

**Concentrations of heavy metals and  
organic contaminants in ash collected  
from the Izmit hazardous/clinical  
waste incinerator, April 2000**

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## 1. Summary

In April 2000, samples of furnace bottom ash, and of fly ash from economiser and electrostatic precipitator, were collected from the Izaydas (Izmit Waste and Residue Treatment, Incineration and Recycling Co. Inc.) incinerator and returned to the Greenpeace Research Laboratories for analysis. Two of the samples (ESP and economiser ash) were forwarded to an accredited laboratory in the UK for determination of concentrations of chlorinated dioxins and furans.

Ash collected from the electrostatic precipitator (MI0065) yielded the highest levels of heavy metal contamination, comprising 1.5% by weight of copper, 6.6% zinc and 2.5% lead. Polychlorinated biphenyls (PCBs) were identified in all of the ash samples analysed, including in the bottom ash. In addition, chlorinated dioxins were identified in the two samples of fly ash, with higher levels in the ESP sample than in the economiser ash.

Taken together, these results clearly indicate that, in April 2000, the Izaydas incinerator was continuing to incinerate wastes with a significant chlorine content. This would have been some considerable time after a temporary permit issued by the Ministry of Environment for its limited operation (for non-chlorinated wastes only) was issued. Furthermore, the appearance of PCBs in the bottom ash and fly ashes strongly suggests the presence of PCBs or PCB-containing wastes in the feedstock going to the incinerator. The precise nature of waste feedstock being incinerated, and the proportion of this made up by hazardous wastes, cannot be determined from this study but should be verified by the operator and/or the Municipality. The content of heavy metals and chlorinated compounds in the ashes generated by the incinerator would, in turn, render those hazardous wastes also.

## 2. Introduction

### 2.1 *The Izaydas Incinerator: a brief history*

The Izmit Waste and Residue Treatment, Incineration and Recycling Co. Inc. (Izaydas) was founded in 1996 by the Greater Izmit Municipality within the scope of the Izmit Integrated Environment Project. The company was formed to operate the Clinical and Hazardous Waste Incinerator, the Industrial and Domestic Landfill and the Industrial and Domestic Wastewater Treatment Plant. Both the incinerator, which has an annual capacity of 35,000 tonnes, and the landfill are located just 2 km from the Solaklar village and only 10 km from the city of Izmit. The landfill has a capacity of 790,000 m<sup>3</sup> of industrial waste and 3,125,000 m<sup>3</sup> of household waste (IGCM 1994).

The waste incinerator was constructed by the German company Lurgi, with the intention of incinerating a range of wastes (including hazardous wastes) for "power generation" (5.2 MW/hour). According to literature describing the overall waste management project (IGCM 1994), hazardous wastes to be incinerated included:-

- outdated herbicides and other pesticides,
- cosmetic and pharmaceutical wastes,
- refinery waste and wastes from oil and coal processing plants,
- used lubricants and oil residues,
- soil and dust contaminated with oil,
- solvents and paints,

- resins, glues and pastes,
- plastic and rubber products (including polyester and PVC products),
- used tires,
- wastes from plastic production plants and chlorinated residues of plastic products.

Although it was planned to begin operation in August 1997, the Ministry of Environment refused to grant an operating permit on the basis of test burns, arguing that the plant had some technical deficiencies that would lead to emission of toxic chemicals, especially dioxins and furans. According to information from the construction company (Haznews 1998), the plant was designed to meet German emission standards from 1986. At the same time, the area within which the industrial wastes and toxic ash from the incinerator would be landfilled did not meet the standards of Hazardous Waste Control Regulations of the Ministry.

The plant operated illegally, without any permit, until action by Greenpeace Mediterranean in the late 1990's led to an order from the Ministry of Environment to the Kocaeli Governorship to stop the transportation of all hazardous wastes to Izaydas and their incineration on site (MoE 1998).

After the major earthquake in August 1999, the Ministry of Environment granted Izaydas a temporary operating permit to incinerate the infected waste generated during and after the earthquake. The Ministry stated in its declaration, however, that no chlorinated waste would be incinerated, in order to avoid the formation of dibenzo-dioxins and furans. In a letter to Greenpeace in March 2000, the Ministry of Environment admitted that almost 68 tonnes of clinical waste had been incinerated at Izaydas. Given that a substantial proportion of clinical waste is comprised of the chlorinated plastic PVC, this acceptance immediately contradicts the commitment that no chlorinated materials should be incinerated.

