

Dublin Waste to Energy Project

Report on Performance Demonstration Tests

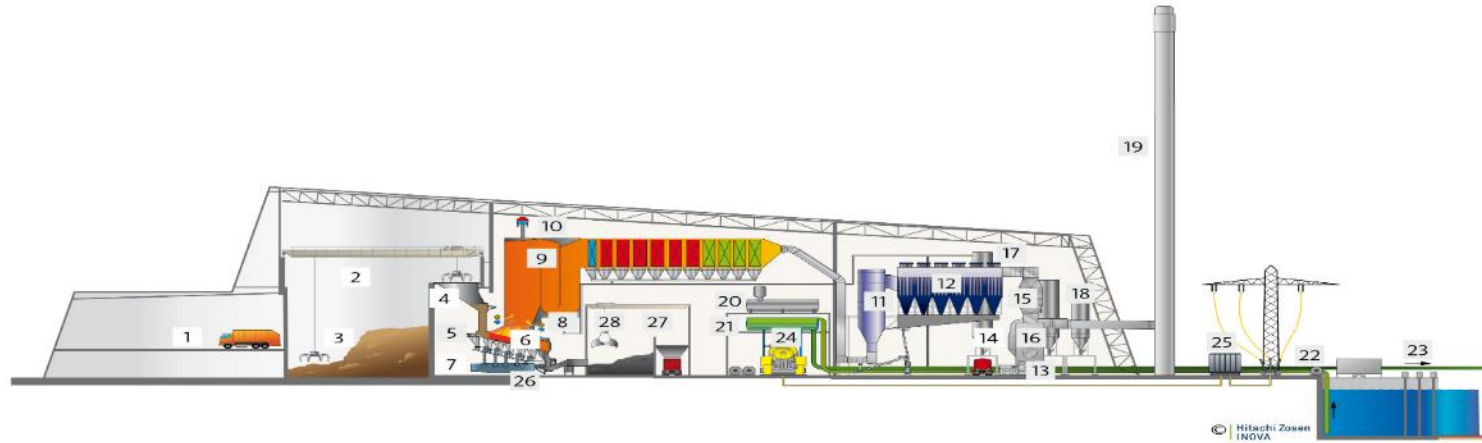
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**CDM
Smith**

DWTE Process Schematic



© Hitachi Zosen
INOVA

Waste Delivery and Storage

- 1 Tipping hall
- 2 Waste bunker
- 3 Waste crane

Combustion and Boiler

- 4 Feed hopper
- 5 Ram feeder
- 6 Hitachi Zosen Inova grate
- 7 Primary air
- 8 Secondary air
- 9 Four-pass boiler
- 10 Boiler drum

Flue Gas Treatment

- 11 SemiDry reactor
- 12 Fabric filter
- 13 Induced draft fan
- 14 Silencer
- 15 Flue gas heat exchanger
- 16 Wet scrubber
- 17 Residue silo
- 18 Additive silos
- 19 Stack

Energy Recovery

- 20 Feed water tank
- 21 Water cooled condenser
- 22 Cooling water pump
- 23 Fish screen and return system/water intake filter
- 24 Turbine
- 25 Transformer

Residue Handling and Treatment

- 26 Bottom ash extractor
- 27 Bottom ash bunker
- 28 Bottom ash crane

Overview

PPP Co. is tasked with conducting a series of tests to demonstrate the operational capacity of the DWTE Facility pursuant to Schedule 08 of the PA. These tests include:

- Pre-Commissioning Tests;
- Performance Demonstration Tests (PDT); and
- Performance Acceptance Tests (PAT).



Pre-Commissioning Tests

Pre-Commissioning Test

- Prerequisite
 - Substantially Complete Construction Per Project Agreement/Approved Design;
 - Complete Mechanical/Electrical Check Outs (MECs);
 - Approximately 260 MEC Walkdowns undertaken.
- Test Requirements
 - Minimum 48 Hours Continuous Operation;
 - Minimum 24 Hours Above 80% Nominal Input Capacity (NIC) Within 48-Hours;
 - Compliance with Emission Limits for CEM Measured Pollutants.

