POPS LEGACY ELIMINATION AND POPS RELEASE REDUCTION PROJECT

IZAYDAŞ CLINICAL AND HAZARDOUS WASTE INCINERATION FACILITY

TEST BURN PROGRAM REPORT

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EXECUTIVE SUMMARY

As part of a GEF (Global Environment Facility) Project entitled “Persistent Organic Pollutants Legacy Elimination and POPs Release Reduction Project”; a Test Burn Program has been carried at Clinical and Hazardous Waste Incineration Plant by IZMIT Waste and Residue Treatment Incineration And Utilization Corporation (IZAYDAS), located in Izmit (KOCAELİ) in the Republic of Turkey. The overall objective is to support Turkey in developing a demonstrated national commercial capability available to meet its obligations under the Stockholm Convention respecting the destruction of Persistent Organic Pollutants (POPs) and as well as halogenated hazardous waste generally. The GEF support is additionally justified by the expectation that this work would serve to increase regional capacity generally for the elimination of POPs and other chemical waste.

In order to accomplish this objective the Test Burn Program undertaken by IZAYDAS as supported by the UNDP Project Management Unit (PMU) involved the operational performance of the IZAYDAS plant being evaluated during a series of test burns involving a POPs pesticide waste (HCH from the Merkim site being addressed in the GEF project) at two feed rates (overall chlorine content levels of 2 and 3%), and a high concentration PCB Oil waste at 2 % chlorine content levels. The overall Test Burn Program consisted of three main parts: i) determination of test burn conditions including the characterization of waste feed and feed rates to be evaluated; ii) measurement of all relevant facility input and output values required to define facility technical and environmental performance; and iii) evaluation and interpretation of the results in terms of destruction efficiency parameters and emissions compared to the reference standards and/or regulatory limits being applied. Actual test burns were carried out between December 12, 2016 and December 16, 2016.

The results of this Test Burn Program as reported in detail in the report indicated that the technical and environmental performance of the IZAYDAS plant on the representative POPs waste streams used fully complied with both national regulatory requirements and with the primary international guidance issued by the Basel Convention and GEF. This included i) operating conditions, ii) regulated flue gas emission parameters (including the range of standard air pollutant combustion gasses, particulate TOC, volatile heavy metals and PCDD/F), iii) PCDD/F and originating POPs in solid and liquid residual releases; and iv) destruction efficiency (DE and DRE). With respect to the latter, the levels of DE and DRE achieved were more than two orders of magnitude better than internationally specified requirements.

The overall conclusion made on the basis of the results from the Test Burn Program is that the IZYADAS facility more that meets both national regulatory requirements and prevailing international standards when applied to POPs pesticide and high concentration PCB oil wastes. On that basis, IZAYDAS believes its plant is fully qualified for the commercial destruction of POPs waste including such opportunities that may be offered by international projects such as financed by the GEF.

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ABBREVIATIONS AND ACRONYMS

APC	Air Pollution Control
BAT	Best Available Technology
BEP	Best Environmental Practice
BTEX	Benzene, toluene, ethylbenzene, and ortho-, meta-, and para- xylenes
CEMS	Continuous Emission Monitoring System
DDT	Dichloro-diphenly-trichlorethane
DE	Destruction Efficiency
DRE	Destruction Removal Efficiency
EPA	Environmental Protection Agency
EU	European Union
GEF	Global Environment Facility
HCH	Hexachlorocyclohexane (Lindane)
HHV	Higher Heat Value
HTI	High Temperature Incineration
IZAYDAS	IZMIT Waste and Residue Treatment Incineration and Utilization Corporation.
LHV	Lower Heat Value
MoEU	Ministry of Environment and Urbanization
OCP	Organochlorine pesticide
PCB	Polychlorinated byphenils
PCDDs	Polypolychlorobenzodioxins
PCDFs	Polychlorodibenzofurans
PLANT	IZAYDAS Clinical and Hazardous Waste Incineration Plant
POPs	Persistent Organic Pollutants
STAP	GEF Scientific and Technical Advisory Panel
TBP	Test Burn Program
TDS	Total Dissolved Solid
TEQ	Toxic Equivalent
TOC	Total Organic Carbon

TUBITAK	Turkish Scientific and Technological Research Institution
TUBITAK-MAM	Turkish Scientific and Technological Research Institution – Marmara Research Centre
TURKAK	Turkish Accreditation Agency
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

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SECTION 1 INTRODUCTION

1.1. Background of the Project

This work is being done as part of a GEF Project entitled "POPs Legacy Elimination and POPs Release Reduction Project" being undertaken jointly by UNDP and UNIDO as GEF Implementing Agencies with the Ministry of Environment and Urbanization (MoEU) as the national Executing Agency.

The overall Project is aimed at addressing POPs legacies in Turkey through elimination of POPs Pesticide and PCB stockpiles, and initiating clean-up of associated POPs and chemical pollutant contaminated sites, as well as dealing with longer term PCB phase out consistent with the country's Stockholm Convention obligations, reducing U-POPs release in major industrial sectors , and providing targeted institutional, regulatory and technical capacity strengthening, all within a sound chemicals management framework[1].

Component 1 of this Project is supervised by UNDP and includes provision for the qualification of needed hazardous waste infrastructure to international standards under its Outcome 1.3. The intention of this as approved by the GEF for support is assist Turkey in developing national commercial capability to meet its obligations under the Stockholm Convention and as well as environmentally sound management halogenated hazardous waste generally. The GEF support is additionally justified by the expectation that this work would serve to increase regional capacity generally for the cost effective elimination of POPs and other chemical waste. The principle activity being undertaken under Outcome 1.3 (Activity 1.3.2) involves GEF support for the upgrading investment of IZYDAS incineration facility being undertaken in large measure by the owner and additionally making a financial contribution to a formal Test Burn Program (TBP) at the facility to demonstration its capability against international performance standards on specific POPs Pesticide and PCB waste streams. The scope of the upgrading investment (US$ 7,727,206) and involving a GEF contribution of US$750,000 is defined in an agreement between IZAYDAS and MOEU administered by UNDP[2]. This work and the outcome being reported in this document forms the substantive deliverable to a parallel agreement between these parties coving the GEF contribution to the TBP in the amount of US$100,000.

1.2. Regulatory Requirements and International Standards

1.2.1. National Regulatory Requirements

The TBP will be generally implemented in accordance with the provisions laid down in national legislation and regulations, particularly the Regulation on Waste Incineration No, 2772, October 6, 2010[3].

The principle parts of this regulation relevant to undertaking the TBP are summarized as follows:

- According to Article 5; in the license of the incineration facility, the categories of waste which may be treated by incineration and emission parameters shall be explicitly listed. The list shall compose of the categories of waste and quantity of wastes by codes set up in the Annex 2-A of Regulation on General Principles of Waste Management[4]. The minimum and maximum mass flows of those

[1] http://www.thegef.org/sites/default/files/project_documents/9-29-2014_ID4601_r_ProjeDoc.pdf
[2] Investment Protocol between MOEU, Kocaeli Municipality and IZAYDAS on monitoring of investment and release of GEF Funds with regard to POPs Legacy Elimination and POPs Release Reduction Project
[3] https://www.csb.gov.tr/dosyalar/images/file/Atiklarin_Yakilmasina_Iliskin_Yonetmelik.pdf
[4] http://www.resmigazete.gov.tr/eskiler/2015/04/20150402-2.htm

hazardous wastes, their lowest and maximum calorific values and their maximum contents of pollutants, e.g. PCBs, PCPs ,Cl ,F,S , heavy metals shall be specified.

- According to Article 8, before obtaining a license for a new waste or extended operating conditions, the operator of the incineration plant shall undertake a test burn and during a 3-month-period undertake the analysis of the wastes to be incinerated and to submit such analysis to MoEU in order to define the resulting the waste water releases emission and air emissions for the defined waste feeding volumes.
- The operational conditions of the incinerator are identified in Article 10. It includes operation temperature (accordingly Cl value of waste), retention time and others requirements.
- Flue gas emission limits of incinerators are identified in Article 11.
- According to Article 15, all test burn analyses annually should be done including measurements for dioxins and furans at least every six months with one such measurement at least every three months being carried out for the first 12 months of operation.
- The actual test burn requirements in Article 8 specify a submission of a plan to MoEU in advance in accordance with a prescribed format (Appendix 7 of the regulation) and that the test burns may be witnessed by authorities and then a report submitted upon request.

It is noted that requirements for test burns in Turkey have been harmonized with the EU Incineration Directive (2000/76/EU)[5] in respect to operating conditions, technical requirements and flue gas emission limits (see Section 3).

1.2.2. International Standards

In addition to the EU Incineration Directive referenced above, relevant international standards will be used as guidance in the design, implementation, and result assessment of the TBP are the following:

- *"General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants"; The Basel Convention, UNEP/CHW.12/5/Add.2/Rev.1, Geneva, July 2015*[6]: The Basel Convention issues and periodically updates technical guidelines for the environmentally sound management of POPs waste which are adopted by the Stockholm Convention as the basis for convention compliance, particularly in respect to Article 6.
- *"Selection of Persistent Organic Pollutant Disposal Technology for the Global Environmental Facility, An Advisory Document", GEF Scientific and Technical Advisory Panel (STAP), November 2011*[7] : This advisory document covers the overall selection and requirements applicable to POPs disposal technology including those applicable to POPs destruction and irreversible transformation. It is generally are adopted for GEF projects including this Project as specified in the above referenced Project Document.

- *Directive 2010/75/EU of the European Parliament and the Council on Industrial Emissions (Integrated Pollution Prevention and Control)*[8]: This EU directive is the standard framework pollution control directive for industrial facilities including combustion facilities such as waste incinerators that is widely utilized to define a broad range of emission limits as well as applicable sampling and analytical methods.

[5] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32000L0076&qid=1469966412229&from=EN
[6] http://www.basel.int/Implementation/POPsWastes/TechnicalGuidelines/tabid/5052/Default.aspx
[7] http://www.thegef.org/publications/selection-persistent-organic-pollutant-disposal-technology-gef
[8] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:334:0017:0119:en:PDF

1.2.3. Technical, Environmental and Safeguards Performance Standards

The specific commitments made in the project document that form the main technical and environmental performance specifications based on the above standards are a demonstrated capability to achieve a destruction efficiency (DE) of 99.99%, destruction removal efficiency (DRE) of 99.9999%, and a maximum PCDD/F emission limit of 0.1 ng TEQ/Nm3. It should also be noted that the DE requirement contained in the most recent update of the Basel Guidelines is 99.999%.

The technical performance of POPs destruction technologies generally and individual operating destruction facilities are to be evaluated based on the level of destruction and irreversible transformation they achieve. This requires consideration of all waste and release output streams from the technology, inclusive of POPs other than those being destroyed, that may be unintentionally produced during the destruction process. Destruction Efficiency (DE), which is the percentage of originating POPs destroyed or irreversibly transformed by the technology is the more comprehensive measure of destruction applicable to originating POPs, where it can be reliably and reproducibly measured. Destruction and Removal Efficiency (DRE) is the percentage of original POPs destroyed, irreversibly transformed or removed from the air emission stream. DRE may serve as a supplementary performance parameter recognizing it only accounts for releases to air and not what could be transferred to other by-products and residuals streams. A DE>99.99% and DRE>99.9999% is recommended as working benchmarks for application in GEF projects including this one as defined in the above referenced Project Document. In general, higher DEs are preferred and a higher DE of 99.999% is recommended in the recently updated version of the Basel Guidelines. However, technologies should also be evaluated on a case-by-case basis. Where large amounts of POPs require disposal and financial capacity is limited, the actual volume of POPs destroyed or irreversibly transformed may be maximized by use of a lower cost option that achieves the specified minimum DE, rather than a higher cost option that exceeds the minimum DE.