After the Volganefit tanker accident at Marmara sea in December 1999, 900 tonnes of fuel oil Number six was washed on the shores of Istanbul. The oily residues were collected in PVC bags and sent to Izaydas, despite repeated warnings from Greenpeace to the authorities that fuel oil could be recycled and that the burning of PVC would emit dioxins. Greenpeace notes that Izaydas continues to receive and incinerate chlorinated waste.

Recently Izaydas announced that the industrial landfill has been rebuilt to meet standards set by the Ministry. At the same time, however, the company still continues to incinerate waste, despite the fact that the temporary permit has long expired.

## *2.2 Collection of samples by Greenpeace*

On 5<sup>th</sup> April 2000, representatives of Greenpeace Mediterranean and Greenpeace International visited the incinerator compound and were permitted to collect a total of four samples of ash, taken from different sections of the installation:-

- MI0064 – bottom ash from the furnace;
- MI0067 – ash from economiser/heat exchanger;
- MI0065/66 – fly ash from electrostatic precipitator (ESP).

Samples were collected in bulk from the ash deposits discarded from the installation at each point and were further sub-sampled into small (100ml) quantities. All samples were returned to the Greenpeace Research Laboratories, University of Exeter (UK), for analysis of heavy metal and organic contaminants. Two samples (MI0065, ESP ash; MI0067, economiser ash) were forwarded to an accredited laboratory for determination of concentrations of chlorinated dioxins and furans.

### 3. Materials and Methods

All samples were collected in 100 ml glass bottles (pre-cleaned in nitric acid, de-ionised water and analytical grade pentane) and stored in cool, dark conditions for shipment and storage prior to analysis. Only samples MI0064, 0065 and 0067 were analysed, as MI0066 was a duplicate of sample MI0065. Heavy metal concentrations were determined by ICP atomic emission spectrophotometry (AES), following acid digestion and using appropriate certified reference materials in addition to intra-laboratory standards. Organic compounds were isolated and identified as far as possible using gas chromatography and mass spectrometry, following liquid:solid extraction into a mixture of pentane and acetone. Full details of the methods for sample preparation and for metals and GC-MS screening analysis are given in Appendix 1. In addition, quantitative dioxin/furan analyses were conducted on samples MI0065 and MI0067 by EUS Laboratories, Southampton (UK), according to UKAS accreditation standards.

### 4. Results and Discussion

Concentrations of six heavy metals determined in the ash samples are reported in Table 1 above. Complete heavy metal data for individual samples are reported in Appendix 2.

As may be expected, all ashes contained concentrations of heavy metals substantially elevated above levels which may be expected in soils from uncontaminated areas. Ash collected from the electrostatic precipitator (MI0065) yielded the highest levels of heavy metal contamination, comprising 1.5% by weight of copper, 6.6% zinc and 2.5% lead. Such levels of contamination indicate the hazardous nature of the fly ash generated by the incinerator and, in turn, the high heavy metal content of the waste stream. The potential for heavy metals to leach out of the ash if subsequently exposed to rainfall is clear. Moreover, such heavily contaminated fine ash deposits would represent a substantial dust hazard if not properly contained.

Sample	Description	Concentration (mg/kg)					
		Cr	Cu	Mn	Ni	Pb	Zn
MI0064	Bottom ash	525	6970	457	263	1163	5903
MI0065	ESP ash	517	15483	376	689	25541	66356
MI0067	Economiser ash	454	3082	440	204	1738	9287

**Table 1. Concentrations of heavy metals in ash samples originating from the furnace, pollution control device (ESP) and economiser/heat exchanger, Izmit incinerator.**

Heavy metal concentrations in the bottom ash and economiser ash were generally lower, though still substantial, including 1.16 and 1.73 g/kg lead respectively. As a result, these ashes should also, of course, be designated as hazardous wastes.