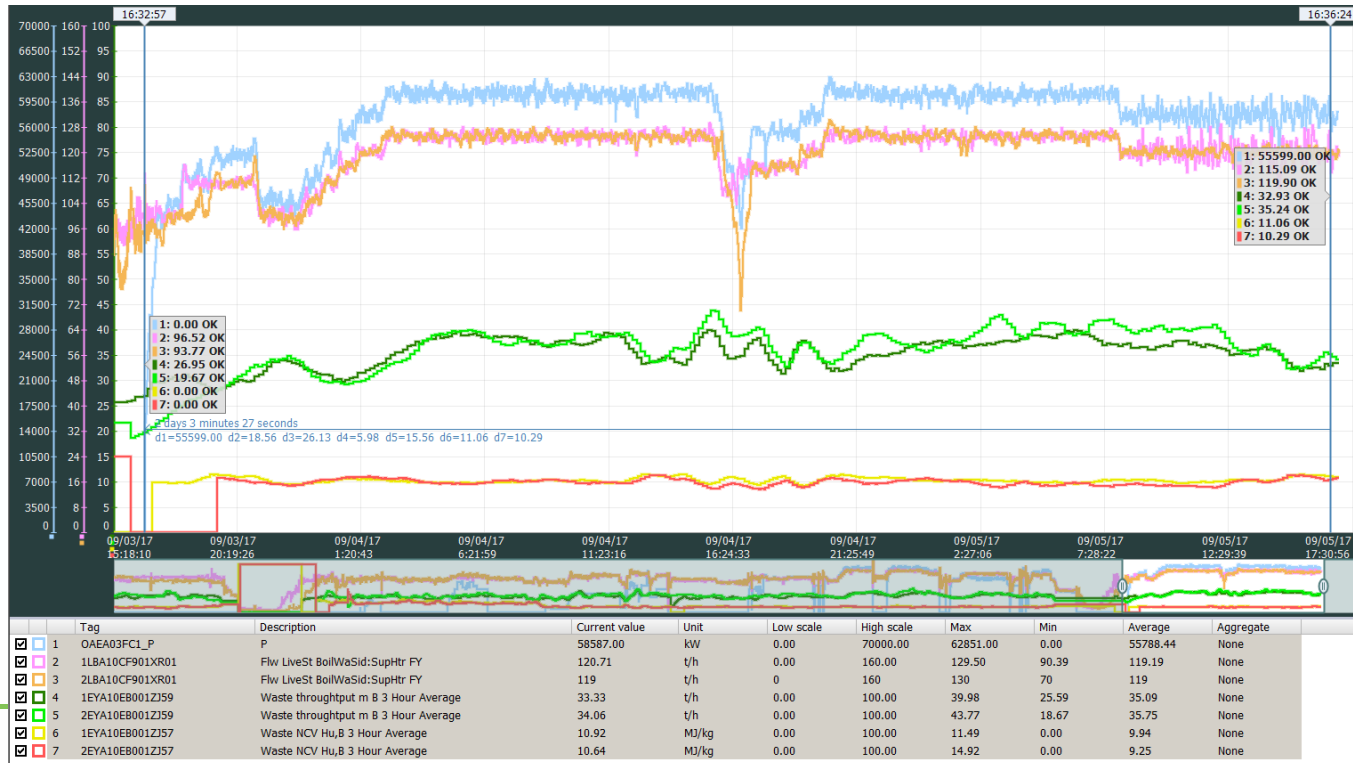
Pre-Commissioning Test Results – Summary

