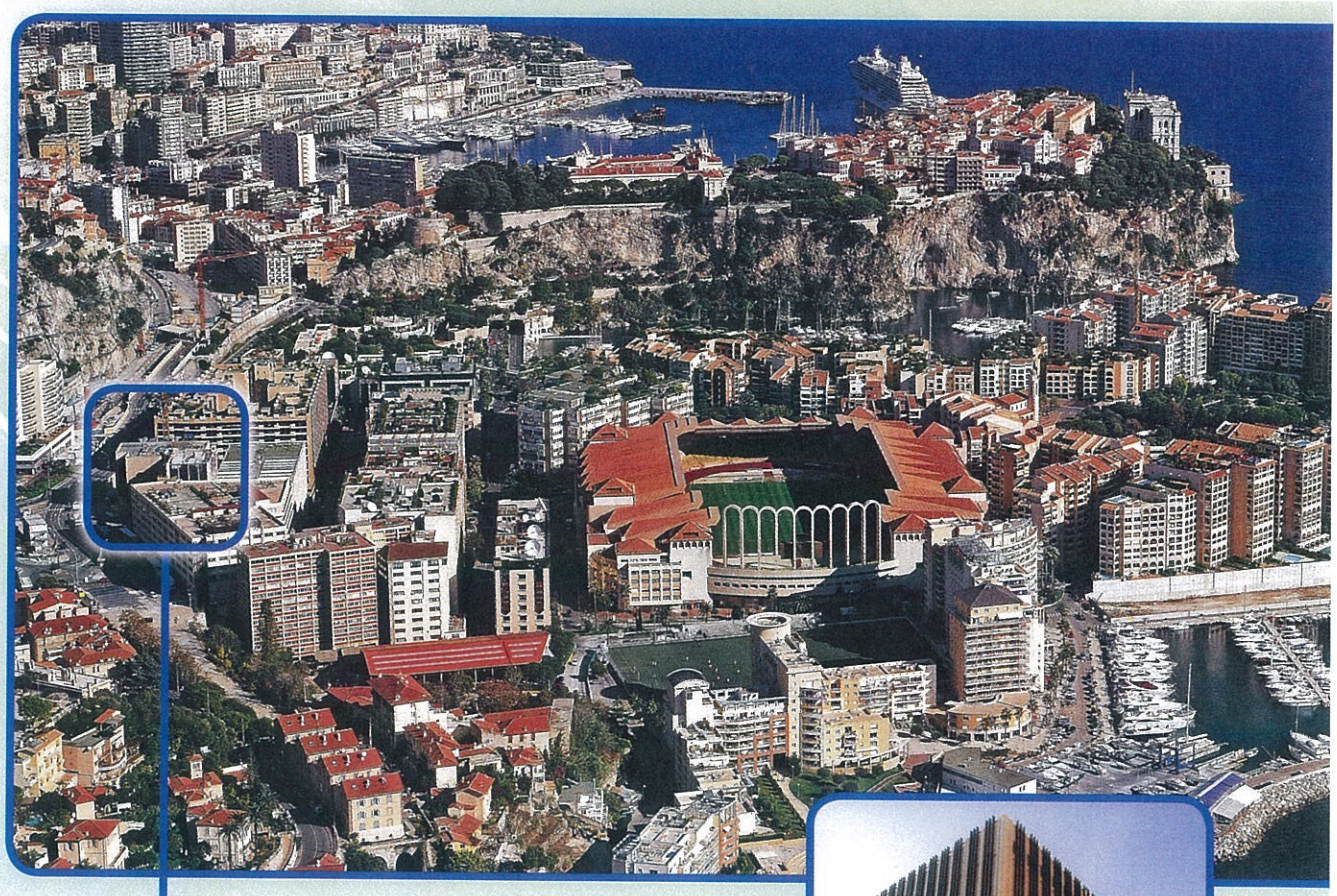
1898 ▸ 1938 First waste incineration facility.

1938 ▸ 1980 The second facility, replacing the first, became obsolete.

From 1980 Construction and operation of the third generation facility, in the same location at Fontvieille.

- **1994** First technical development: wet scrubbing of the smoke.
- **2006** Second technical development: optimisation of combustion and addition of catalytic-type smoke treatment process.