With respect to organic contaminants, the greatest number were isolated from the bottom ash from the incinerator furnace, indicative of incomplete combustion of some components of the waste feedstock (see Table 2). Among the numerous aromatic organic compounds identified were 1,4-dichlorobenzene and two polychlorinated biphenyls (PCBs), though the latter were only detectable using selective ion monitoring. Although they can be produced as products of incomplete combustion in incinerators, their presence in the bottom ash residues strongly suggests the inclusion of PCBs or PCB-contaminated materials in the incinerator feedstock. Although far fewer organic contaminants were isolated in total from the economiser and ESP ash samples, as may be expected, the same two PCBs were identified in both samples. The appearance of these persistent organochlorines in ash drawn from the devices after exit from the furnace, may indicate carry through of incompletely combusted materials from the furnace into the stack and/or *de novo*<sup>1</sup> synthesis of chlorinated organic compounds during the cooling of the stack gases and particulates. Given the diversity of organic compounds identifiable in the bottom ash, including PCBs, it seems likely that the appearance of these compounds in the ESP ash results at least in part from incomplete combustion of PCB containing wastes, although further investigations would be necessary in order to confirm their origin.

The presence of chlorinated contaminants in the ESP ash was further confirmed by the results of the dioxin analysis for this sample (0.28 ng I-TEQ/g, ppb). Relatively few data are available concerning concentrations of dioxins and furans in the ash from incinerators burning clinical or hazardous waste; a far greater data set is available for municipal waste incinerators. Examination of these data reveals that the highest levels are generally found in fly ash. Levels characteristically range from parts per trillion (ppt) to parts per billion (ppb) (EEA 2000). For example, research on eight MSW incinerators in Spain found mean levels in fly ash between 0.07 and 3.5 ng I-TEQ/g (ppb) (Fabrellas *et al.* 1999). Another study on a MSW incinerator in Spain reported levels in fly ash from two analyses of 0.37 and 0.65 ng I-TEQ/g (ppb) (Abad *et al.* 2000). Particularly high levels were reported for one Spanish incinerator in 1997 (41 ppb TEQ) although levels recorded for the same installation in 1999 were lower (Stieglitz *et al.* 1999). At 0.28 ng/g TEQ, therefore, dioxin levels in the fly ash from the Izmit incinerator are not among the highest recorded, but nevertheless fall within the broad range reported for incinerators in other regions.

Dioxins were also detectable in the ash from the economiser/heat exchanger boiler, located between the furnace and the ESP, although at substantially lower concentrations (0.0082 ng I-TEQ/g) than in the ESP fly ash. The extents to which dioxins in the two ash samples were generated as products of incomplete combustion or *de novo* synthesis, or arose as a result of carry-over from the feedstock, cannot be determined precisely from this study. Nevertheless, the higher dioxin concentrations in the ESP ash compared to that in the economiser do suggest continued *de novo* synthesis of chlorinated dioxins in the stack gases and on associated particulates as the gases continue to cool between these two sections.

<sup>1</sup>*de novo* - newly synthesised, i.e. not carried over from the original waste material but generated through chemical reactions occurring in exhaust gases exiting from the furnace. *de novo* synthesis of dioxins can occur both through chemical reactions between appropriate "dioxin pre-cursor" molecules (e.g. chlorinated phenols) or through more fundamental reactions involving elemental carbon, chlorine and oxygen (especially in the presence of copper or certain other heavy metals which may act as catalysts and of fine particulates which provide active surfaces).

Sample	Description	No. compounds isolated	No. identified	No. chlorinated	No. PCBs
MI0064	Bottom ash	60	32	3	2
MI0065	ESP ash	13	2	2	2
MI0067	Economiser ash	12	3	3	2

**Table 2. Summary of results from analysis of ash samples for organic contaminants. “No. identified” indicates the number of the compounds isolated in each case which could be identified to match qualities greater than 90%.**

Differences are also apparent in the substantially higher concentrations of certain heavy metals, especially lead and copper which form relatively volatile compounds (e.g. chlorides), in the ESP. The lower concentrations of metals and dioxins in the economiser residues may relate to differences in the physicochemical composition of the deposits which collect in this section compared to the ESP, suggesting a possible influence of the different temperature regimes and particle size distributions in the two sections.