Neither DE nor DRE take into account the potential for transformation of originating POPs to other POPs in the technological process. Therefore, any technology should demonstrate that this potential is minimized and at acceptable levels. Ensuring application of best available techniques and best environmental practices (BAT/BEP) to define safe design and operating conditions specific to the technology involved is recommended to maximize achievable environmental performance. For solid residuals or by-products containing either original or transformation POPs, the current provisional Basel low-POPs content levels should apply as an upper limit, noting that these may be changed and expanded periodically. Lower levels based on BAT/BEP should be attained where practical. Similarly, limits for air release of original and transformation POPs should be set at a level generally accepted in developed countries. For polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo-furans (PCDD/PCDF), this is 0.1 ng TEQ/Nm^3 to air and <0.3 ng TEQ/l for waste water effluent, again noting that BAT/BEP applicable to technologies can result in substantially better performance.

Additionally, international standards also require implementation of measures generally referred to as Safeguard Measures which are also typically part of the project specific environmental safeguard requirements for GEF projects as administered by UNDP in this case. As applied specifically to this TBP, these include having and implementing documented processes, procedures and oversight actions as follows which will also be part of a GEF Project's monitoring and evaluation plan:

- Demonstrated institutional/regulatory commitment and capacity to undertake appropriate oversight and enforcement;
- A national POPs inventory and endorsed NIP, regularly maintained and updated consistent with Convention obligations;
- Unambiguous legal custody and ownership of POPs stockpiles and wastes, covering rights of access, assignment of financial liability for disposal and environmental damage, and monitoring and site closure;
- Credible environmental assessment and permitting applied to facilities and activities which are benchmarked against international standards and practice;
- Performance monitoring during operations and documentation of the fate of all residues;
- Public participation, consultation and disclosure including timely access to information about POPs stockpile and waste disposal and input on how these activities are conducted; and
- Health, safety and emergency response plans covering protection and monitoring of workers involved in operating the technology and any potentially exposed members of the public.

SECTION 2 TEST BURN PLAN

The following provides details of this test burn program design and requirements that will apply in its implementation noting these are generally consistent with and/or incremental to the requirements set out in the national Regulation on Waste Incineration (Section 1.2).

In the Test Burn, besides the baseline hazardous industrial wastes currently being disposed at the IZAYDAS plant, representative HCH by-product material from the Merkim site in Kocaeli and high concentration PCB transformer dielectric oil from a stakeholder who has PCBs will be co-disposed with.

2.1. Collection, Reception and Storage of POPs Waste

2.1.1. Preparation of Baseline Waste Menu

Detailed planning was undertaken in order to coordinate the operational steps involved namely the acceptance, recording, laboratory, intermediate storage, and incineration. The aim is to determine a baseline emission and operational disposal performance for comparison with the targeted POPs waste test burns. This plant serves different sectors of industry and public institutions, accepting a variety of wastes (different type, calorific value and composition) for final disposal. It is important that comprehensive planning and characterization of the selected representative baseline waste for co-disposal with the targeted waste.

This work involved the preparation of a representative daily waste incineration menu characteristic of what the plant normally accepts in a time frame of twenty four hours. Firstly, all type of wastes were classified as physical and chemical (solid wastes, liquid wastes, aqueous liquid wastes, special liquid wastes, barrel wastes etc.) and those most appropriate and representative from the waste being regularly supplied to the plant were selected according to the following main conditions and constraints:

- The plant should be operated according to the emission criteria (given in regulations) and other environmental aspects.
- The total amount of waste to de disposed of and the percentages of wastes in this total amount are readily and reproducibly available.
- The characteristics of waste, such as concentration, calorific value, halogen, nitrogen, sulfur, heavy metal content are determined
- Delivery method for the waste specified(tanker, big container, drum, small container)
- The preparation requirements of the waste in the storage area defined.

The aim of this baseline waste feed plan is to bring together the main conditions given above for a reliable incineration process that is consistent during the all working periods.

The main control parameters describing the incineration process are:

- The calorific values of wastes
- Minimum temperature in the post combustor
- Primary pollution related parameters of the waste such as F, Cl, Br, I, S, P.

On this basis, a basic daily Waste Incineration Menu applied during the routine operation of the plant contains the physical and chemical waste characteristics required to operate the plant in accordance

with the regulatory requirements. Selected wastes from the Daily Waste Incineration Menu were prepared in the menu area by appropriate packaging and labelling by the Waste Acceptance Unit.

2.1.2. Preparation of Pesticide-HCH waste

In accordance with the purpose of the Test Burn Program, one of the selected POPs wastes was HCH (Hexachlorocyclohexane)/HCH by product material, which are solid chlorinated pesticides. These wastes were supplied by IZAYDAS teams who collected the required amounts from the POPs Pesticide stockpiles in a warehouse complex located in the Merkim site in Kocaeli.

As seen in the photographs below, IZAYDAS staff entered MERKIM waste storage area consistent with appropriate personal safety and environmental security measures. HCH waste has been packed with 60 liter HDPE barrels. The barrels has been made secure by wrapping and placing on the wooden pallets. The wastes on the pallets were transported by the forklift to a truck having a hazardous waste transport license for transport to the IZAYDAS plant.

2.1.3. Preparation of Pesticide- PCB transformer dielectric oil

In accordance with the purpose of the Test Burn Program, the other selected POPs wastes was high concentration PCB transformer dielectric oil, which was in liquid form. These wastes will be supplied by IZAYDAS teams from the warehouses located in the Erdemir site in Zonguldak.

The required amount of PCBs waste oils was discharged from the transformers in ERDEMIR storage area by IZAYDAS staff. PCBs waste oils has been filled in 1 cubic meter IBC containers and transported to IZAYDAS by the trucks with hazardous waste transport license.






2.2. Form of Test Burn Feed Menu

The intention is that each type of POPs waste test burns will be done at one or more feed rate/chlorine content combinations. Each Test Burn was held over a 24 hour period. In total, four test burns covering different waste streams and feed conditions. Each test consisted of three period in a time frame of eight hours. In the first eight hours period, the plant operation conditions were stabilized before initial sampling. In the second and third eight-hour periods, the samples were also taken (Section 2.5).

The first test burn in the TBP was a full 24 hour baseline test burn (Test 1) using a typical commercial hazardous waste stream (1.03% halogen level) as described above as selected to be co-disposed with POPs waste, inclusive of two full sampling periods. This was followed by a 24 hour test burn run with HCH (Test 2) at a feed rate giving a 2.23% total halogen feed level, then immediately by a 24 hour HCH test run at 3.01% total halogen feed level (Test 3). In both cases this covered two full sampling periods. At that point, the unit reverted to the baseline waste for a period of a period of 8 hours. This was followed by a 24 hour test run on PCB transformer oil at a 2.23% halogen feed level (Test 4) with two full sampling periods scheduled. At that point, the unit returned to the baseline feed and normal commercial operation. Table 5 illustrates this target schedule. In planning this, the assumption was it is undertaken continuously without interruption. However it was also recognized that operating circumstances may not allow that and the schedule might interrupted as mutually agreed between UNDP and IZAYDAS. However, the principle of maintaining continuous runs on individual tests was to be maintained and, where an interruption occurs, it would be preceded by a minimum 8 hour run on the baseline prior to starting the next POPs waste test run.

2.2.1. Wastestream of Test Menu

Table 1-TEST 1-BASELINE MENU (%1,03 HALOGEN)

STORAGE LOCATION	WASTE TYPE	EXPLANATION	CAL. VALUE	CONTENT %					
			kJ/kg	F	Cl	Br	I	P	S
TANK FARM	HHV liquid	Waste oils	38.079	0,03	0,16	0,06	0,06	0,06	0,95
TANK FARM	HHV liquid	Waste oils	32.019	0,03	0,16	0,06	0,06	0,06	0,58
TANK FARM	LHV liquid	Waste aqueous liquids	1.647	0,03	0,16	0,06	0,06	0,06	0,1
TANK FARM	LHV liquid	Waste aqueous liquids	1.647	0,03	0,16	0,06	0,06	0,06	0,1
BUNKER	Solid	Bulk mixed waste	10.522	0,03	0,5	0,06	0,06	0,06	0,1
SPECIAL LIQUID FIELD	Special liquid	Liquid waste	38.312	0,03	0,16	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Empty Cyanide Bags	42.904	0,03	0,16	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Liquid	Mixed Chemicals	3.829	0,03	0,16	0,06	0,06	0,06	0,32
BARREL WAREHOUSE	Liquid	Isocyanate	26.419	0,05	3,77	0,07	0,18	0,26	0,12
BARREL WAREHOUSE	Solid	Cytotoxic Drugs	1.000	0,1	4	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Liquid	Trichlorethylene	18.682	0,05	50,98	0,07	0,18	0,26	0,12
BARREL WAREHOUSE	Solid	Metal barrel	1.000	0,1	0,1	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Solid	Powder Waste	12.617	0,03	0,35	0,06	0,06	0,06	0,16
BARREL WAREHOUSE	Liquid	Chemical waste	11.238	0,03	0,17	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Pathological Waste	1.000	0,1	4	0,1	0,1	0,1	0,1
HCV: High Calorific Value			Halogen (kg/h)	48,59					
LCV: Low Calorific Value			Halogen (%)	1,03%					

Table 2-TEST 2-HCH FEED MENU (%2,23 HALOGEN)

STORAGE LOCATION	WASTE TYPE	EXPLANATION	CAL. VALUE	CONTENT %					
			kJ/kg	F	Cl	Br	I	P	S
TANK FARM	HHV liquid	Waste oils	36390	0,03	0,16	0,06	0,06	0,06	0,86
TANK FARM	HHV liquid	Waste oils	41242	0,03	0,16	0,06	0,06	0,06	0,2
TANK FARM	LHV liquid	Waste aqueous liquids	1647	0,05	0,27	0,07	0,18	0,26	0,12
TANK FARM	LHV liquid	Waste aqueous liquids	1647	0,05	0,27	0,07	0,18	0,26	0,12
BUNKER	Solid	Bulk mixed waste	12000	0,03	0,5	0,06	0,06	0,06	0,49
SPECIAL LIQUID FIELD	Liquid	Mixed liquids	38312	0,03	0,16	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Cytotoxic Drugs	1000	0,1	4	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Liquid	Trichlorethylene	18682	0,05	50,98	0,07	0,18	0,26	0,12
BARREL WAREHOUSE	Solid	Metal barrel	1000	0,1	0,1	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Liquid	Powder Waste	12617	0,03	0,35	0,06	0,06	0,06	0,16
BARREL WAREHOUSE	Solid	Chemical waste	11238	0,03	0,17	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	HCH	10589	0,03	56,3	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Cytotoxic	1000	0,1	4	0,1	0,1	0,1	0,1
HCV: High Calorific Value			Halogen (kg/h)	95,63					
LCV: Low Calorific Value			Halogen (%)	2,23%					

Table 3-TEST 3-HCH FEED MENU (%3,01 HALOGEN)