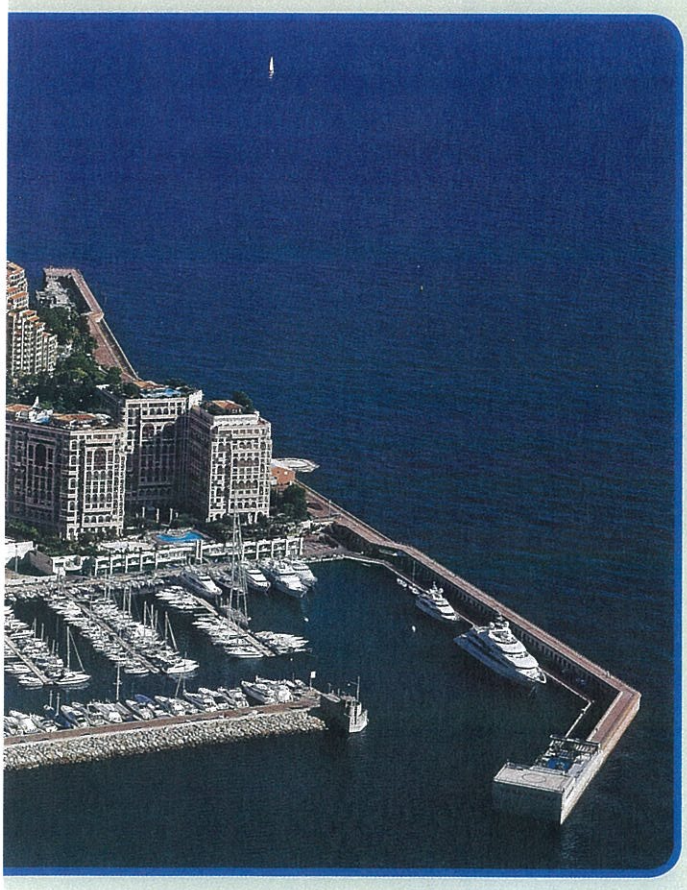
A WATCHWORD: WASTE RECOVERY

The Principality of Monaco has always striven to conserve the quality of its environment and be self-sufficient in terms of the processing of its waste. Thus in 1898 the first waste recovery facility was constructed on a site adjoining the current facility.

The incineration of waste involves mineralisation of this waste. This process offers numerous advantages, in particular a significant reduction of about 90% by volume and 75% by mass of the waste that needs to be stored.

The modern design of treatment units involves not only incineration of the waste and recovery of the energy produced by combustion, but also adds value to this energy in the form of electricity and heat. Waste recovery facilities can therefore be regarded as being industrial co-generation units whose primary objective is the incineration of waste.

The current facility is the third of its type. It was fired up in 1980. It is capable of incinerating 80,000 tonnes of waste per annum, making it of medium size in terms of European units. It has all the latest equipment and meets European smoke discharge standards.



A FACILITY WHICH IS FULLY INTEGRATED IN ITS URBAN ENVIRONMENT

The Monaco facility has many special features. Located right in the heart of the Fontvieille district, great care has been taken to ensure that it blends in architecturally: its outer walls are lined with sound insulation which minimises noise emission to the surrounding areas.

The chimney, which is usually the most visible part of this type of facility, is here fully incorporated into the building.

In addition, the usual white plumes of water vapour have been entirely eliminated. The building is earthquake resistant and occupies a ground area of only 1500 m^2, justifying its vertically-orientated design. Finally, some of the energy that is recovered is used in adsorption coolers in a neighbouring thermal-refrigeration plant to produce chilled water. This is used for air-conditioning purposes in industrial and administrative sector buildings.

