TMC/ DFW Europe

Client: **DFW Europe**
Project: **Explanation of equivalence cremation oven**

Toelichting op de Melding Activiteitenbesluitequivalence electric cremator for Crematoria, rev. a

TMC/ DFW Europe

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a	21-09-2020	Explanation equivalence electric crematorium for crematoria, final	TMC/DFW Europe	WJ Tichelman On behalf of TMC/DFW
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Summary

In consultation with DFW Europe, a request was made to provide a supplement regarding the electrically operated cremator in order to demonstrate that it is equivalent in terms of environmental and technical requirements to a gas-fired incinerator in accordance with the current Activities Decree.

It is an electric cremator and no natural gas is used. Operating an electrical installation differs from the usual gas-fired installations, but the current relevant legislation and regulations will be complied with. (Mainly the AIM and the Bal, Activities Regulation Decree.)

The description given below for an electrically operated cremator and subsequent technology deviates from Article 4.118 of the Activities Decree (section 4.8.9) and 4.112 of the Activities Regulation (section 4.8.8).
It should also be noted that these regulations in the Activities Regulation relate to firing the combustion and after-combustion chamber with natural gas with Low-NOx burners.

There are special Crematoria Regulations for incineration installations in crematoria. In order to comply with this regulation, which includes air emission requirements in the waste gases, the furnace is fitted with a downstream filter technology.
The requirement for mercury in the Activities Decree is 0.05 mg/Nm³.

1 Process description

This chapter describes the procedures and activities that take place at the establishment. Particularly with regard to the next of kin, importance is attached to piety, care and ethics.

1.1 Ceremonies and procedures

The ceremonies normally take place from Monday to Saturday between 07:00 and 23:00. These ceremonies consist of services in the auditorium (a large and a small auditorium) and the opportunity to offer condolences in the foyers/coffee rooms.

Cremations can also take place from Monday to Saturday between 07:00 and 23:00.
On average, two ceremonies and cremations take place per day, but in the maximum situation three ceremonies and cremations can take place in one day in the day period (between 07:00 and 19:00) and one ceremony and cremation in the evening period (between 07:00 and 19:00). 19:00 and 23:00). Up to 900 cremations per year.

1.2 Process description cremations

It is an electric cremator and no natural gas is used. Operating an electrical installation differs from the usual gas-fired installations, but the current legislation and regulations will be complied with to the extent that it is relevant. (Mainly the AIM and the Bal, Activities Regulation Decree.)

Cremation will take place on the same day after the ceremony. The coffin with the deceased is transported on the catafalque to the cremation room. This is where identification takes place according to the Law. A non-combustible identification stone is placed on the chest. The cremation room is accessible at all times for operation, inspection and maintenance. After that, the box is fed into the oven.

An electric cremator of the DFW Electric type will be installed in new crematoria. This is a fully automatic electric cremator with associated downstream technology. This is in accordance with the Best Existing Technology (BBT).
Below is a general example description of the techniques used in the cremation process.

1.2.1.1 General description electric oven

The automatic electric cremator is designed to operate as efficiently as possible, with the composition of the refractory construction ensuring that the heat in the kiln is retained for as long as possible. (See Appendix 2) The main and post-combustion chambers are brought up to temperature before the first input by means of the heating elements (coils) present in the refractory construction. The spirals heat up the refractory construction, so that when the box is entered, it can catch fire via the radiant heat. The temperature release for the main combustion chamber is 600°C and for the post-combustion chamber it is 700°C.

The coffin is placed in the cremator by means of an automatic feeding system. The cremator consists of a main combustion chamber in which the coffin is placed and in which the main combustion takes place. The floor is constructed in such a way as to keep the main combustion chamber completely separate from the after-combustion chamber and thus prevent combustion gases from escaping prematurely. The floor itself

has no openings, so all materials are held for combustion in the main combustion chamber. The flue gas from this phase of the process leaves the main combustion chamber through openings in the walls and flows to the post-combustion chamber where combustion of the gas phase occurs (post-combustion).