STORAGE LOCATION	WASTE TYPE	EXPLANATION	CAL. VALUE	CONTENT %					
			kJ/kg	F	Cl	Br	I	P	S
TANK FARM	HHV liquid	Waste oils	38079	0,03	0,16	0,06	0,06	0,06	0,95
TANK FARM	HHV liquid	Waste oils	32019	0,03	0,16	0,06	0,06	0,06	0,58
TANK FARM	LHV liquid	Waste aqueous liquids	1647	0,03	0,16	0,06	0,06	0,06	0,1
TANK FARM	LHV liquid	Waste aqueous liquids	1647	0,03	0,16	0,06	0,06	0,06	0,1
BUNKER	Solid	Bulk mixed waste	10522	0,03	0,5	0,06	0,06	0,06	0,1
SPECIAL LIQUID FIELD	Liquid	Mixed liquids	38312	0,03	0,16	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Pathological Waste	1000	0,1	4	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Solid	Cytotoxic and Cytostatic Drugs	1000	0,1	4	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Liquid	Trichlorethylene	18682	0,05	50,98	0,07	0,18	0,26	0,12
BARREL WAREHOUSE	Solid	Empty Cyanide Bags	42904	0,03	0,16	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Powder Waste	12617	0,03	0,35	0,06	0,06	0,06	0,16
BARREL WAREHOUSE	Solid	HCH	10589	0,03	56,87	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Cytotoxic	1000	0,1	4	0,1	0,1	0,1	0,1
HCV: High Calorific Value			Halogen (kg/h)	140,33					
LCV: Low Calorific Value			Halogen (%)	3,01%					

Table 4-TEST 4-PCBs OIL FEED MENU (%2,06 HALOGEN)

STORAGE LOCATION	WASTE TYPE	EXPLANATION	CAL. VALUE	CONTENT %					
			kJ/kg	F	Cl	Br	I	P	S
TANK FARM	HHV liquid	Waste oils	38079	0,03	0,16	0,06	0,06	0,06	0,95
TANK FARM	HHV liquid	Waste oils	32019	0,03	0,16	0,06	0,06	0,06	0,58
BUNKER	LHV liquid	Waste aqueous liquids	1647	0,03	0,16	0,06	0,06	0,06	0,1
SPECIAL LIQUID FIELD	LHV liquid	Waste aqueous liquids	1647	0,03	0,16	0,06	0,06	0,06	0,1
BUNKER	Solid	Bulk mixed waste	10522	0,03	0,5	0,06	0,06	0,06	0,1
SPECIAL LIQUID FIELD	Liquid	PCB transformer oil	16179	0,03	48,12	0,06	0,06	0,06	0,1
SPECIAL LIQUID FIELD	Liquid	PCB transformer oil	17671	0,03	45,45	0,06	0,06	0,06	0,1
SPECIAL LIQUID FIELD	Liquid	PCB transformer oil	14659	0,03	51,92	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Pathological Waste	1000	0,1	4	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Solid	Cytotoxic Drugs	1000	0,1	4	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Liquid	Mixed Chemicals	3829	0,03	0,16	0,06	0,06	0,06	0,32
BARREL WAREHOUSE	Solid	Empty Cyanide Bags	42904	0,03	0,16	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Powder Waste	12617	0,03	0,35	0,06	0,06	0,06	0,16
BARREL WAREHOUSE	Liquid	Chemical waste	11238	0,03	0,17	0,06	0,06	0,06	0,1
BARREL WAREHOUSE	Solid	Cytotoxic	1000	0,1	4	0,1	0,1	0,1	0,1
BARREL WAREHOUSE	Solid	Metal barrel	1000	0,1	0,1	0,1	0,1	0,1	0,1
HCV: High Calorific Value			Halogen (kg/h)	95,60					
LCV: Low Calorific Value			Halogen (%)	2,06%					

2.3. Test Burn Program Schedule

Planned Test Schedule is shown in the Table 5 below:

*Table 5-**Target Test Burn Program Schedule***

DATE	SHIFT	TIME	TEST NO	MENU NAME	TEST CONDITION	SAMPLING	SAMPLING CODE
12.12.16	Night shift	24.00-08.00	Test 1	Baseline feed	1.03% Halogen	No	No
12.12.16	Day shift	08.00-16.00	Test 1	Baseline feed	1.03% Halogen	First sampling period	TEST 1/A
12.12.16	Evening shift	16.00-24.00	Test 1	Baseline feed	1.03% Halogen	Second sampling period	TEST 1/B
13.12.16	Night shift	24.00-08.00	Test 2	HCH feed	2.02% Halogen	No	No
13.12.16	Day shift	08.00-16.00	Test 2	HCH feed	2.02% Halogen	First sampling period	TEST 2/C
13.12.16	Evening shift	16.00-24.00	Test 2	HCH feed	2.02% Halogen	Second sampling period	TEST 2/D
14.12.16	Night shift	24.00-08.00	Test 3	HCH feed	3.09% Halogen	No	No
14.12.16	Day shift	08.00-16.00	Test 3	HCH feed	3.09% Halogen	First sampling period	TEST 3/E
14.12.16	Evening shift	16.00-24.00	Test 3	HCH feed	3.09% Halogen	Second sampling period	TEST 3/F
15.12.16	Night shift	24.00-08.00	Test 1	Baseline feed	1.03% Halogen	No	No
15.12.16	Day shift	08.00-16.00	Test 4	PCBs oil feed	2.06% Halogen	No	No
15.12.16	Evening shift	16.00-24.00	Test 4	PCBs oil feed	2.06% Halogen	First sampling period	TEST 4/G
16.12.16	Night shift	24.00-08.00	Test 4	PCBs oil feed	2.06% Halogen	Second sampling period	TEST 4/H

2.4. Waste Characterization Sampling and Analyses

The IZAYDAS was responsible for sampling and making the detailed characterization of each container of POPs waste received as part of the TBP. IZAYDAS utilized their own laboratories which has the necessary accreditations where capability existed and the remaining analyzes was carried out in the fully accredited TUBITAK[9] laboratories. TUBITAK has the accretidation Certification[10] according to the rule of TS EN ISO/IEC 17025:2012 by TURKAK (Turkish Accreditation Agency). The accredation certification is accepted an international accreditation[11].

The analytical methods used to carry out characterization of the wastes contained in the selected waste menus for the Test Burn Program are given in the Table 6.

[9] The Scientific and Technological Research Council of Turkey (TÜBİTAK) is the leading agency for management, funding and conduct of research in Turkey. It was established in 1963 with a mission to advance science and technology, conduct research and support Turkish researchers. The Council is an autonomous institution and is governed by a Scientific Board whose members are selected from prominent scholars from universities, industry and research institutions. TÜBİTAK is responsible for promoting, developing, organizing, conducting and coordinating research and development in line with national targets and priorities.

[10] https://mam.tubitak.gov.tr/sites/images/mam---/ctue_akreditasyon_belgeleri_2015.pdf

[11] TURKAK, started to provide accrediation services in 2001 and became a signatory of MLA with EA for all the available accreditation schemes at 2008. Currently TURKAK is a full member of EA, IAF and ILAC. TUBITAK laboratuaries has been accredited according to international accreditation standard by TURKAK.

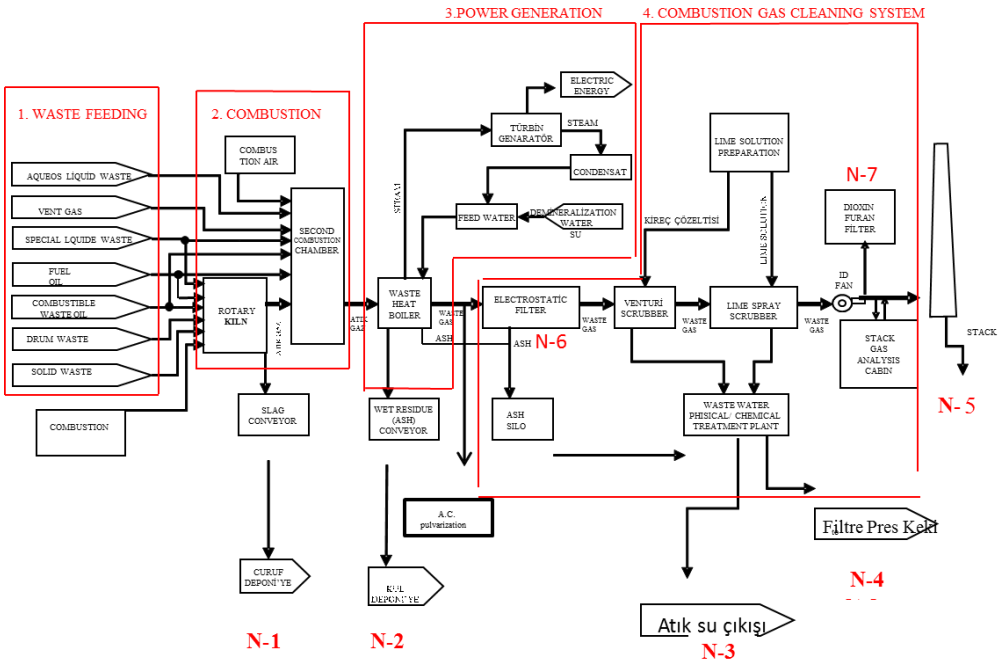
Table 6-Analyses in Waste Menu

TEST	PARAMETER	ANALYTICAL METHOD
TEST 1-Baseline Feed Waste	Calorific Value-(kj/kg)	TS 16023
	Dry Ingredients (%)	TS 9546 EN 12280
	Chlorine-(%)	TS EN 14582-TS EN ISO 10304-3
	Fluorine-(%)	TS EN 14582-TS EN ISO 10304-3
	Bromin-(%)	TS EN 14582-TS EN ISO 10304-3
	Iodin-(%)	TS EN 14582-TS EN ISO 10304-3
	Phosphor-(%)	TS EN 14582 - TS EN ISO 10304-1
	Sulfur-(%)	TS EN 14582 - TS EN ISO 10304-1
	TOC - mg/kg	TS12089 EN 13137
	BTEX – mg/kg	EPA8015 D - EPA 5021A
	Loss of Ignition (%)	TS EN 12879
TEST 2-HCH Feed TEST 3-HCH Feed	Calorific Value-(kj/kg)	TS 16023
	Dry Ingredients (%)	TS 9546 EN 12280
	Chlorine-(%)	TS EN 14582-TS EN ISO 10304-3
	Fluorine-(%)	TS EN 14582-TS EN ISO 10304-3
	Bromin-(%)	TS EN 14582-TS EN ISO 10304-3
	Iodin-(%)	TS EN 14582-TS EN ISO 10304-3
	Phosphor-(%)	TS EN 14582 - TS EN ISO 10304-1
	Sulfur-(%)	TS EN 14582 - TS EN ISO 10304-1
	TOC - mg/kg	TS12089 EN 13137
	BTEX – mg/kg	EPA8015 D - EPA 5021A
	Loss of Ignition (%)	TS EN 12879
	Total organic pesticides (OCP) – mg/kg	ISO 10382 (TUBITAK)
	HCH (total/congeners) – mg/kg, % concentration	ISO 10382 (TUBITAK)
	DDT – mg/kg	ISO 10382 (TUBITAK)
	PCCD/F (total/congeners) – ng/kg	EPA 1613 (TUBITAK)
TEST 4-PCB FEED	Calorific Value-(kj/kg)	TS 16023
	Dry Ingredients (%)	TS 9546 EN 12280
	Chlorine-(%)	TS EN 14582-TS EN ISO 10304-3
	Fluorine-(%)	TS EN 14582-TS EN ISO 10304-3
	Bromin-(%)	TS EN 14582-TS EN ISO 10304-3
	Iodin-(%)	TS EN 14582-TS EN ISO 10304-3
	Phosphor-(%)	TS EN 14582 - TS EN ISO 10304-1
	Sulfur-(%)	TS EN 14582 - TS EN ISO 10304-1
	BTEX – mg/kg	EPA8015 D - EPA 5021A
	PCCD/F (total/congeners) – ng/kg	EPA 1613 (TUBITAK)
	PCB – mg/kg, % concentration	ISO 10382 (TUBITAK)