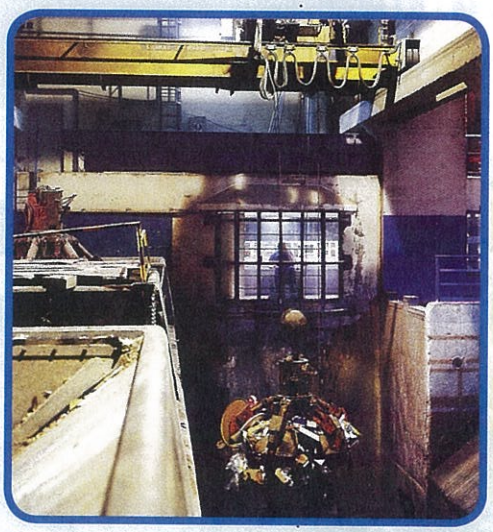
OPERATIONAL DETAILS

1 Waste comes not only from the Principality but also from neighbouring communes. It is made up of about 70% household waste, 23% assorted waste such as packaging, non-hazardous industrial waste (D.I.B.), waste from parks and open spaces or from industrial processes, and sludge from the Monaco sewage treatment works. The latter is not mixed with waste from the tipping floor, but introduced directly into the combustion chamber by means of IC 850 equipment designed and manufactured at the Monaco facility.

2 An 8-metre long weighbridge records all information relating to weights on entry to and on leaving the facility. The unloading hall is closed and kept at a negative pressure in order to prevent odours and dust from escaping from it. Bulk metal waste, batteries, electrical and electronic equipment waste (D3E) and fluorescent tubes are taken out to be removed to the relevant recycling processes. Green waste and bulky waste suitable for incineration are crushed so that they can be mixed with the waste contained in the pit.

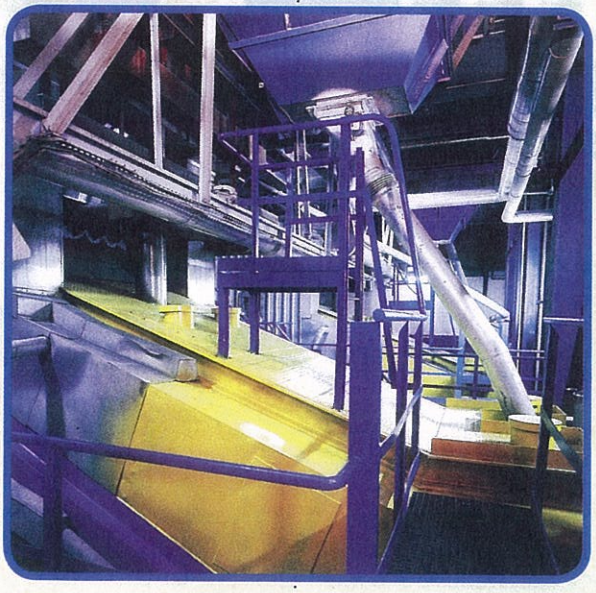
3 The storage pit has a capacity of 1200 m^3 and was designed to take the product from 2 to 4 days' collections. Two overhead cranes with grabs stack the waste in the pit and distribute it into the supply hoppers for the three furnaces. The waste falls under gravity along the chute and drops onto the supply table. A feeder, operated by a piston, pushes the waste onto the hearth where it is instantaneously ignited.

4 The hearth, manufactured by Martin, is inclined at 27° and has a surface area of 15.3 m^2. It is made up of a hydraulically operated track which includes three rows of bars which form steps, every other one of which is fixed with the other driven in a backwards and forwards motion. This ensures that the waste is moved in the correct direction and riddled. Regulation of combustion temperature is achieved, on the one hand, by controlling the amount of waste allowed into the furnace and, on the other hand, by controlling the flow of oxidation air that is allowed in.

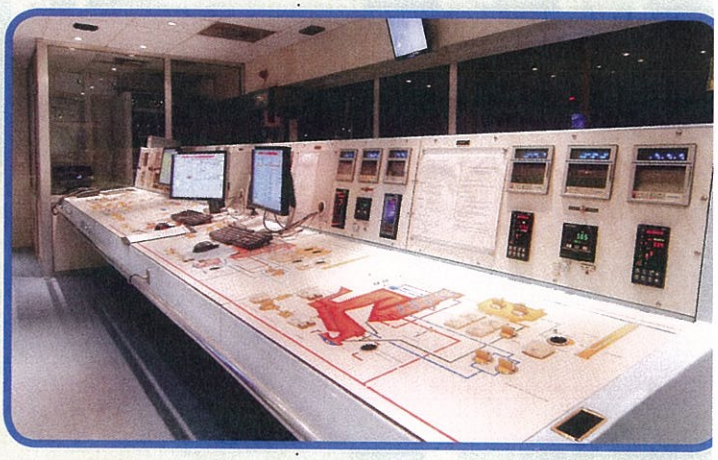


5 The residue from combustion at the end of the hearth is referred to as clinker. This is extracted from the furnace by a drum, then cooled and extinguished in an extractor unit. It is then evacuated using conveyor belts, with ferrous residue being removed using a magnetic separator. The clinker is then stored in a pit and removed by road transport.