The gases enter the post-combustion chamber and are heated by the refractory structure of the post-combustion chamber, these gases being treated with additional supplied air. The gases circulate several times within the after-combustion chamber, in which the temperature of these gases is kept at a minimum of 700°C, so that temperature and oxygen requirements are met and environmental requirements are met. The total volume of the post-combustion chamber is more than sufficient to provide a residence time of approximately 1.5 seconds under all operating conditions. seconds to guarantee.

The refractory construction within this chamber ensures that temperature requirements are maintained, while an adequate supply of air and the flue provide a high level of turbulence to promote complete combustion. The afterburning of the flue gases takes place completely in this chamber, so that odor and smoke are completely destroyed, even at 700 °C. The temperature of the afterburning is continuously recorded. These registration data are kept in the establishment for at least one year.
Periodic inspection and maintenance of the cremator is recorded .

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It should also be noted that these regulations in the Activities Regulation relate to firing the combustion and after-combustion chamber with natural gas with Low-NOx burners.
See also Explanation of the electric cremator.

1.2.2 Downstream filter technology

Through a complete combustion in both chambers, all released substances are burned as much as possible. Dust emissions are kept to a minimum in the cremator. The dust that remains is further removed from the flue gases in the downstream filter technology, so that the final dust content is far below the legal standards. The filter technology also serves to separate harmful substances such as dioxins and furans from the exhaust gases of the cremator. (See Appendix 3)
The filtering process is completely dry, which means that only dry auxiliary materials (additive) are used and only dry residues remain.

The downstream filter technology consists of the following components:
- Heat exchanger;
- cyclone;
- the addition of the additive;
- filter cloths;
- the radial fan;
- removing the residues.
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Heat exchanger
The still hot combustion gases from the cremator must be cooled before these gases can be cleaned. The flue gases from the cremator enter the cooler through a refractory lined channel and are cooled to the operating temperature of the filter, which is approximately 130 ˚C. The heat content of the flue gases is transferred to the separate dry cooler by recirculating the cooling water. There is a facility available where the application of heat recovery is easy to realize.
This includes
- Preheating combustion air cremator.
- Heating of the crematorium itself.
- Cooling.

Cyclone
The cyclone placed after the heat exchanger serves to separate coarse dust and any glowing sparks that may have come out of the furnace with the flow of the exhaust gases. These particles are deposited in a reservoir for residues by means of an automatic dust lock / impeller.

Capture of Mercury, dioxins and furans.
The capture of mercury compounds, dioxins and furans can take place by adding additives between the cyclone and the particulate matter filter or by installing a fixed bed filter system after the particulate matter filter. The absorption of mercury, dioxins and furans takes place with the aid of the additive in the dust (cake layer) of the filter bags in the first system. Or to the activated carbon mixture in the fixed-bed filter in the second system.
The importance of this is the separation of harmful substances until a residual part of mercury of less than 0.05 mg/m3 remains, in accordance with the requirements of the Activities Decree.
As a result, the limit values can be adhered to for harmful substances in the waste gases (dioxins and furans less than 0.1 ng TEQ/Nm3). Both systems ensure that the emission requirements described in the Activities Decree are met.

Filter cloths and filter cartridges
The filter has automatic compressed air cleaning. The filter cloths and cartridges are arranged horizontally. These filters separate the dust particles until a residual dust content of less than 5 mg/m $^{3 \text{ remains}}$.

radial fan
The radial fan for the cleaned gas (exhaust gas) is placed after the filter. The entire installation is therefore operated with underpressure. A radial fan sucks the cleaned gas through the filter and blows it into the atmosphere through the chimney. This fan is controlled by a frequency converter. This ensures that the cremator operates with the correct negative pressure at all times.

Removing the residuals
Residues are discharged separately at the cyclone and the filter. With the cyclone, this happens continuously as long as the filter installation is in operation. The residues of the filter cloths are removed after the service has ended.