2.5. Test Burn Sampling Points and Sample Analyses

The main objective of this activity was to obtain quantitative data sufficient to reliably calculate DE and DRE for each POPs waste test and quantify the amount of unintended POPs releases and other possible priority pollutants associated with the processing of POPs waste from all potential release points. This provides the core data to be used for the determination of compliance with national emission limits and international standards and Stockholm Convention requirements related to the destruction or irreversible transformation of the POPs waste as being evaluated in this TBP. It was to be obtained from the sampling and associated laboratory analysis of air emissions from the facility flue gas stack, solid residue releases from various release points in the process and condensate waste water releases. The required sampling and analysis will also cover the broader range of emission and release requirements specified in the Regulation on Waste Incineration which is harmonized with the relevant EU directives previously referenced. The following provides a general description of what is to be sampled and analyzed, where, and by what methods. The sampling locations are illustrated in the plant process schematic below:

- N-1 (Sampling point 1): Slag (bottom ash) from the rotary kiln with samples to be taken from the slag containers used to extract this solid residue.
- N-2 (Sampling point 2): Ash from the waste heat boiler system with samples taken from the bottom ash collector
- N-3 (Sampling point 3: Physical / chemical treatment effluent
- N-4 (Sampling point 4): Waste water treatment system filter press cake samples
- N-5 (Sampling point 5): Combustion Plant Flue stack air releases taken at sampling points prior to release.
- N-6 : dust sample from bottom of the electrostatic precipitator
- N-7: activated carbon from dioxin filter



2.5.1. Flue Gas Emission Sampling and Analysis (Sampling point N-5)

Flue-gas emission performance of the plant was to be demonstrated by the measuring of the potential releases flue gas stack, including of target POPs not destroyed in the plant and unintended releases. Sampling and analyses of parameters in the Table 7 were provided by TUBITAK. The sampling and analysis data generation was undertaken as a combination of automated continuous sampling and data collection using the facility's CEMS and periodic manual sampling at the stack itself (in accordance with the national Regulation on Waste Incineration)

Table 7-Stack gas emission analyses and methods

PARAMETER	ANALYTICAL METHOD	TEST 1	TEST 2	TEST 3	TEST 4
Gas flow rate - m^3/sec	TS ISO 10780	✓	✓	✓	✓
Moisture Content - %	EPA Method 4	✓	✓	✓	✓
Gas outlet temperature -^oC	TS ISO 10780	✓	✓	✓	✓
Gas pressure – mbar	TS ISO 10780	✓	✓	✓	✓
Regulated heavy metals - mg/ m^3 (Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V+Hg+Cd+Tl)	EPA Method 29	✓	✓	✓	✓
PCDD/F - ng/m^3	EN 1948 – 1,2,3	✓	✓	✓	✓
NOX, SO2, CO, O2-mg/m^3	TS ISO 7935, TS ISO 12039, EPA CTM 022	✓	✓	✓	✓
Total particulate - mg/m^3	TS ISO 9096	✓	✓	✓	✓
Halogens - mg/m^3	ISO 15713	✓	✓	✓	✓
TOC - mg/m^3	EPA 25A	✓	✓	✓	✓
OCP - ng/m^3	TS EN 1948-1		✓	✓	
HCH (total/all congeners) - ng/m^3	TS EN 1948-1	-	✓	✓	-
DDT - ng/m^3	TS EN 1948-1	-	✓	✓	-
PCBs - ng/m^3	ISO 10382	-	-	-	✓

2.5.2. Physical/Chemical Plant Discharge Water ((Sampling Point N-3)

Table 8-Discharge Water analyses and methods

PARAMETER	ANALYTICAL METHOD	TEST 1	TEST 2	TEST 3	TEST 4
Total Suspended Solids –mg/l	SM-2540 D	✓	✓	✓	✓
Mercury – mg/l	SM-3112 AAS	✓	✓	✓	✓
Cd, Tl, As, Pb, Cr, Cu, Ni - mg/l	EPA 6020 A ICP	✓	✓	✓	✓
PCDD/F - ng/l	TS EN 1948-3	✓	✓	✓	✓
OCP - ng/m^3	ISO 10382	-	✓	✓	-
HCH (total/all congeners)- ng/m^3	ISO 10382	-	✓	✓	-
DDT - ng/m^3	ISO 10382	-	✓	✓	-
PCBs - ng/m^3	ISO 10382	-	-	-	✓

2.5.3. Released Solid Residues (Slag/bottom ash: N-1 , waste heat boiler ash: N-2, filter press cake: N-4)

Table 9-Slag, Ash from boiler, Filter press cake analyses and methods

PARAMETER	ANALYTICAL METHOD	TEST 1	TEST 2	TEST 3	TEST 4
As, Ba, Cd, Cr, Cu	EPA 6020 A ICP-MS	✓	✓	✓	✓
Hg	SM-3112 AAS	✓	✓	✓	✓
Mo, Ni, Pb, Sb, Se, Zn	EPA 6020 A ICP-MS	✓	✓	✓	✓
Chloride (Cl^- mg/ l)	SM4110 B	✓	✓	✓	✓
Fluoride (F^- mg/ l)	4500- F^- C	✓	✓	✓	✓
Sulphate ($SO_4^{==}$ mg/ l)	SM4110 B	✓	✓	✓	✓
Dissolved Organic Carbon (DOC mg/ l)	SM4110 B	✓	✓	✓	✓
Total Dissolved Solids (TDS mg / l)	SM-2540 C	✓	✓	✓	✓
Phenol (C6H5OH mg/ l)	SM-5530 D	✓	✓	✓	✓
PCDD/F – mg/kg	TS EN 1948-3	✓	✓	✓	✓
OCP - mg/kg	ISO 10382	-	✓	✓	-
HCH (total/all congeners)- mg/kg	ISO 10382	-	✓	✓	-
DDT - mg/kg	ISO 10382	-	✓	✓	-
PCBs - mg/kg	ISO 10382	-	-	-	✓

2.5.4. APC Residues (Bag house filter dust: N-6, dioxin filter residues: N-7)

Table 10-Dust from Baghouse and Activated Carbon from Dioxin filter analyses and methods

PARAMETER	ANALYTICAL METHOD	TEST 1	TEST 2	TEST 3	TEST 4
OCP - mg/kg	ISO 10382	-	✓	✓	-
HCH (total/all congeners)- mg/kg	ISO 10382	-	✓	✓	-
DDT - mg/kg	ISO 10382	-	✓	✓	-
PCDD/F - mg/kg	TS EN 1948-3	-	✓	✓	✓
PCBs - mg/kg	ISO 10382	-	-	-	✓

The following illustrate the locations of sampling points:

N-2: Wet Ash(from boiler) N-1: Slag (bottom ash) N-3: : Physical / chemical treatment effluent

N-4: Filterpres Cake N-5: Stack gases emission N-6: Fly ash from electrostatic precipitator

N-7: Activated Carbon from Dioxin Removal filter

Stack gas emission sampling

S Activated Carbon Sampling

Fly Ash Sampling

Sample set for Test 2B

SECTION 3 TEST BURN PROGRAM RESULTS

The Test Burn was carried out between 12 December 2016 and 16 December 2016. The samples taken from the sampling points shown in detail in the Section 2.5 and all necessary parameters were sampled, measured and analyzed by TUBITAK and IZAYDAS. In addition, the Plant's own CEMS) has continuously carried out measurements of the applicable parameters in the flue gas in accordance with national legislation. Below is a description of each test as performed and associated results.

3.1. Waste Streams

3.1.1. Test 1: Baseline Waste

As defined Section 2.1.1, the wastes prepared and labelled in accordance with the Test 1-Basic Menu were loaded into the rotary kiln and the second combustion chamber at the night shift by 00:00 o'clock on December 12, 2016. The same waste menu was fed for twenty-four hours. During the test burn of the Test 1 -Basic Menu, there was no interruption in any malfunction or waste supply. As planned, the test was completed at 24:00 o'clock on December 12, 2016.

Table 11-TEST 1-BASIC MANU (%1,03 HALOGEN)

PARAMETER	UNIT	BUNKER	BARREL								PCL-1	PCL-2	AQUEOUS LIQUIDS	SPECIAL LIQUID	FUEL
			Empty Cyanide Bags	Mixed Chemicals	Isocyanate	Cytotoxic/ Cytostatic Drugs	Trichloro ethylene	Metal Contaminated Barrel	Powder Waste	Chemical waste					
Type		Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	HHV liquid	HHV liquid	LHV liquid	Special liquid	fuel oil
Type of feed		Bulk	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Burner	Burner	Lens	Lens[12]	Burner
Location of feed		R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	P.C.C	P.C.C	R.K	R.K
Nominal feed rate	kg/h	3337	51,625	38,17	28,583	37,54	48,25	29,583	31,67	63,25	441,21	223,79	392	244	95,865
Physical state		Solid	Solid	Liquid	Liquid	Solid	Liquid	Solid	Solid	Solid	Liquid	Liquid	Liquid	Liquid	Liquid
HHV	kJ/kg	10.522	42.904	3.829	26.419	1.000	18.682	1.000	12.617	11.288	32.019	32.019	1.647	38.312	42.297
Flor	%	0,03	0,03	0,03	0,05	0,1	0,05	0,1	0,03	0,03	0,03	0,03	0,03	0,03	0,05
Chlorine	%	0,5	0,16	0,16	3,77	4	50,98	0,1	0,35	0,17	32.019	38.079	0,16	0,16	0,27
Bromine	%	0,06	0,06	0,06	0,07	0,1	0,07	0,1	0,06	0,06	0,03	0,03	0,06	0,06	0,07
Iodine	%	0,06	0,06	0,06	0,18	0,1	0,18	0,1	0,06	0,06	0,16	0,16	0,06	0,06	0,18
Phosphorus	%	0,06	0,06	0,06	0,26	0,1	0,26	0,1	0,06	0,06	0,06	0,06	0,06	0,06	0,26
Sulfur	%	0,1	0,1	0,32	0,12	0,1	0,12	0,1	0,16	0,1	0,06	0,06	0,1	0,1	2,22
Loss of ignition	%	76,49	-	-	-	-	-	-	-	-	98,00		90	-	-
Dry Ingredients	%	61,695	-	-	-	-	-	-	-	-	5,00		2	-	-
BTEX	mg/kg	11,335	-	-	-	-	-	-	-	-	not measured	not measured	not measured	-	-
Total organic pesticides (OCP)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HCH (total/congenerous)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DDT	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCDD/F (total/congenerous)	ng/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOC	mg/kg	647.531	-	-	-	-	-	-	-	-	831.893	-	60.653	-	-
PCB	mg/kg	-	-	-	-	-	-	-	-	-		-	-	-	-

[12] Lens is a type of burner and it is used for different type of liquid waste to be able to feed in smaller amounts.

3.1.2. Test 2: HCH (2.02% Halogen)

As defined Section 2.1.2, the wastes was prepared and labelled in accordance with the Test 2-HCH Feeding Menu were loaded into the rotary kiln and the second combustion chamber at the night shift by 00:00 o'clock on December 13, 2016. The same waste menu was fed for twenty-four hours. During the test burn of the Test 2 -HCH Feeding Menu, there was no interruption in any malfunction or waste supply. As planned, the test was completed at 24:00 o'clock on December 13, 2016..