6 Recovery of energy from the combustion gases is accomplished in the CNIM boilers which produce 13.3 tonnes per hour of steam which is superheated at 300°C and 28.5 bar. The smoke cools on contact with the screens and the various tube assemblies so that it is at 230° degrees at the outlet from the economiser. The heat exchangers are regularly cleaned using steam-driven rotary and harrow-type soot removers. The support burners which run on fuel oil are kept in reserve and automatically start up in the event of the temperature in the combustion chamber dropping below 850°C.



7 The energy recovered in the boiler is recycled in three forms: electricity, heat and refrigeration. The electricity is produced by a 2.6 Megawatt back-pressure turbine-driven alternator which supplies the facility directly. Excess energy is supplied to the Principality's grid and represents an amount of energy equivalent to that used for public lighting. The exhaust steam from the turbine is fed to a thermal-refrigeration plant which is connected to an urban heating and cooling network which supplies the Fontvieille district. The hot water supplied to it is at 95°C and the cold water at 5°C.



8 Dust removal is carried out using two-field electrostatic filters which enable dust levels of less than 30 mg/Nm^3 to be achieved at the outlet and before final treatment.
The ash that is recovered represents the second type of residue from a waste recovery plant (25 kg per tonne).

9 In order to comply with changes in regulations, an additional dust treatment stage was introduced in 1993 and then optimised in 2006. Its purpose is to ensure that emissions of chlorine, sulphur and heavy metals are strictly limited, and to ensure improved filtration of dust at the electrostatic filter outlet. The system that is installed in this wet-type facility involves scrubbing the smoke in two reactors and a filter agglomeration module where the acidic gases are absorbed and pollutants transferred to a milk-of-lime and soda solution. This solution is subsequently purified in a small effluent treatment plant.

10 The pollutant materials carried by the effluent are separated using precipitation, flocculation and settling, and water is removed on a filter press. The residue obtained after compression is known as a "filter cake", and this is the third type of sub-product generated by combustion. The residual water is filtered by passing it successively through a sand filter and an activated charcoal filter before being discharged.

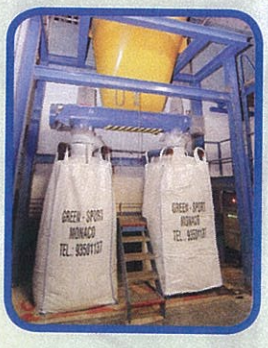
11 The clinker that is recovered at the end of the hearth after combustion represents the most significant proportion of the sub-products from the facility after combustion, that is, about 250 kg per tonne of household waste. Considering the good geo-technical characteristics of the clinker, and on condition that the chemical analysis is favourable, the clinker may be used as sub-ballast in road construction or as backfill. The ferrous materials from combustion and large metal items are passed to recycling centres.