1.2.3 Energy

The electric oven has energetic advantages.
The oven can continue to be heated to temperature overnight using the so-called overflow energy
During and between daytime cremations, the oven does not use any extra energy.
The oven offers great flexibility; the oven can be kept at operating temperature with relatively little energy and is therefore always ready for operation.
The heat is stored as much as possible in the refractory construction.
The filter is provided with a thermal insulation on the outside, which will reduce the surface temperature of the filter from 150 °C to 40 °C.
Thermal insulation aims to:

- Absolute safety in the immediate vicinity of the filter for the personnel;
- Extending the life of the filter;
- Reduction of ambient noise.

Electricity consumption depends, among other things, on the number of cremations that take place per day. With an increasing number of cremations per day, energy consumption decreases accordingly.
If the oven is out of use for a longer period of time, such as at night or at the weekend, the fan placed on the filter is regulated to the lowest possible speed. This happens because of the partial operation of the installation, which is necessary in order to prevent condensation in the filter system.

Heat recovery
There is a facility for applying heat recovery at the heat exchanger.
This provides most of the heating for the crematorium. As a result, only little energy is used from other sources.

1.2.4 Process controls and safety features

It is an electric cremator and no natural gas is used. Operating an electrical installation differs from the usual gas-fired installations, but the current legislation and regulations will be complied with to the extent that it is relevant. (Mainly the AIM and the Bal, Activities Regulation Decree.)

Electrical intermediate circuits also prevent opening of the coffin insertion door if the temperature in the afterburner chamber is below 700°C.
The cremator is equipped with an automatic exhaust control to maintain a preset condition for all normal combustion conditions within the main combustion chamber.

The cremator is standard equipped with an oxygen analyzer. This analyzer ensures continuous regulation, monitoring and registration of the oxygen content in the flue gases

1.2.5 Ash processing

After the cremation is completed, the ashes, the identification stone and other residues are collected in the ash pan of the cremator.
The identification stone is checked and removed from the ash pan and the ash pan is placed in the ash mill (cremulator). The ash mill grinds the ashes. The separated parts are collected separately by the installation. The cremulator is set up in the ash treatment room. (See Appendix 4)

Ash processing table
On request, the crematorium can place the ashes of a deceased person in a different container. Examples are a decorative urn, a medallion or a special tube to take the ashes home. This action releases particulate matter, which could be inhaled by the employee concerned. To prevent this, an "ash processing table" is provided. In this device, any dust released is immediately extracted and protection for the employees of the crematorium is therefore guaranteed. The ash processing table is equipped with an extraction wall with filter unit. (See Appendix 5).
Due to the local underpressure created directly above the table, all dust particles are discharged directly to the filter unit. The filter unit can also serve as an extraction system for the cremulator. The air flow from the filter unit meets the emission requirements of 5 mg/m ^{3} with regard to dust from the Activities Decree.

2 Basis of equality

2.1 Introduction

The technology of an electrically operated cremator and subsequent technology deviates from Article 4.118 of the Activities Decree (section 4.8.9) and 4.112 of the Activities Regulation (section 4.8.8).
It should also be noted that these regulations in the Activities Regulation relate to firing the combustion and after-combustion chamber with natural gas with Low-NOx burners and not to an electric cremator.

The competent authority indicates that an electrically operated cremator may be permitted on the basis of equivalence.
It must be demonstrated that it is possible to achieve at least the same environmental quality with an electrically operated cremator and subsequent technology as with gas-fired ovens.

Below is a further explanation of the characteristics of an electric cremator.
In order to demonstrate the equivalence of meeting the emission requirements, a measurement report is attached for the same electric cremator that has been set up in Geleen.
The automatic electric cremator is designed to operate as efficiently as possible, with the composition of the refractory construction ensuring that the heat in the kiln is retained for as long as possible.

The main and post-combustion chambers are brought up to temperature before the first input by means of the heating elements (coils) present in the refractory construction. The spirals heat up the refractory construction, so that when the box is entered, it can catch fire via the radiant heat. The minimum temperature release for the main combustion chamber is 600 °C and for the post-combustion chamber it is a minimum of 700 °C. During the cremation process itself, the spirals are electrically turned off.

2.2 Explanation electrically operated cremator

2.2.1 General consideration

With regard to the state of affairs regarding the new technique of cremation by means of an electrically powered cremation oven introduced by DFW Europe BV, DFW Europe BV states the following.