Table 12-TEST 2-HCH FEEDING (%2,23 HALOGEN)

PARAMETER	UNIT	BUNKER	BARREL								PCL-1	PCL-2	AQUEOUS LIQUIDS	SPECIAL LIQUID	FUEL
			Pathological Waste	Cytotoxic /Cytostatic	Trichloro ethylene	Metal Contaminated Barrel	Powder Waste	Chemical waste	HCH-Pesiticde	Cytotoxic					
Type		Solid	Solid	Solid	Liquid	Solid	Solid	Liquid	Solid	Solid	HHV liquid	HHV liquid	LHV liquid	Special liquid	fuel oil
Type of feed		Bulk	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Burner	Burner	Lens	Lens	Burner
Location of feed		R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	P.C.C	P.C.C	R.K	R.K
Nominal feed rate	kg/h	3125	10,71	26,67	31,71	29,542	36,625	55,92	107,417	21,75	379,58	229,79	414	250	144
Physical state		Solid	Solid	Solid	Liquid	Solid	Solid	Liquid	Solid	Solid	Liquid	Liquid	Liquid	Liquid	Liquid
HHV	kJ/kg	10.522	1.000	1.000	18.682	1.000	12.617	11.238	10.589	1.000	32.019	38.079	1.647	38.312	42.297
Flor	%	0,03	0,1	0,1	0,05	0,1	0,03	0,03	0,03	0,1	0,03	0,03	0,03	0,03	0,05
Chlorine	%	0,5	4	4	50,98	0,1	0,35	0,17	56,067	4	0,16	0,16	0,16	0,16	0,27
Bromine	%	0,06	0,1	0,1	0,07	0,1	0,06	0,06	0,06	0,1	0,06	0,06	0,06	0,06	0,07
Iodine	%	0,06	0,1	0,1	0,18	0,1	0,06	0,06	0,06	0,1	0,06	0,06	0,06	0,06	0,18
Phosphorus	%	0,06	0,1	0,1	0,26	0,1	0,06	0,06	0,06	0,1	0,06	0,06	0,06	0,06	0,26
Sulfur	%	0,1	0,1	0,1	0,12	0,1	0,16	0,1	0,1	0,1	0,58	0,95	0,1	0,1	2,22
Loss of ignition	%	76,49	-	-	-	-	-	-	100	-	98,00	-	90	-	-
Dry Ingredients	%	61,695	-	-	-	-	-	-	93,53	-	5,00	-	2	-	-
BTEX	mg/kg	11,335	-	-	-	-	-	-	61	-	not measured	not measured	not measured	-	-

Total organic pesticides (OCP)	mg/kg		-	-	-	-	-	-	725.000	-	-	-	-	-	-
HCH (total/congenerous)	mg/kg		-	-	-	-	-	-	725.000	-	-	-	-	-	-
DDT	mg/kg		-	-	-	-	-	-	<10	-	-	-	-	-	-
PCDD/F (total/congenerous)	ng/kg		-	-	-	-	-	-	255,2	-	-	-	-	-	-
TOC	mg/kg	647.531	-	-	-	-	-	-	301.310	-	831.893	-	60.653	-	-
PCB	mg/kg		-	-	-	-	-	-	<10	-	-	-	-	-	-

3.1.3. Test 3: HCH (3.0% Halogen)

As defined Section 2.1.2, the wastes prepared and labelled in accordance with the Test 3-HCH Feeding Menu were loaded into the rotary kiln and the second combustion chamber at the night shift by 00:00 o'clock on December 14, 2016. The same waste menu was fed for twenty-four hours. During the test burn of the Test 3- HCH Feeding Menu, there was no interruption in any malfunction or waste supply. As planned, the test was completed at 24:00 o'clock on December 14, 2016.

Table 13-TEST 3-HCH FEEDING (%3,01 HALOGEN)

PARAMETER	UNIT	BUNKER	BARREL						PCL-1	PCL-2	AQUEOUS LIQUIDS	SPECIAL LIQUID	FUEL
			Cytotoxic and Cytostatic Drugs	Trichlorethylene	Empty Cyanide Bags	Powder Waste	HCH-Pesiticde	Cytotoxic					
Type		Solid	Solid	Liquid	Solid	Solid	Solid	Solid	HHV liquid	HHV liquid	LHV liquid	Special liquid	fuel oil
Type of feed		Bulk	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Burner	Burner	Lens	Lens	Burner
Location of feed		R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	P.C.C	P.C.C	R.K	R.K
Nominal feed rate	kg/h	3125	30,4	27,67	51,92	28,67	176,583	15,29	408,12	216,42	418	250	31
Physical state		Solid	Solid	Liquid	Solid	Solid	Solid	Solid	Liquid	Liquid	Liquid	Liquid	Liquid

HHV	kJ/kg	10.522	1.000	18.682	42.904	12.617	10.589	1.000	32.019	32.019	1.647	38.312	42.297
Flor	%	0,03	0,1	0,05	0,03	0,03	0,03	0,1	0,03	0,03	0,03	0,03	0,05
Chlorine	%	0,5	4	50,98	0,16	0,35	56,87	4	0,16	0,16	0,16	0,16	0,27
Bromine	%	0,06	0,1	0,07	0,06	0,06	0,06	0,1	0,06	0,06	0,06	0,06	0,07
Iodine	%	0,06	0,1	0,18	0,06	0,06	0,06	0,1	0,06	0,06	0,06	0,06	0,18
Phosphorus	%	0,06	0,1	0,26	0,06	0,06	0,06	0,1	0,06	0,06	0,06	0,06	0,26
Sulfur	%	0,1	0,1	0,12	0,1	0,16	0,1	0,1	0,58	0,58	0,1	0,1	2,22
Loss of ignition	%	76,49	-	-	-	-	100	-	98,00	-	90	-	-
Dry Ingredients	%	61,695	-	-	-	-	93,53	-	5,00	-	2	-	-
BTEX	mg/kg	11,335	-	-	-	-	61	-	not measured	not measured	not measured	-	-
Total organic pesticides (OCP)	mg/kg	-	-	-	-	-	732.000	-	-	-	-	-	-
HCH (total/congenerous)	mg/kg	-	-	-	-	-	732.000	-	-	-	-	-	-
DDT	mg/kg	-	-	-	-	-	<10	-	-	-	-	-	-
PCDD/F (total/congenerous)	ng/kg	-	-	-	-	-	255,2	-	-	-	-	-	-
TOC	mg/kg	647.531	-	-	-	-	301.310	-	831.893	-	60.653	-	-
PCB	mg/kg	-	-	-	-	-	<10	-	-	-	-	-	-

3.1.4. Test 4: PCB

After the Test 3 and before switching to the Test 4, the Basic Menu (the waste menu for Test 1 is the same) had been fed for six hours during the night shift and when the operating conditions enter the regime, as defined Section 2.1.3, the wastes prepared and labelled in accordance with the Test 4-PCB Oil Feeding Menu were loaded into the rotary kiln and the second combustion chamber at the day shift by 08:00 o'clock on December 15, 2016. Due to the viscosity of waste oil containing PCB, it was fed for two hours to reach the stable conditions and the Test 4 was started at 08:00 o'clock on December 15, 2016. The same waste menu was fed for twenty-four hours. During the test burn of the Test 4- PCB Oil Feeding Menu, there was no interruption in any malfunction or waste supply. As planned, the test was completed at 08:00 o'clock on December 16, 2016.

Table 14-TEST 4-PCB OIL FEEDING (%2,06 HALOGEN)

PARAMETER	UNIT	BUNKER	BARREL							PCL-1	PCL-2	AQUEOUS LIQUIDS	SPECIL LIQUID			fuel oil
			Cytotoxic and	Mixed Chemicals	Empty Cyanide Bags	Powder Waste	Chemical waste	Cytotoxic	Metal Contaminated Barrel				Number 7 IBC	Number 4 IBC	Number 3 IBC	
Type		Solid	Solid	Liquid	Solid	Solid	Solid	Solid	Solid	HHV liquid	HHV liquid	LHV liquid	Special liquid	Special liquid	Special liquid	fuel oil
Type of feed		Bulk	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Barrel	Burner	Burner	Lens	Lens	Lens	Lens	Burner
Location of feed		R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	R.K	P.C.C	P.C.C	R.K	R.K	R.K	R.K
Nominal feed rate	kg/h	3429	25,8	23,04	47,33	25,38	44,71	16,46	39,583	443,7	223,8	397	61	46	38	61,91
Physical state		Solid	Solid	Liquid	Solid	Solid	Solid	Solid	Solid	Liquid	Liquid	Liquid	Liquid	Liquid	Liquid	Liquid
HHV	kJ/kg	10.522	1.000	3.829	42.904	12.617	11.238	1.000	1.000	32.019	32.019	1.647	16.179	17.671	14.659	42.297
Flor	%	0,03	0,1	0,03	0,03	0,03	0,03	0,1	0,1	0,03	0,03	0,03	0,03	0,03	0,03	0,05
Chlorine	%	0,5	4	0,16	0,16	0,35	0,17	4	0,1	0,16	0,16	0,16	48,12	45,45	51,92	0,27
Bromine	%	0,06	0,1	0,06	0,06	0,06	0,06	0,1	0,1	0,06	0,06	0,06	0,06	0,06	0,06	0,07
Iodine	%	0,06	0,1	0,06	0,06	0,06	0,06	0,1	0,1	0,06	0,06	0,06	0,06	0,06	0,06	0,18
Phosphorus	%	0,06	0,1	0,06	0,06	0,06	0,06	0,1	0,1	0,06	0,06	0,06	0,06	0,06	0,06	0,26
Sulfur	%	0,1	0,1	0,32	0,1	0,16	0,1	0,1	0,1	0,58	0,58	0,10	0,1	0,1	0,1	2,22
Loss of ignition	%	76,49	-	-	-	-	-	-	-	98,00	-	90	95	95	95	-
Dry Ingredients	%	61,695	-	-	-	-	-	-	-	5,00	-	2	0,5	0,5	0,5	-
BTEX	mg/kg	11,335	-	-	-	-	-	-	-	not measured	not measured	not measured	145,6	145,6	145,6	-
Total organic pesticides (OCP)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	<10	<10	<10	-
HCH (total/congenerous)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DDT	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

PCDD/F (total/congeneous)	ng/g	-	-	-	-	-	-	-	-	-	-	-	44,57	44,57	44,57	-
TOC	mg/kg	647.531	-	-	-	-	-	-	-	831.893	-	60.653	427.184	427.184	427.184	-
PCB	mg/kg	-	-	-	-	-	-	-	-	-	-	-	223.000	223.000	223.000	-

3.2. Chlorine Feeding Rates

The chlorine feeding rates during Test 1, Test 2, Test 3 and Test 4 are shown in Table 15 and the halogen feeding rates are shown in Table 16. As is seen, the target rates of chlorine and halogen feeding rates with the realized chlorine and halogen feeding rates are close to each other and it can be seen that the target concentrations were generally achieved.