## Conclusions

This study has confirmed that dioxins are present in the fly ash trapped by the electrostatic precipitator of the Izmit incinerator, at levels in the same range as those reported for fly ashes from incinerators in other locations. What is not known, of course, is the efficiency with which the ESP is operating in terms of capturing the particulates from the stack gases, i.e. what proportion of the dioxin and heavy metal contaminated fly ash escapes from the stack and is dispersed directly over the surrounding area. Moreover, the retention of dioxins and other contaminants by the ESP does not represent an overall reduction on the quantities of such hazardous substances generated and/or emitted from the incineration process, as the ashes themselves represent hazardous waste streams which requires onward management.

In general terms, it is highly probable that while emissions from incinerators to air via stack gases have decreased over the last couple of decades, emissions to ashes have consequently increased. A study of a Spanish incinerator (Abad *et al.* 2000) noted that only a minor proportion of total dioxin output was through stack gases, the majority being present in ash residues. Indeed, Wikstrom (1999) proposed that the total dioxin emissions from incineration probably have not been reduced greatly in recent decades. Similarly, a theoretical assessment of the total emissions from a MSW incinerator in Sweden reported that a reduction of dioxins emitted in flue gases would inevitably result in an increase in levels in ash (GRAAB 1996). In this way, total dioxin emissions from an incinerator (to air and to ash) are likely to remain the same, irrespective of improvements in air pollution abatement technology, depending primarily on the nature of the feedstock, efficiency of combustion and the rate and extent of stack gas cooling.

It is worth noting also that, in addition to chlorinated dioxins, it is also likely that other halogenated dioxins and furans are present in the incinerator ashes, and flue gases, such as brominated and mixed chlorinated/brominated compounds. These compounds were not

quantified in the current study. Furthermore, Kashima *et al.* (1999) suggested that iodinated dioxins are also likely to be present.

The results of the current study also indicate that PCBs, or PCB-contaminated wastes, formed a significant part of the feedstock of the Izmit incinerator. This would appear to be in direct contradiction to the condition in the temporary operating permit from the Municipality that the incinerator should not handle chlorinated wastes. The incinerator was also clearly operating in April 2000, long after the temporary permit had first been issued as an emergency measure. Moreover, the appearance of PCB residues in the bottom ash is strongly indicative of inefficient and incomplete combustion of wastes within the furnace.

Given the levels of heavy metals and organic contaminants in the bottom and fly ashes as reported above, the Izmit incinerator is also clearly generating large quantities of heavily contaminated, hazardous solid wastes in the process of combusting the feedstock. Direct emissions of hazardous substances to air have not been evaluated in the current study, but are likely also to be significant.

More generally, it should be noted that a range of alternative (non-combustion) technologies already exist for the destruction of PCB stockpiles and PCB-containing wastes, as well as other hazardous wastes. Several are already in commercial operation, handling PCBs and other chlorinated wastes. Alternatives to incineration also exist for the sterilisation of clinical wastes, including autoclaves and microwave systems. Such systems destroy pathogens on all surfaces of the clinical waste materials without the need to destroy the waste material itself, thereby avoiding the formation of dioxins during incineration.

In selecting appropriate alternative destruction technologies for hazardous chemical wastes, a key criterion should be the ability to operate the process in a closed-loop configuration, such that any waste streams which may contain hazardous residues may be recirculated back through the process. It is only in this manner that the objective to eliminate the generation and output of hazardous by-products of destruction, including dioxins, may be achieved. Incinerators and related combustion technologies can never be operated in such a “closed-loop” configuration.

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**A. Organic analysis****A.1. Preparation of samples for organic screen analysis**

All solvents were of High Purity Grade (PRAG or low haloform). Glassware used in the extraction and clean up procedures was cleaned in detergent, rinsed with tap water and deionised water, dried in the oven overnight at 105<sup>0</sup>C, and rinsed three times with low haloform pentane.

**A.2. Extraction of samples**

In preparation for analysis of extractable organic compounds, approximately 30g (wet weight) was weighed and transferred to a clean 100 ml glass bottle. Samples were spiked with deuterated naphthalene (an internal standard) at a concentration of 4.7 mg/kg. 15ml of pentane was added, followed by 5ml of acetone. All samples were then sonicated for 2 hours.