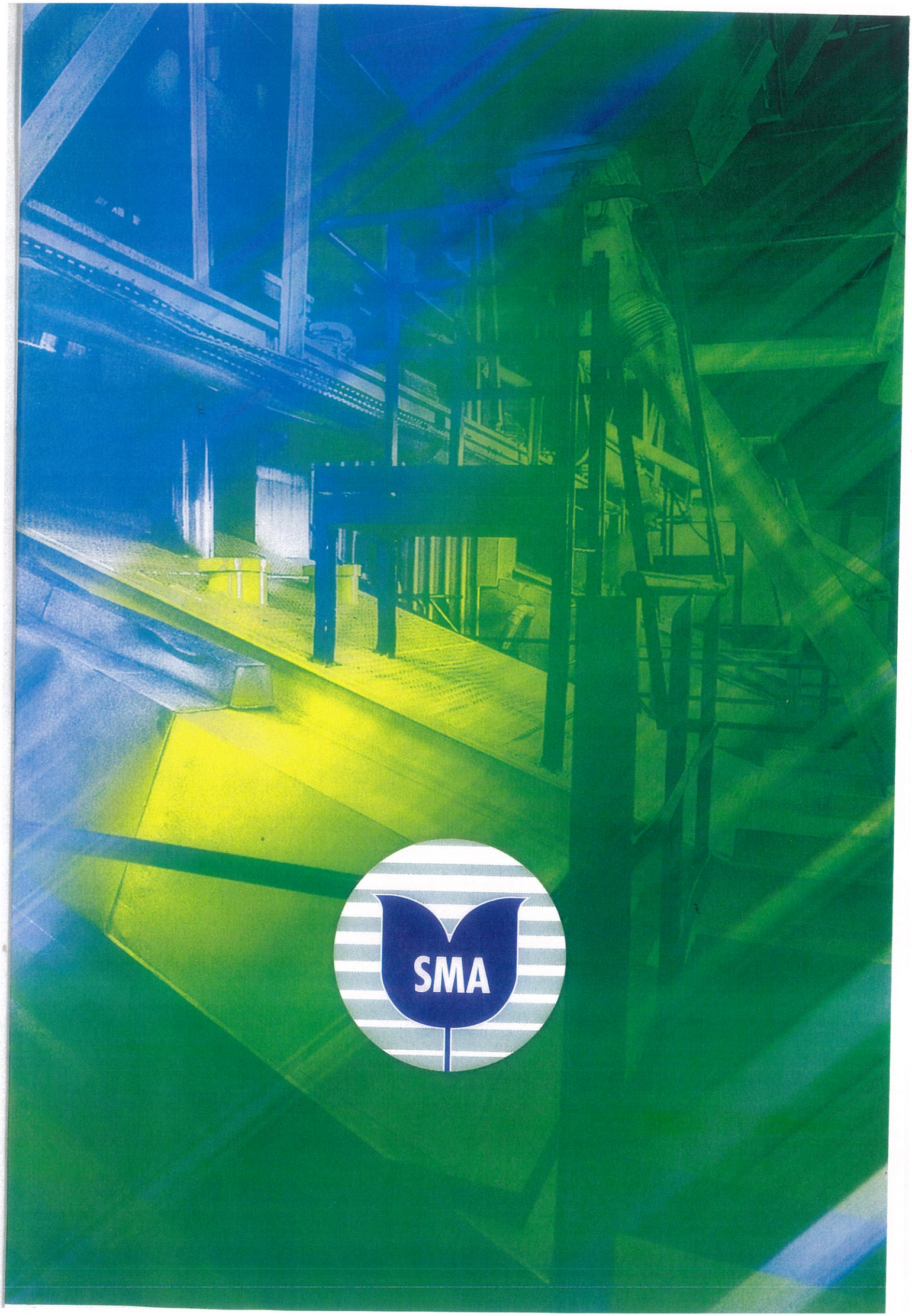
12 The ash is driven by endless screws and stored in a silo before being filled into sealed "big-bags". Because of its potential capacity for pollution, this final waste is taken to Class 1 specialist land-fill disposal centres. Before being buried in special technical chambers, this residue undergoes stabilisation and solidification treatment which traps its toxic constituents.

13 The filter cakes are residues of the supplementary smoke treatment (de-chlorination) which are obtained after settling and removal of water on a press filter. This waste is also sent to a specialist Class 1 land-fill centre where it undergoes the same treatment as the ash.

14 SCR-type catalytic treatment was installed in 2006 to eliminate NOx (oxides of nitrogen). The gases are heated to 250°C by burners running on natural gas and are then mixed with ammonia gas used as a reagent. The catalytic reaction which converts the NOx contaminants into nitrogen and water vapour is carried out in the catalytic units.