The description given below for an electrically operated cremator and subsequent technology deviates from Article 4.118 of the Activities Decree (section 4.8.9) and 4.112 of the Activities Regulation (section 4.8.8).
It should also be noted that these regulations in the Activities Regulation relate to firing the combustion and after-combustion chamber with natural gas with Low-NOx burners.

2.2.2 Characteristics of the electrically operated cremation installation.

A big difference is the serenity surrounding the entire cremation installation (electric cremator and subsequent technology) in which work is done. This is a significant difference compared to a gas-fired cremator.
In addition, the course of the cremation process itself has also improved. DFW found that the electric cremation process performed with this technique exceeded its expectations. Also with regard to how the cremation process can be controlled, whereby cremation can be done at lower temperatures in the main and afterburner chambers in order to meet the required emission requirements.
This, in combination with an automatic infeed machine, ash pan lift, application of a tilting valve to be able to cool the ashes before removal, which techniques have been adopted from the gas-fed cremation installations, this electric cremator appears to be a good combination of existing and new technology. to be.

The required process time (as was known in advance) is currently slightly longer than for a gas-fired cremator (process time now approx. 100 minutes), but the flow of data that is now obtained gives DFW sufficient opportunities to make various improvements in this respect. bring.
Simultaneously with the construction and development of the electric cremator, DFW Europe has developed a new very extensive data logging system and has recently started using it.
The (large) flow of data that is collected by DFW's technicians from the electric cremator(s) already installed makes it very possible for DFW to make good analyzes and therefore to implement further modifications with advancing insight with which the new ones to be deliver electric cremators, as in the situation of a new crematorium provide even better performance.

Not only progress in the time span of process management, but in particular where, in the opinion of DFW, considerable catching up can be made, is the amount of energy required per cremation compared to the current cremation systems.

Before the “real cremation” starts with the input, the cremation combustion chamber and the post-combustion chamber are preheated in the electric cremator.
The starting temperatures at the infeed of the coffin into the cremator that DFW currently maintains are 600°C for the cremation combustion chamber and 700°C for the post- combustion chamber.
Immediately after the introduction of a coffin into the cremation chamber, we see the temperature in the afterburner chamber rise within a few seconds (3 to 4) to well above 800°C.

This 800°C is the limit value that is adhered to in the current technology of gas-fired cremators in order to be able to process peaks in CO and other combustion products at the start of the cremation process.
Of course, behind the oven itself is the downstream technology to reduce the other combustion components to the legal requirements.

DFW indicates that with the electric cremator, this 700°C and the residence time of the waste gases of at least 1.5 seconds in the post-combustion chamber are also amply met, in accordance with the design of this electric cremator, derived from the gas-fired oven.
The internal temperature (accumulated energy) of the entire construction of this electric cremator is much higher than that of a gas-fired cremator, achieving optimum combustion in the cremation chamber and after the combustion chamber, see section 5.2.4.

The combustion process of the coffin of a first cremation process in an electric furnace is therefore already comparable to a third and fourth cremation process in a gas-fired cremation furnace. Namely, in a third/fourth cremation process in a gas-fired cremator, no more energy needs to be added by means of the gas burners intended for that purpose. This is in view of the fact that sufficient energy is stored in the refractory construction from the previous cremation processes.
By means of this energy, accumulated in the refractory construction , the coffin is ignited by means of pyrolysis, whereby the cremation process is started by self-ignition.
This process of operation takes place in an electrically operated cremator already during a first cremation.