Table 15-Chlorine feeding rates

WASTE STREAMS	TEST 1A-TEST 1B			TEST 2A-TEST 2B			TEST 3A-TEST 3B			TEST 4A-TEST 4B		
	Standard Waste Supply			HCH-FEED (2,23% Halogen)			HCH-FEED (2,98% Halogen)			PCB OIL FEED (2,03% Halogen)		
	Waste Feed Rate kg/h	Chlorine Ratio %	Chlorine Entry Rate kg/h	Waste Feed Rate kg/h	Chlorine Ratio %	Chlorine Entry Rate kg/h	Waste Feed Rate kg/h	Chlorine Ratio %	Chlorine Entry Rate kg/h	Waste Feed Rate kg/h	Chlorine Ratio %	Chlorine Entry Rate kg/h
Bunker	3337	0,5	16,69	3125	0,5	15,63	3125	0,5	15,63	3429	0,5	17,15
Barrel	328,67	8,39	27,57	320,34	24,66	79,01	330,50	35,26	116,54	222,29	0,90	2,01
PCL	665	0,16	1,06	609,37	0,16	0,97	624,54	0,16	1,00	443,7	0,16	0,71
Aqueous Liquid	392	0,16	0,63	414	0,16	0,66	418	0,16	0,67	397	0,16	0,64
Special Liquid	244	0,16	0,39	250	0,16	0,40	250	0,16	0,40	145	48,27	69,99
Fuel	95,87	0,27	0,26	144	0,27	0,39	31	0,27	0,08	61,91	0,27	0,17
TOTAL	5062,5	0,92	46,59	4862,7	2,00	97,06	4779,04	2,81	134,31	4698,901	1,93	90,65

Table 16-Halogen feeding rates

HALOGENES	TEST 1A-TEST 1B		TEST 2A-TEST 2B		TEST 3A-TEST 3B		TEST 4A-TEST 4B	
	Standard Waste Supply		HCH-FEED (2,23% Halogen)		HCH-FEED (2,98% Halogen)		PCB OIL FEED (2,03% Halogen)	
	Halogen Concentration %	Halogen Entry Rate kg/h	Halogen Concentration %	Halogen Entry Rate kg/h	Halogen Concentration %	Halogen Entry Rate kg/h	Halogen Concentration %	Halogen Entry Rate kg/h
Flor	0,032	1,60	0,032	1,56	0,031	1,48	0,03	1,55
Chlorine	0,920	46,59	1,996	97,06	2,810	134,31	1,85	91,01
Bromine	0,061	3,08	0,061	2,97	0,061	2,89	0,06	2,99
Iodine	0,065	3,27	0,065	3,16	0,062	2,96	0,06	3,06
TOTAL	1,1	54,55	2,15	104,75	2,96	141,64	2,00	98,61

3.3. Operating Parameter Summary

During the operation of the plant, the continuous measurement devices located on the plant units recorded the combustion temperatures and flue gas flow rate in the rotary kiln and the secondary

combustion chamber. The instantaneous values were also continuously transmitted to the monitors in the plant control room. The minimum, maximum and average measurement results recorded for each test period are shown in the table below.

Table 17-The summary of principle plant operating parameters for Test Burns

DATE	**12.12.2016**		**13.12.2016**		**14.12.2016**		**15.12.2016**	
TEST CODE	**TEST 1A**	**TEST 1B**	**TEST 2A**	**TEST 2B**	**TEST 3A**	**TEST 3B**	**TEST 4A**	**TEST 4B**
TEST CONDITION	**Standard Waste Feeding**		**HCH-Feeding (2,23% Halogen)**		**HCH-Feeding (2,98% Halogen)**		**PCB Oil Feeding (2,03% Halogen)**	
PARAMETRE								
Rotating kiln temperature ºC								
Maximum	1.248,30	1.250,20	1.228,10	1.217,00	1.253,00	1.247,80	1.241,10	1.261,30
Minimum	1.024,50	977,20	1.028,00	994,00	1.018,60	928,70	1.034,00	1.033,10
Average	1.117,04	1.110,66	1.135,16	1.114,28	1.127,64	1.115,76	1.130,38	1.123,61
Secondary combustion chamber temperature ºC								
Maximum	1.147,49	1.162,92	1.166,49	1.154,34	1.167,28	1.181,75	1.165,49	1.162,66
Minimum	1.049,55	1.026,96	1.021,13	1.036,08	1.072,18	1.040,17	1.092,38	1.063,48
Average	1.105,80	1.097,79	1.108,15	1.105,90	1.123,09	1.119,87	1.129,86	1.109,51
Chimney gas outlet temperature ºC								
Maximum	63,40	64,40	64,20	62,10	62,60	63,00	62,60	63,20
Minimum	59,90	59,20	57,00	55,90	58,40	56,40	58,70	57,70
Average	61,70	61,90	60,66	60,40	60,59	60,58	60,70	61,23
Flue gas outlet flow rate m/s								
Maximum	7,20	10,41	7,22	6,71	6,73	7,38	6,82	7,03
Minimum	5,07	5,59	5,48	5,04	5,28	4,93	5,47	4,78
Average	6,31	6,45	6,29	6,15	5,98	5,93	6,02	5,83
Flue gas volumetric flow rate-actual measured m^3/h								
Maximum	45.953,40	56.850,50	46.050,80	42.662,20	42.735,00	47.273,50	43.097,40	44.750,10
Minimum	32.234,60	35.377,70	35.043,50	32.119,00	33.585,80	31.137,30	34.791,50	30.094,40
Average	40.124,22	40.862,03	40.019,18	39.097,00	38.002,67	37.709,09	38.281,87	37.099,18
Flue gas volumetric flow rate-STP value Nm^3/h								
Maximum	26.091,30	24.627,60	19.833,70	19.850,30	20.472,80	23.134,90	16.912,90	20.315,80
Minimum	2.370,80	1.965,90	10172,70	4.215,80	13.086,70	8.282,20	7.479,30	11.731,60
Average	15.985,56	15.567,03	15.698,56	15.286,54	14.905,03	14.807,06	14.992,13	14.471,54

The above data and particularly flow rates correlate with the established operating regime of the plant in terms of maintaining the standard limits on resident times noted in Annex 1, namely > 14 seconds for the rotary kiln and >2.5 seconds in the secondary combustion chamber.

3.4. N-5 (Sampling Point 5): Facility Output Flue Gas Measurement Results

3.4.1. Plant Operating Performance and CEMS Monitored Emissions

The performance of the plant's operating and flue gas treatment systems were measured and recorded by the CEMS continuous emission monitoring system. The parameters that were continuously measured and recorded in accordance with the legislation are given in the Table 18 for each test.

Table 18- Summary of Plant Operation Performance

DATE		**12.12.2016**		**13.12.2016**		**14.12.2016**		**15.12.2016**	
TEST CODE		**TEST 1A**	**TEST 1B**	**TEST 2A**	**TEST 2B**	**TEST 3A**	**TEST 3B**	**TEST 4A**	**TEST 4B**
TEST CONDITION		**Standard Waste Feeding**		**HCH-Feeding (2,23% Halogen)**		**HCH-Feeding (2,98% Halogen)**		**PCB Oil Feeding (2,03% Halogen)**	
PARAMETER	**Unit**								
Flue gas outlet flow rate,avg.	m/s	6,31	6,45	6,29	6,15	5,98	5,93	6,02	5,83
volumetric flow rate(act), avg.	m^3/saat	40124,22	40862,03	40019,18	39097,00	38002,67	37709,09	38281,87	37099,18
volumetric flow rate(STP), avg.	Nm^3/saat	15985,56	15567,03	15698,83	15286,54	14905,03	14807,06	14992,13	14471,54
Stack gases composition									
CO	mg/Nm³	23,29	24,91	8,14	4,10	10,80	10,13	8,62	4,36
NO	mg/Nm³	143,26	142,04	136,38	145,78	150,58	135,91	160,13	154,25
NO2	mg/Nm³	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
NOx	mg/Nm³	219,39	222,97	214,36	230,01	230,64	214,95	244,86	242,53
SO2	mg/Nm³	29,73	10,78	20,10	10,82	9,60	15,72	15,78	10,37
TOC	mg/Nm³	2,04	5,52	0,08	0,77	0,24	0,61	1,58	1,33
HF	mg/Nm³	0,00006	0,00475	0,00788	0,00725	0,00888	0,01194	0,01406	0,00963
HCl	mg/Nm³	0,31	0,25	0,23	0,20	0,17	0,31	0,33	0,26
TOZ	mg/m^3	0,20	0,20	0,15	0,14	0,16	0,16	0,19	0,17
O2	% Vol	9,08	9,56	9,36	9,88	9,84	9,66	9,20	9,64
CO2	% Vol	9,47	9,94	9,72	9,22	9,32	9,47	9,71	9,46
Humidity	%	23,08	24,59	22,06	22,25	22,03	21,95	22,12	22,23

3.4.2. Combustion gases, POPs, Halogens and Heavy Metals Analyses Results

As part of the Test Burn, the measurements of the emissions generated during all test conditions were carried out in accordance with the methods defined in the Section 2.5.Chimney Gas Emissions Samples and Analysis by TUBITAK. Some of the measured parameters were combustion gases, halogens, heavy metals and OCP, HCH, DDT, PCDD / PCDF and PCB. The measurement results are given in the following tables.

Table 19-The Combustion Gases and Particulate Measurement Results

The Results of Combustion Gases and Dust Measurement										
		TEST 1A	**TEST 1B**	**TEST 2A**	**TEST 2B**	**TEST 3A**	**TEST 3B**	**TEST 4A**	**TEST 4B**	**Limit Value***
Date of measurement		**12.12.2016**		**13.12.2016**		**14.12.2016**		**15.12.2016**		**-**
Chimney diameter	M	1,35				1,35				-
Chimney cross-sectional area	m^2	1,43				1,43				-
Gas velocity	m/s	7,8	7,8	7,2	7,1	7,4	7,2	7,1	7,1	-
Gas temperature	°C	65	65	60	58	63	64	64	62	-
Gas flow	m^3/h	40193	40193	37102	36586	38132	37102	36586	36586	-
Gas flow	Nm^3/h	27361	25844	26264	25897	26620	25732	25491	25708	-
Gas pressure	mbar	1011	1010	1013	1021	1027	1027	1022	1027	-
H_2O	%	15,6	20,2	13,7	14,9	15,3	15,6	14,8	15,0	-
CO_2	%	9,1	9,1	8,9	8,9	9,3	9,3	8,7	8,3	-
O_2	%	8,9	10,3	9,4	9,5	9,9	8,8	9,6	10,2	-
CO,	mg/Nm^3	2,47	3,27	1,72	0,83	1,23	3,05	1,43	1,40	100
SO_2	mg/Nm^3	0,24	0,27	1,01	0,25	0,26	0,23	0,25	0,26	200
NO	mg/Nm^3	142	165	145	146	145	147	163	174	-
NO_x	mg/Nm^3, NO_2	218	253	223	223	222	226	250	267	400
Dust	mg/Nm^3	1,65	4,49	5,60	0,17	0,09	7,95	2,72	8,89	30
Humidity	%	15,6	20,2	13,70	14,9	15,3	15,6	14,80	15	

* Regulation on Waste Incineration ,Annex-5b-Daily average

Table 20-Halogen Measurement Results

Measured / Analyzed parameter	**Concentration, ng/Nm^3**								
	TEST 1A	**TEST 1B**	**TEST 2A**	**TEST 2B**	**TEST 3A**	**TEST 3B**	**TEST 4A**	**TEST 4B**	Limit Value*
	12.12.2016		**13.12.2016**		**14.12.2016**		**15.12.2016**		
HCl	<0,35	<0,40	<0,43	<0,39	<0,46	<0,42	<0,44	<0,48	60
HF	0,00006	0,00475	0,00788	0,00725	0,00888	0,01194	0,01406	0,00963	4

* Regulation on Waste Incineration , Annex-5b

Table 21-Total organic carbon (TOC) analysis results

	Concentration (mg/Nm^3)	**Limit Value* (mg/Nm^3)**
TEST 1A	1,48	20
TEST 1B	1,68	
TEST 2A	2,16	
TEST 2B	1,57	
TEST 3A	2,44	
TEST 3B	2,26	
TEST 4A	1,61	
TEST 4B	1,11	