15 After dust removal, scrubbing and catalytic treatment, the gases are discharged to atmosphere through a horizontal silencer and a chimney which forms an integral part of the building. The gas is heated in order to prevent white plumes of steam being formed. Sampling probes are inserted in the chimneys and connected to an analyser which provides continuous measurements of the main contaminants that are discharged. Thus in the event of a drift in the process the command and control system immediately alters the regulation settings so that the operation regains its standard and stable state.

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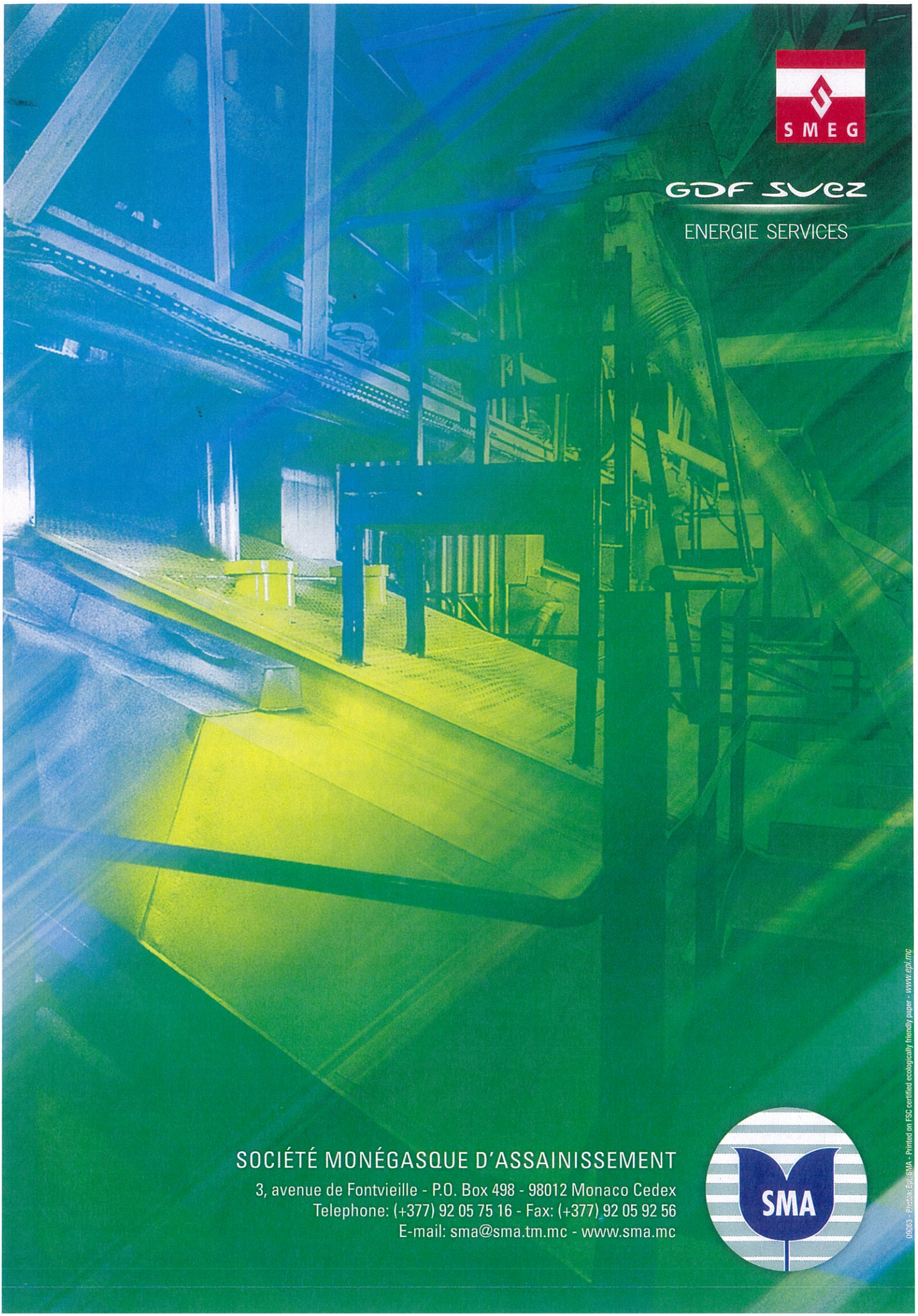
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