2.2.3 Cremator operation

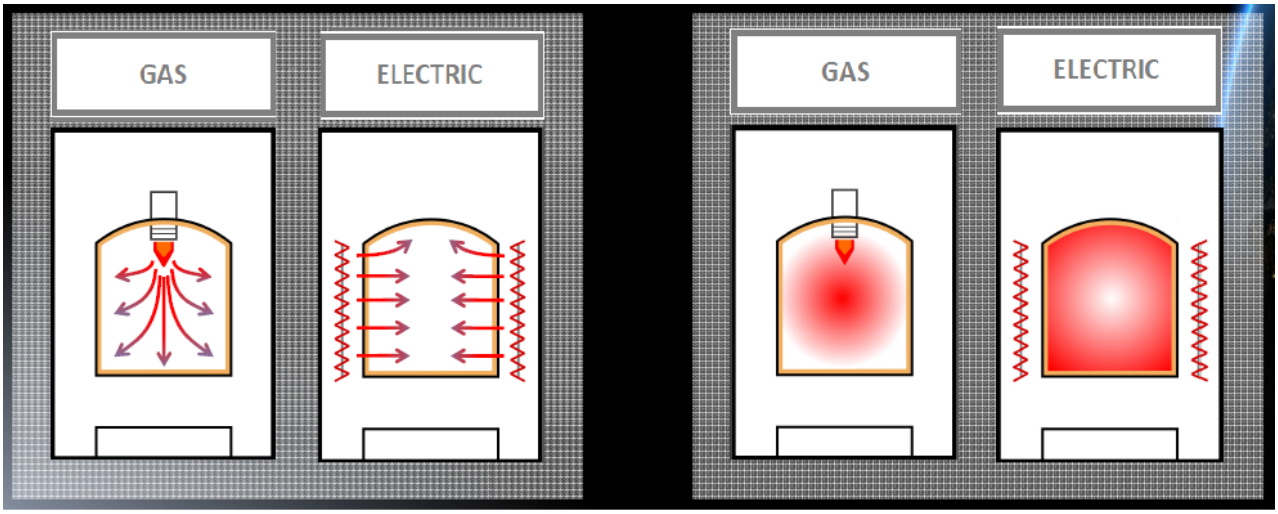
The automatic electric cremator is designed to operate as efficiently as possible, with the composition of the refractory construction ensuring that the heat in the kiln is retained for as long as possible.
The main and post-combustion chambers are brought up to temperature before the first input by means of the heating elements (coils) present in the refractory construction . The spirals heat the refractory construction , so that when the box is entered, it can catch fire via the radiant heat. The minimum temperature release for the main combustion chamber is 600°C and for the post-combustion chamber it is a minimum of 700°C. During the cremation process itself, the spirals are electrically turned off.

The description given above for an electrically operated cremator and subsequent technology deviates from Article 4.118 of the Activities Decree (section 4.8.9) and 4.112 of the Activities Regulation (section 4.8.8).
It should also be noted that these regulations in the Activities Regulation relate to firing the combustion and after-combustion chamber with natural gas with Low-NOx burners.

2.2.4 Additional substantiation

As indicated, in this situation of a Crematorium, there are electrically operated installations.

The difference between an electric oven and a gas oven is the fact that the electric oven is fully heated up before starting a process. This indicates that the total with refractory construction is up to temperature. Both the afterburner and the cremation chamber.
In a gas-fired oven, only the after-combustion chamber is heated for 15-30 minutes by means of a burner, after which the entire refractory construction is heated up. See picture in the attachment for clarification.



The reasons for the deviations in temperature are (among other things) that the air temperature in a gas-fired cremator must be at least 800°C, because the refractory construction in the main combustion chamber and post-combustion space at the start of a cremation itself does not always have sufficient radiant heat to be able to meet the criterion for complete combustion in the main chamber and complete afterburning of the resulting gaseous phase.
In this situation, the temperature is measured in the middle of the flue gas flow of the Low-NOx burners. This means that this minimum temperature of 800°C applies there, but that the refractory construction has somewhat lower temperatures when starting a cremation.
An optimum combustion situation is created in the gas-fired main combustion chamber, with NOx emissions resulting from the combustion of natural gas being minimal. For gas-fired afterburning, optimum afterburning of soot and smoke is achieved at this temperature for minimal emissions.

In an electrically driven installation, the heat for combustion comes directly from the radiation of the heating elements (coils) in the refractory construction, from the main combustion chamber and afterburner chamber. In this way a different (perhaps better) heat distribution/balance in the furnace and after-combustion chamber is achieved.