<b>Compound</b>	<b>Ions monitored</b>
Benzene, 1,3-dichloro-	146, 148, 111, 75
Benzene, 1,4-dichloro-	146, 148, 111, 75
Benzene, 1,2-dichloro-	146, 148, 111, 75
Benzene, 1,3,5-trichloro-	180, 182, 145, 74
Phenol, 2,4-dichloro-	162, 164, 63, 98
Benzene, 1,2,4-trichloro-	180, 182, 145, 109
Benzene, 1,2,3-trichloro-	180, 182, 145, 109
Dichlorvos	109, 185, 79, 47
Benzene, 1,2,3,5-tetrachloro-	216, 214, 218, 179
Benzene, 1,2,4,5-tetrachloro-	216, 214, 218, 179
Benzene, 1,2,3,4-tetrachloro-	216, 214, 218, 179
Benzene, pentachloro-	250, 252, 248, 215
alpha-BHC	181, 183, 219, 217
Benzene, hexachloro-	284, 286, 282, 249
Simazine	200, 215, 202, 173
beta-BHC	181, 183, 219, 217
gamma-BHC	181, 183, 219, 217
delta-BHC	181, 183, 219, 217
o,p'-DDE	246, 248, 318, 176
p,p'-DDE	246, 318, 246, 316
o,p'-DDD	235, 237, 165, 199
p,p'-DDD	235, 237, 165, 199
o,p'-DDT	235, 237, 165, 199
p,p'-DDT	235, 237, 165, 199

***A.1.1 List of compounds in the Standard I used for SIM analysis***

<b>Compound</b>	<b>Ions monitored</b>
Phenol, 2-chloro-	128, 64, 92, 39
Phenol, 2-methyl-	108, 79, 90, 51
Phenol, 3-methyl- and 4-methyl-	108, 107, 79, 77
Phenol, 2,5-dichloro-	162, 164, 63, 99
Phenol, 2,3-dichloro-	162, 126, 63, 99
Phenol, 4-chloro-	128, 65, 130, 100
Phenol, 2,6-dichloro-	162, 164, 63, 98
Butadiene, hexachloro-	225, 190, 260, 118
Phenol, 2,3,5-trichloro-	196, 198, 160, 97
Phenol, 2,4,5-trichloro-	196, 198, 97, 132
Phenol, 3,5-dichloro-	162, 164, 99, 63
Phenol, 2,3,6-trichloro-	196, 198, 97, 132
Phenol, 3,4-dichloro-	162, 164, 99, 63
Atrazine	200, 215, 202, 173
Phenol, pentachloro-	266, 268, 264, 165
Chlordane I	373, 375, 272, 237
Chlordane II	373, 375, 272, 237
PCB-153	360, 362, 290, 218
PCB-138	360, 362, 290, 292
PCB-180	394, 396, 324, 252

### *A.1.2 List of compounds in the Standard II used for SIM analysis*

Extracts were decanted, filtered through a pre-cleaned hydrophobic phase separator filter and collected in reagent tubes. The samples were then acidified to pH 2 with 10% nitric acid. Following this, a second portion of pentane (15ml) and acetone (5ml) were added and the extraction procedure repeated. Finally, both extracts obtained for each sample were combined and evaporated to a volume of approximately 3ml. The concentrated extract was cleaned through a Florisil column, eluted with a 95:5 mixture of pentane: toluene, and evaporated down to a volume of 2 ml under a stream of analytical grade nitrogen. 1-Bromonaphthalene was then added at a concentration of 10 mg/l to provide an indication of GC/MS performance.

### **A.3. Chromatographic analysis**

Organic compounds were identified qualitatively and quantitatively using Gas Chromatography Mass Spectrometry (GC-MS).

The instrumentation used was a Hewlett Packard (HP) 5890 Series II gas chromatograph, interfaced with a HP Chem-Station data system and linked to a HP 5972 Mass Selective Detector operated in scan mode. The identification of compounds was carried out by computer matching against a HP Wiley 275 library of 275,000 mass spectra combined with expert interpretation. In addition, all extracts were analysed using selective ion monitoring (SIM) method against two standard solutions. The lists of compounds contained in Standard I and Standard II are presented below. All individual standards were obtained from Sigma Aldrich Co. Ltd., Supelco, UK. Identification of tris(2-chloroisopropyl) phosphate isomers was additionally checked against technical Fyrol PCF kindly provided by Akzo Nobel, UK.