* Regulation on Waste Incineration , Annex-5b

Table 22-Single heavy metal analysis results

Parameter	Concentration (mg/Nm³)							
	TEST 1A	TEST 1B	TEST 2A	TEST 2B	TEST 3A	TEST 3B	TEST 4A	TEST 4B
Test Date	**12.12.2016**		**13.12.2016**		**14.12.2016**		**15.12.2016**	
Thallium, Tl	<0,0010	<0,0012	<0,0010	<0,0011	<0,0012	<0,0010	<0,0010	<0,0011
Cadmium, Cd	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001
Mercury, Hg	0,0004	0,0005	<0,0001	<0,0001	<0,0002	0,0002	<0,0001	<0,0001
Total Chrome, Cr	0,0055	0,0133	0,0071	0,0049	0,0040	<0,0010	0,0010	<0,0011
Copper, Cu	<0,0010	<0,0012	<0,0010	<0,0011	<0,0012	<0,0010	<0,0010	<0,0011
Cobalt, Co	<0,0010	<0,0012	<0,0010	<0,0011	<0,0012	<0,0010	<0,0010	<0,0011
Manganese, Mn	<0,0010	<0,0012	<0,0010	<0,0011	<0,0012	<0,0010	<0,0010	<0,0011
Nickel, Ni	0,0318	0,0041	0,0058	0,0074	<0,0012	<0,0010	<0,0010	<0,0011
Lead, Pb	<0,0004	0,0007	<0,0004	<0,0004	<0,0005	<0,0004	<0,0004	<0,0004
Antimony, Sb	0,0014	0,0016	<0,0010	<0,0011	<0,0012	<0,0010	<0,0010	<0,0011
Tin, Sn	<0,0199	<0,0248	<0,0203	<0,0212	<0,0231	<0,0194	<0,0210	<0,0211
Arsenic, As	<0,0010	<0,0012	<0,0010	<0,0011	<0,0012	<0,0010	<0,0010	<0,0011
Vanadium, V	<0,0010	0,0019	0,0014	<0,0011	0,0018	<0,0010	<0,0010	<0,0011

Table 23-Results of heavy metal analysis according to the limit values

Parameter	Total concentration (mg/Nm³)								Limit Value* (mg/Nm³)
	TEST 1A	TEST 1B	TEST 2A	TEST 2B	TEST 3A	TEST 3B	TEST 4A	TEST 4B	
Test Date	**12.12.2016**		**13.12.2016**		**14.12.2016**		**15.12.2016**		
Thallium, Tl	<0,0011	<0,0013	<0,0011	<0,0012	<0,0013	<0,0011	<0,0011	<0,0012	0,05
Cadmium, Cd									
Mercury, Hg	0,0004	0,0005	<0,0001	<0,0001	<0,0002	0,0002	<0,0001	<0,0001	0,05
Total Chrome, Cr	0,0513	0,0365	0,0272	0,0262	0,0211	0,0138	0,0154	0,0150	0,5
Copper, Cu									
Cobalt, Co									
Manganese, Mn									
Nickel, Ni									
Lead, Pb									
Antimony, Sb									
Tin, Sn									
Arsenic, As									
Vanadium, V									

* Regulation on Waste Incineration , Annex-5c

Table 24-Dioxin / Furan analysis results

Measured / Analyzed parameter	Concentration, ng/Nm³								
	TEST 1A	TEST 1B	TEST 2A	TEST 2B	TEST 3A	TEST 3B	TEST 4A	TEST 4B	Limit Value*
Test Date	**12.12.2016**		**13.12.2016**		**14.12.2016**		**15.12.2016**		
PCDD	0,0037	0,0046	0,0055	0,0115	0,005	0,004	0,0031	0,0033	-
PCDF	0,0187	0,0213	0,0288	0,0592	0,0408	0,0312	0,0271	0,0285	-
Dioxin/Furan (Total I-TEQ)	0,0224	0,0258	0,0342	0,0707	0,0458	0,0351	0,0303	0,0318	0,1

* Regulation on Waste Incineration , Annex-5c

Table 25-OCP, HCB, DDT and PCB analysis results

Measured / Analyzed parameter	Concentration, µg/Nm³					
	TEST 2A	TEST 2B	TEST 3A	TEST 3B	TEST 4A	TEST 4B
Test Date	**13.12.2016**		**14.12.2016**		**15.12.2016**	
HCH	<0,0027	<0,023	<0,028	<0,024	-	-
OCP	<0,0266	<0,0234	<0,0278	<0,0240	-	-
DDT	<0,0027	<0,0023	<0,0028	<0,024	-	-
PCB	-	-	-	-	<0,0056	<0,0087

SECTION 4 MEASUREMENT RESULTS FOR PERSISTANT ORGANIC POLLUTANTS IN SOLID AND LIQUID RESIDUAL RELEASES

Table 26-Summary of POPs Test Results of Solid Residues

Test Date		12.12.2016		13.12.2016		14.12.2016		15.12.2016	
PARAMETER	**UNIT**	**TEST 1A**	**TEST 1B**	**TEST 2A**	**TEST 2B**	**TEST 3A**	**TEST 3B**	**TEST 4A**	**TEST 4B**
N1-Slag Sample									
PCDD/F (total I-TEQ)	mg/kg	3,36E-06	1,13E-06	3,5210-6	3,11E-06	2,24E-05	6,69E-05	2,92E-04	8,04E-04
OCP	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
HCH	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	-	-
DDT	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	-	-
PCB	mg/kg	-	-	-	-	-	-	<0,01	<0,01
N2-Bottom Wet Ash Sample									
PCDD/F (total I-TEQ)	mg/kg	1,38E-04	2,09E-04	1,85E-04	5,70E-04	2,12E-04	1,54E-04	3,88E-05	3,52E-05
OCP	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
HCH	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	-	-
DDT	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	-	-
PCB	mg/kg	-	-	-	-	-	-	<0,01	<0,01
N4-Filterpres Cake Sample									
PCDD/F (total I-TEQ)	mg/kg	3,29E-03	2,90E-03	3,36E-04	-	5,80E-04	-	6,33E-04	-
OCP	mg/kg	-	-	<0,01	-	<0,01	-	<0,01	-
HCH	mg/kg	-	-	<0,01	-	<0,01	-	-	-
DDT	mg/kg	-	-	<0,01	-	<0,01	-	-	-
PCB	mg/kg	-	-	-	-	-	-	<0,01	-
N6-Electrostatic Precipitator Fly Ash Sample									
PCDD/F (total I-TEQ)	mg/kg	-	-	-	1,52E-02	-	5,01E-03	-	5,43E-03
OCP	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	-	-
HCH	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	-	-
DDT	mg/kg	-	-	<0,01	<0,01	<0,01	<0,01	-	-
PCB	mg/kg	-	-	-	-	-	-	<0,01	<0,01
N7-Activated Carbon Sample									
PCDD/F (total I-TEQ)	mg/kg	-	-	4,58E-04	-	-	7,75E-05	-	6,93E-05
OCP	mg/kg	-	-	<0,01	-	<0,01	<0,01	-	-
HCH	mg/kg	-	-	<0,01	-	<0,01	<0,01	-	-
DDT	mg/kg	-	-	<0,01	-	<0,01	<0,01	-	-
PCB	mg/kg	-	-	-	-	-	-	<0,01	0,11

Table 27-Summary of Test Result of POPs of Liquid Residues

Test Date		12.12.2016		13.12.2016		14.12.2016		15.12.2016		Waste Incineration Legislation Limit Value
PARAMETER	UNIT	TEST 1A	TEST 1B	TEST 2A	TEST 2B	TEST 3A	TEST 3B	TEST 4A	TEST 4B	
N3-Physical/Chemical Treatment Plant Effuluence Sample										
PCDD/F (total I-TEQ)	ng/l	0,0002	0,0067	0,0005	0,0006	0,0037	0,00016	0,0039	0,0004	0,3
OCP	ng/l	-	-	<100	<100	<100	<100	<100	<100	-
HCH	ng/l	-	-	<100	<100	<100	<100	-	-	-
DDT	ng/l	-	-	<100	<100	<100	<100	-	-	-
PCB	ng/l	-	-	-	-	-	-	<0,01	<0,01	1

Table 28-TOC Value in Slag and Bottom Ash

TEST CODE		TEST 1A	TEST 1B	TEST 2A	TEST 2B	TEST 3A	TEST 3B	TEST 4A	TEST 4B	A) Storage Criteria of Inert Wastes Limit Values for III.Class Landfill Facilities	B) Storage Criteria of Non-Hazardous Wastes Limit Values for II.Class Landfill Facilities
Test Date		12.12.2016		13.12.2016		14.12.2016		15.12.2016			
TOC in Slag	mg/kg (%)	141.496 (0,141)	94.893 (0,095)	156.113 (0,156)	70.169 (0,070)	149.793 (0,149)	117.491 (0,117)	100.744 (0,10)	199.848 (0,199)	250.000	25%
TOC in Bottom ash	mg/kg (%)	2.230 (0,0022)	2.830 (0,0028)	4.378 (0,0044)	3.548 (0,0035)	2.100 (0,0021)	2.659 (0,0027)	2.043 (0.0020)	1884 (0.0019)	250.000	25%

The above results meet the requirements of the national incineration regulation (Article 10) of <3% TOC in slage and bottom ash, and likewise meet the limit values applicable to the restrictions applicable to the on-site landfill facilities.

SECTION 5 DESTRUCTION EFFICIENCY RESULTS

Destruction and Removal Efficiency (DRE) is the percentage of original POPs destroyed, irreversibly transformed or removed from the air emission stream. DRE may serve as a supplementary performance parameter recognizing it only accounts for releases to air and not what could be transferred to other by-products and residuals streams. A DE>99.99% and DRE>99.9999% is recommended as working benchmarks for application in GEF projects.

DE and DRE were calculated according to Table 26 which includes mass balance values of Tests.

Table 29-Summary of DE

TEST	DE		
	OCP	HCH	PCB
TEST 2A	99,9999894%	99,9999894%	-
TEST 2B	99,9999857%	99,9999857%	-
TEST 3A	99,9999932%	99,9999932%	-
TEST 3B	99,9999919%	99,9999919%	-
TEST 4A	-	-	99,9999532%
TEST 4B	-	-	99,9999532%

Table 30-Summary of DRE

TEST	DRE		
	OCP	HCH	PCB
TEST 2A	99,9999991%	99,99999991%	-
TEST 2B	99,9999992%	99,9999992%	-
TEST 3A	99,9999994%	99,9999994%	-
TEST 3B	99,9999995%	99,9999995%	-
TEST 4A	-	-	99,9999996%
TEST 4B	-	-	99,999999%

SECTION 6 OVERALL DISCUSSION AND EVALUATION OF RESULTS

The following summarizes the technical and environmental performance results of the TBP in relation to both national regulations and international standards.

i) **Operating Parameters**: Based on the results presented in Table 17_ the temperatures recorded in both the rotary kiln and secondary combustion chamber indicate generally consistent performance across the all test runs and compliance with national regulatory standards and those generally accepted internationally. Likewise the residence times exceed that accepted in international standards. Similarly, the overall operating practice required in the national regulations has been followed.

ii) **Flue Gas Emissions:** Section 3.4 above indicated consistent compliance with national regulations by a significant margins in most cases for all regulated flue gas emission parameters, including the range of standard air pollutant combustion gasses and particulate (Table 19), Halogen gasses – HCl, HF (Table 23, TOC (Table21), volatile heavy metals including Hg (Table 22), and PCDD/F (Table 24), noting that PCCD/F also meets the requirements of the Basel and GEF guidelines by a significant margin indicating high efficiency of the plant's air pollution control system and a significant compliance performance buffer and safety margin to accommodate periodic excursions during normal operations involving halogenated waste streams. Overall, it is noted that air emission performance is only marginally affected by the addition of the POPs waste streams with only small increases in HF and PCDD/F emissions relative to the baseline suggesting that the facility offers BAT/BEP performance with respect to unintended releases.

iii) **Solid and Liquid Residuals**: The results presented in Section 4 show that very small to negligible residual POPs waste concentrations are found in the solid or liquid residuals directly released from the incineration process suggesting a high level of primary destruction in the incineration process. However, it was noted that there was a measurable PCB content in most solid residuals for the PCB tests, albeit at levels much lower than the "low POPs content" adopted by the Stockholm Convention and the Basel Convention guidelines. In the case of PCDD/F, concentrations were recorded in both solid residues and the waste water from the physical/chemical treatment plant. In the latter case these were well with the limit in international standards (<0.3 ng TEQ/l). The PCDD/F content in all solid residues was below the "low POPs" definition of 15 ug TEQ/kg currently adopted by the Stockholm Convention and the Basel Convention guidelines, except for the ESP ash in Test 2 (HCH at 2% Cl) which is slightly above this level. Otherwise the PCDD/F levels are all below 1 ugTEQ/kg noting this is the level being proposed as a revised "low POPs" level in draft Basel Guidelines and remains acceptable for engineered landfill disposal as is done on-site. It should be noted that ESP ash residues are not landfilled at IZAYDAS but treated in the physical/chemical treatment plant.

iv) **Destruction Efficiency**: The results of calculations of DE and DRE indicate that the achieved destruction efficiency exceed the guideline limits of 99,99% and 99,9999% by a substantial margin of more than two orders of magnitude and in terms of DE also exceed the increased requirement now adopted in the Basel guidelines.