In view of the above of the difference between gas-fired and electrically powered cremators and the results of the electric cremators already in use, the suppliers state that when starting a cremation with a lower temperature of at least 600°C and 700 °C can suffice than is prescribed in art 4.118 of the Activities Decree (section 4.8.9) for gas-fired installations, in order to achieve the same optimum combustion effect.

In particular due to the better heat radiation of the refractory construction with electric spirals, an even more certain effect is possible through optimal heat radiation/heat distribution for optimal combustion of the body in the main combustion chamber and possible soot and smoke particles in the afterburning chamber.
In that situation, therefore, no optimal combustion for NOx is necessary, other than as a result of the burning of the body, because there is no question of a gas-fired installation.

In the opinion of the kiln supplier, therefore , lower minimum input temperatures when starting a cremation can also suffice in this situation than stated in art 4.112 of the Activities Regulation for gas-fired kilns. It should also be noted that this is a question of minimum input temperatures.

Once the electric furnace is in operation, the combustion temperatures in the furnace and afterburner chamber are many times higher. The same also applies to gas-fired furnace installations.

2.2.5 Afterburning

It is shown below (by means of a measurement report from the crematorium in Geleen) that the residence time in the post-combustion chamber is at least 1.5 seconds under normal operating conditions.
Immediately after the insertion of a box has taken place, we see the temperature in the afterburner chamber rise within a few seconds (3 to 4) to far above 800°C.

Emission measurements in Geleen have shown that, even with a temperature of 750°C in the afterburner chamber, this electric cremator also amply meets the emission requirements of the Activities Decree and also aims to burn the flue gases (CO, CxHy and germs and dioxins.)

In the attached appendix 1 with the measurement report with reference R003-1271511PZX-V02 dated September 19, 2019 it is stated that the residence time of gases in the afterburning chamber of the furnace is 2.4 seconds at a flue gas flow rate of 4044 m3/h and a furnace volume of 2 65 m.

2.2.6 Emission measurements

In order to demonstrate the emission equivalence, a measurement report is attached for a similar electric cremator and subsequent technology that has been set up in the Nedermaas crematorium in Geleen.

With the experience of the past 35 years of this downstream technology and in which a similar filter installation is placed behind the electric cremation oven of the crematorium, we can and may assume that behind all the previously installed gas-fired cremation ovens (about 110 units) from DFW that the emissions with regard to particulate matter, dioxins and mercury (heavy metals) from this installation are at least the same as from a gas-fired cremation installation.

All measurements at the cremation ovens and subsequent techniques installed by DFW in the Netherlands show that the requirements set in the Activities Decree with regard to air emissions are amply met.
The big difference is that large reductions in CO2 and NOx emissions (by more than 50%) are achieved with the new technology, because natural gas is not used.

Because the gas burners are missing in an electric oven , this has an effect on
a) a lower flue gas volume flow and
b) a relatively higher oxygen content during the combustion process because there are no gas burners that could cause a reduction in oxygen in combination with air.

Appendix 1 shows the measurement report with reference R003-1271511PZX-V02 dated 19 September 2019 from Crematorium Nedermaas in Geleen with such an electric cremator and downstream technology, indicating that this new electric cremation furnace installation with downstream technology meets the requirements. The measurement report indicates that this electrically operated installation also meets at least the same environmental quality for gas-fired ovens.
The entire report has been released for publication by DFW.

2.2.7 Process controls and safety features

It is an electric cremator and no natural gas is used. Operating an electrical installation differs from the usual gas-fired installations, but the current legislation and regulations will continue to be complied with insofar as relevant. (Mainly the AIM and the Bal, Activities Regulation Decree.)

No later than six months after the electric cremator installation has been put into use, and thereafter annually, the proper functioning of the installation is checked by an expert. At least the operation of the automatic controls and the continuous measuring equipment is checked. This in accordance with Article 4.112 paragraph 9 of the Activities Regulation.

Attachments

Appendix 1 **Emission measurement report Tauw R003 1271511 PZX V02 dated Sep 19. 2019**
Appendix 2 **Information DFW Electric Cremator and Automatic Feeder (ATM)**
Appendix 3 **Subsequent technology**
Appendix 4 **Cremulator**
Appendix 5 **Ash processing**