Results are reported as a list of those compounds reliably and tentatively identified. Match qualities of 90% or greater against HP Wiley 275 library or identification confirmed against standard compounds (using retention times and mass-spectra obtained during calibration) are assumed to give reliable identifications. Tentative identification refers to quality matches of between 51% and 90% against the HP Wiley 275 library only. Analytes yielding match qualities of 50% or less are assumed to be unidentified.

## **B. Heavy Metal Analysis**

### **B.1. Preparation of samples for heavy metal analysis**

All chemicals were of High Purity Aristar Grade. All glassware was cleaned in detergent, rinsed with tap water and deionised water, soaked in 10% nitric acid overnight, rinsed with deionised water and dried in an oven.

### **B.2. Digestion of samples**

Samples were air dried until weighing readings became constant (approx. 5 days). They were then crushed using a pestle and mortar until homogenous and sieved through a 2-mm mesh. 0.5 g of sample was weighed into a glass 100 ml boiling tube and to this 10 ml of deionised water was added, followed by 7.5 ml of concentrated hydrochloric acid and 2.5 ml of concentrated nitric acid. The samples were digested at room temperature overnight prior to being placed onto a Gerhardt Kjeldatherm digestion block (40 space) connected to a Gerhardt Turbosog scrubber unit (filled with 10% w/v sodium hydroxide). The samples were then refluxed at 130 °C for four hours.

After cooling to ambient temperature, the digests were filtered into volumetric flasks, diluted with deionised water, made up to a volume of 50 ml and mixed. A Standard Reference Material, BCR-143 (trace elements in a sewage sludge amended soil), certified by the Commission of the European Communities, Brussels, and a blank sample, were prepared with the batch of samples. All were prepared in 15% v/v hydrochloric acid and 5% v/v nitric acid.

### **B.3. Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)**

Following preparation, samples were analysed by ICP-AES, using a Varian Liberty-100 Sequential Spectrometer. The following metals were quantified directly: manganese, chromium, zinc, copper, lead, nickel, cobalt and cadmium. A multi-element instrument calibration standard was prepared at a concentration of 10 mg/l, matrix matched to the samples (i.e. in 15% v/v hydrochloric acid and 5% v/v nitric acid). The calibration was validated using a quality control standard (8 mg/l), prepared internally from different reagent stocks. Any sample exceeding the calibration range was diluted accordingly, in duplicate, and re-analysed.

## APPENDIX 2: ANALYTICAL RESULTS FOR INDIVIDUAL SAMPLES

**Sample Number:** MI0064

**REFERENCE NUMBER:** TU001

**SAMPLE TYPE:** INCINERATOR ASH

**Location:** Kocaeli, Izmit, Turkey

**Sampling Date:** 05.04.00

**Sample Information:** Sample collected from slag/botom ash commercial rotary kiln slagging plant type, Izmit Solaklar Koyo Meukii waste incinerator.

### INORGANIC ANALYTICAL RESULTS

**Analysis method:** ICP-AES

**Prepared by Kevin Brigden**

<b>METAL</b>	<b>CONCENTRATION (mg/kg dry weight)</b>
Cadmium	<2
Chromium	525
Cobalt	33
Copper	6970
Lead	1163
Manganese	457
Mercury	0.44
Nickel	263
Zinc	5903

## ORGANIC ANALYTICAL RESULTS

Analysis method: GC/MS screen

Number of compounds isolated: 60

### Compounds identified to better than 90%:

1,1'-Biphenyl, 2,2',3,4,4',5'-hexachloro- (PCB-138)	SIM only
1,1'-Biphenyl, 2,2',4,4',5,5'-hexachloro- (PCB-153)	SIM only
1H-Indene, 2,3-dihydro-	
Benzene, 1,2,3,5-tetramethyl-	
Benzene, 1,2,3-trimethyl-	
Benzene, 1,2,4-trimethyl-	
Benzene, 1,2-dimethyl-	
Benzene, 1,3,5-trimethyl-	
Benzene, 1,3-diethyl-	
Benzene, 1,4-dichloro-	SIM only
Benzene, 1-ethyl-2-methyl-	
Benzene, 1-ethyl-3,5-dimethyl-	
Benzene, 1-methyl-2-(1-methylethyl)-	
Benzene, 1-methyl-4-(1-methylethyl)-	
Benzene, 2-ethyl-1,3-dimethyl-	
Benzene, 2-ethyl-2,3-dimethyl-	
Benzene, propyl-	
Bicyclo[4.2.0]octa-1,3,5-triene	
Cycloeicosane	
Diphenylmethylene-cyclopropane	
Eicosane	
Heneicosane	
Heptacosane	
Naphthalene	
Naphthalene, 1,3-dimethyl-	
Naphthalene, 1,5-dimethyl-	
Naphthalene, 1,6-dimethyl-	
Naphthalene, 1-methyl-	
Naphthalene, 2,3,6-trimethyl-	
Naphthalene, 2-methyl-	
Phenanthrene, 4-methyl-	
Phenol, 3-methyl-	SIM only