The overall observation made on the basis of the results from the Test Burn Program reported above is that the IZYADAS facility more that meets both national regulatory requirements and prevailing international standards when applied to POPs pesticide and high concentration PCB oil wastes. This is only conditioned technically by the feed levels of these wastes and associated overall feed chlorine content , namely up to 3% Cl for HCH waste and 2% for PCB liquid waste. On that basis, IZAYDAS is

prepared to offer its facility for the commercial destruction of POPs waste including such opportunities that may be offered by international projects such as financed by the GEF.

It is further noted that the degree by which the technical and environmental performance has exceeded these requirements, particularly for critical emission requirements such as PCDD/F and destruction efficiency parameters indicates that the facility should have the potential to handle higher feed rates and associated chlorine content and could be subject to further evaluation in the future as a basis for increasing the competitive position of the facility in the future.

ANNEX I: IZAYDAS BACKGROUND AND PROCESS DESCRIPTION

The IZMIT Waste and Residue Treatment Incineration and Utilization Corporation (IZAYDAS) is generally considered to be a leading national environmental management infrastructure asset and the most advanced fully integrated hazardous waste service provider currently operating in Turkey. While other commercial incineration facilities exist and are licensed to handle hazardous waste none offer the capability that IZAYDAS provides in terms of approaching modern Best Available Technology (BAT) and Best Environmental Practice (BEP). This was the basis for the selection of this facility for assistance under the above referenced GEF Project. The expectation is that it can serve as the core infrastructure to support the country in meeting its obligations under the Stockholm Convention (ratified in 2009) and specifically those under Article 6 covering the provision of environmentally sound disposal of POPs stockpiles and wastes through their destruction or irreversible transformation. Additionally, the qualification of the facility is seen as adding needed commercial POPs destruction capability in the region.

IZAYDAS was established by the Metropolitan Municipality of Izmit in 1996 and is wholly owned by the Municipality although operates as an independent commercial entity. Its scope of operation includes licenced facilities providing the following services in the region and nationally:

- Hazardous Waste Incineration and Energy Production,
- Hazardous Waste Landfill,
- Landfilling of Domestic and Industrial Waste,
- Medical Waste Sterilization,
- Marine Waste Management,
- Biogas and Integrated Energy Generation,
- Laboratory Services,
- Waste Transportation Services,
- Wind Power Generation,

The IZAYDAS incineration facility (Figure 1) is classed in terms of technology as high temperature rotary kiln (HTI) technology inclusive of automated mass solid, bulk liquid, drum and speciality waste feed systems, a secondary combustion unit, a waste heat/energy recovery system, a modern air pollution control (APC) system, and solid/liquid residual management system. The APC system consists of an electrostatic precipitation unit, venture scrubber, caustic scrubber, and PCDD/F activated carbon filter before exiting to atmosphere via a 65 m stack. Waste water from the waste heat boiler and scrubbers are treated in a physical chemical treatment plant prior to discharge to Domestic and Industrial Waste Water Treatment Plant operated by Kocaeli Metropolitan Municipality. Solid residues in the form of rotary kiln bottom ash, waste heat boiler ash, precipitator and scrubber solids are disposed of in the onsite hazardous waste landfill. Saturated activated carbon is returned for destruction in the incinerator.

IZAYDAS has is the Environmental Permit and Licence (253 numbered and dated August 24, 2012) entitled air emissions, incineration and co-incineration issued under the "Regulation on Incineration of Wastes" No, 2772, October 6, 2010[13]. This permit applicable to the incineration facility was issued initially in 2002, last updated in 2012 and is current valid though to August 24, 2017. It allows the facility to incinerate a wide range of hazardous wastes as defined by the European Waste Catalogue Codes as adopted in Turkey including halogenated wastes which would generally cover POPs wastes.

[13] Resmi Gazete Tarihi: 06.10.2010 Resmi Gazete Sayısı: 27721

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Figure 1: Overview of the IZAYDAS Incineration Facility

The general purpose of the incineration Plant which has the incineration capacity of 5.400 kg-waste/h is based on the disposal of hazardous wastes and clinical wastes such as plastic waste, used oil, pharmaceutical and cosmetic waste, petrochemical waste, PVC, solvent, paint wastes, adhesives and adhesives, sewage sludge etc. from industrial sources by high temperature incineration process

The declaration, labeling, transport and disposal of Hazardous Wastes which are accepted by the Plant is carried out within the framework of the relevant regulations of the Ministry of Environment and Urbanization (MOEU).

Under optimum operating conditions, the annual capacity of the plant is ~35.000 ton-waste/year. The wastes accepted to the plant are first weighed, recorded, receiving screening analysis is done on the samples taken from them and then sent to intermediate storage areas.

The incineration process in rotary kiln is first started with propane gas but once in steady state operation is sustained by the waste. According to the feed daily menu prepared by Waste Acceptance/Planning Department, the waste feeding is taken in to the kiln when the inside temperature reaches 921 ^{o}C.

The waste is incinerated;

- at temperatures of 921 ^{o}C – 1250 ^{o}C in the rotary kiln with a retention time of waste in the rotary kiln of 95-120 minutes and of gases in the rotary kiln of ~14 seconds.
- At temperatures of 1050 ^{o}C – 1250 ^{o}C in the secondary combustion chamber with a minimum retention time of gases in the secondary combustion chamber of 2,5 seconds.

The heat values are 55 GJ/hr. in rotary kiln and 31 GJ/hr. secondary combustion chamber. Slag discharge hole is placed between the outlet of rotary kiln and the entrance of secondary combustion chamber and it is a wide – long slot. The slag is falls down on a wet type conveyor, collected and then sent to special landfill area following laboratory analysis.

The gas coming from the secondary combustion chamber enters the boiler which has natural circulation across a 2500 m^2 heating surface area at a temperature of 1050-1250 °C and leaves the boiler at 180-200 °C. 27.1 ton/hr. steam is produced (at 350 °C , 40 bar pressure). 21.7 ton/hr., 40 bar

and 350 °C steam is fed to the Turbine-Generator and 5.2 MW/hr. electric power is produced. The internal power need for plant operation is ~1,5 MW/hr. The excess power is given to the external off-site electrical system.

The ash from the first part of the boiler are taken to a wet type conveyor, the ash from super heater and economizer parts are transferred to an ash silo. All ash residues are send to the special landfill area following their laboratory analysis.

Electrostatic filter is the first unit of gas cleaning system. The dust content of flue gas is controlled by two independent section under high voltage electrical area. The design dust removal efficiency of filter is 99.63 %. The temperature of flue gas drops to 180-200 °C after the boiler and larger dust particles are removed there. Flue gas then passes through the electrostatic filter and dust particles less than 1 μm are effectively removed here. The dust is removed from the system by a hammering device and taken into the ash silo for disposal in an on-site hazardous waste landfill.

The flue gas coming from Electrostatic Filtration is counter-flow flushed with a 10% concentration of lime milk solution in the Venturi Scrubber. The heavy metals and any residual material containing halogens are absorbed in Venturi scrubber.

The flue gas coming from Venturi Scrubber is passed through the droplet holders after than passed through the Lime Spray Scrubber which has the neutralization, oxidation and absorption partitions and further residual remaining of the halogen compounds and heavy metals in the SO_2 and in flue gas are captured.

The last step of the flue gas cleaning system is a Dioxin/Furan control unit. The purpose of this unit is to remove the derivatives of dioxin and dibenzofuran and also remaining hazardous organic material and to minimize their emissions. There are five activated carbon columns in the unit and the flue gas is extracted by a secondary ID fan and send to the chimney. Residuals are returned to the incineration process.

The wastewaters coming from scrubbers, the filtrate of filter press and other wastewaters of gas cleaning system are treated in Physical/Chemical Waste Water treatment Plant. The wastewaters collected in the storage tank are processed using some chemicals such as TMT-15, FeCl3, polyelectrolyte and 10% lime solution. The wastewater from the treatment system is sent to the main offsite Industrial and Domestic Wastewater Treatment Plant operated by the municipality after analysis in the laboratory.

CONTINUOUS EMISSION MEASUREMENT SYSTEM (CEMS):

The flue gas composition is continuously monitored and controlled by the on-line analyzers in the Chimney Gas Analysis Chamber linked to the main control room and digital data collection/storage capability.

Analysis system Cabinet includes: i) MCS100FTAnalyzer; ii)Flowsic100; iii) FWE200; and iv) Thermocouple devices all as follow:.

- TOC-NO_x-CO-SO_2-HF-HCL-CO_2-O_2 and the humidity is measured by MCS100FT.

MCS100FT Analyzer consists of FID and FTIR parts. It draws the sample through the probe on the platform on the chimney. There is a ceramic filter in the probe and the gas filtered from the particles is passed through a 30 m heated line and heated to 180 ° C without moisture condensation and is drawn to the unit in the Analysis Cabinet by vacuum drawing of the air of the instrument. TOC is measured at the FID unit by means of the generated current in the combustion chamber by burning the hydrogen gas. According to the magnitude of the wave length in the frequency responses in the

infrared spectrum, the corresponding of other parameters (NO_x-CO-SO_2-HF-HCL-CO_2-O_2-H_2O) are formed and can be measured. The measured values are sent to the monitoring and reporting computer ENVIDAS in the Analysis Cabinet via RS232 communication. It is sent to SCADA in 4-20mA for observation from the control room.

- FLOW: Flowsic100 measures flow rate

Flowsick100 operates on a ultrasonic time difference principle and consists of two units as master and slave. It measures the speed and calculates the flow from the speed. Master and slave units communicate via a junction box. Flowsic100 is located on the first platform on the chimney and communicates with both SCADA and ENVIDAS via two communication cables.

- DUST (Particulate): Measured by FWE200 instrument.

The FWE200 measures total particulate using a principle of light diffraction. Like the other parameters, it is sent to ENVIDAS and SCADA. The FWE200 is located on the first platform on the chimney

- FLUE GAS TEMPERATURE; measures with thermocouple

At the point where the thermocouple is located on the first platform on the chimney, the thermocouple measures the temperature and sent to the analysis cabinet via the communication cable.