### Compounds tentatively identified:

1-Octadecene  
1-p-Menthen-8-yl acetate  
28-nor-17beta(h)-Hopane  
Benzene, (1-methylpropyl)-

Benzene, 1,2,3,4-tetramethyl-  
Benzene, 1-ethyl-2,3-dimethyl-  
Benzene, 1-ethyl-3-methyl-  
Benzene, 1-methyl-2-propyl-  
Benzene, isopropyl-  
Decane, 2-methyl-  
Decane, 2-methyl-  
Docosane  
Eicosane, 9-octyl-  
Heptadecane  
Heptane, 2,6-dimethyl-  
Hexadecane  
Isoquinoline, 1,2,3,4-tetrahydro-  
Octadecanoic acid, 2-[(1-oxohexadecyl)oxy]ethyl ester  
Pentadecane, 2-methyl-  
Tetradecane  
Tricosane

**Sample Number:** MI0065

**REFERENCE NUMBER:** TU002

**SAMPLE TYPE:** INCINERATOR ASH (ESP)

**Location:** Kocaeli, Izmit, Turkey

**Sampling Date:** 05.04.00

**Sample Information:** Sample collected from electrostatic precipitator, Izmit Solaklar Koyo Meukii waste incinerator.

### INORGANIC ANALYTICAL RESULTS

**Analysis method: ICP-AES**

**Prepared by Kevin Brigden**

<b>METAL</b>	<b>CONCENTRATION (mg/kg dry weight)</b>
Cadmium	85
Chromium	517
Cobalt	32
Copper	15483
Lead	25541
Manganese	376
Mercury	5.33
Nickel	689
Zinc	66356

## ORGANIC ANALYTICAL RESULTS

**Analysis method:** GC/MS screen

**Number of compounds isolated:** 13

### **Compounds identified to better than 90%:**

1,1'-Biphenyl, 2,2',3,4,4',5'-hexachloro- (PCB-138)	SIM only
1,1'-Biphenyl, 2,2',4,4',5,5'-hexachloro- (PCB-153)	SIM only

### **Compounds tentatively identified:**

5-Eicosene, (E)-  
5-Undecanone, 2-methyl-  
6H-Purin-6-one, 1,7-dihydro-  
Hydroxylamine, O-decyl-  
Nonadecane  
Octadecane

**Sample Number:** MI0067

**REFERENCE NUMBER:** **TU004**

**SAMPLE TYPE:** **ECONOMISER ASH**

**Location:** Kocaeli, Izmit, Turkey

**Sampling Date:** 05.04.00

**Sample Information:** Sample collected from incinerator heat exchanger, Izmit Solaklar Koyo Meukii waste incinerator.

### INORGANIC ANALYTICAL RESULTS

**Analysis method: ICP-AES**

**Prepared by Kevin Brigden**

<b>METAL</b>	<b>CONCENTRATION (mg/kg dry weight)</b>
Cadmium	11
Chromium	454
Cobalt	13
Copper	3082
Lead	1738
Manganese	440
Mercury	1.42
Nickel	204
Zinc	9287

## ORGANIC ANALYTICAL RESULTS

**Analysis method:** GC/MS screen

**Number of compounds isolated:** 12

### **Compounds identified to better than 90%:**

1,1'-Biphenyl, 2,2',3,4,4',5'-hexachloro- (PCB-138)	SIM only
1,1'-Biphenyl, 2,2',4,4',5,5'-hexachloro- (PCB-153)	SIM only
Benzene, 1,4-dichloro-	

### **Compounds tentatively identified:**

Octadecane, 3-ethyl-5-(2-ethylbutyl)-