- Dates: 03-05 September 2017

Criteria	Requirements	Result	Date/Time
Continuous Operation	>48 Hours	48 Hours, 3 Minutes	3/9/17 16:33 – 5/9/17 16:36
Operation at >80% NIC	>24 Hours	24 Hours	4/9/17 16:36 – 5/9/17 16:36
Environmental	Compliance with CEM Measured Pollutants	All Emissions <ELVs	3/9/17 16:33 – 5/9/17 16:36

Pre-Commissioning Test: Control System Trend

- Dates: 03-05 September 2017



Pre-Commissioning Test Results:

24-hour average CEMS Data

CEMS Parameter	Line 1		Line 2		PA 24-Hour ELV	IE Licence 24-Hour ELV	Pass / fail
	First 24 hours	Second 24 hours	First 24 hours	Second 24 hours			
Hydrogen Chloride (HCl)	0	0	0	0	9 mg/m ³	10 mg/m ³	Pass
Sulphur Dioxide (SO ₂)	3.0	3.9	4.2	4.2	45 mg/m ³	50 mg/m ³	Pass
Carbon Monoxide (CO)	1.0	1.9	1.0	0.3	50 mg/m ³	50 mg/m ³	Pass
Nitrogen Oxides (NO _x)	162	170	158	171	180 mg/m ³	200 mg/m ³	Pass
Total Organic Carbon (TOC)	0	0	0	0	9 mg/m ³	10 mg/m ³	Pass
Dust	1	1	1	1	9 mg/m ³	10 mg/m ³	Pass

Pre-Commissioning Test Results:

Maximum Value CEMS data

CEMS Parameter	Line 1		Line 2		PA Half-Hour ELV	IE Licence Half-Hour ELV	Pass / fail
	First 24 hours	Second 24 hours	First 24 hours	Second 24 hours			
Hydrogen Chloride (HCl)	0	0	0	0	54 mg/m ³	60 mg/m ³	Pass
Sulphur Dioxide (SO ₂)	4.0	4.0	5.0	5.0	180 mg/m ³	200 mg/m ³	Pass
Carbon Monoxide (CO)	2.0	15	32	2.0	100 mg/m ³	100 mg/m ³	Pass
Nitrogen Oxides (NO _x)	187	188	188	189	360 mg/m ³	400 mg/m ³	Pass
Total Organic Carbon (TOC)	0	1	1	0	18 mg/m ³	20 mg/m ³	Pass
Dust	1	1	2	2	27 mg/m ³	30 mg/m ³	Pass



Performance Demonstration Tests

Performance Demonstration Tests (PDT)

- Prerequisites
 - Completion of Pre-Commissioning Tests
- Test Requirements
 - 720 Hour (30 Day) Continuous Operation
 - Operation at 80-100% NIC
 - Max 5 “Stoppages”
 - Max 10 Hours/Individual Stoppage
 - Max 48 Hours Total Stoppage Time
 - 336 Hour (14 Day) Run Within 30 Day Test
 - Operation at >90% Average NIC
 - Max 3 “Stoppages”
 - Max 10 Hours/Individual Stoppage
 - Max 24 Hours Total Stoppage Time
 - Compliance with Environmental Warranties at all times

Definition of “Stoppages”

- (A) the time that the plant drops below line “ABC” until the time it rises above line “ABC” of the capacity diagram contained in Appendix C (Bid Proposals) (Effectively <60% NIC or <7 MJ/kg LHV); or
- (B) the time when the plant is not complying with the Environmental Warranties; or
- (C) the time when the plant in any period is operating below 80% of the NIC for more than 1 hour.

Environmental Warranties

- Air Quality Warranty
 - CEMS Monitored Pollutants
 - Stack Test Monitored Pollutants (undertaken by Exova Catalyst Ireland)
- Residue Quality Warranty (lab analysis undertaken by SGS Belgium NV)
- Waste Water Quality Warranty
- Noise Warranty (undertaken by AECOM)

Air Quality Warranty: CEMS Monitored Pollutants

- Total Dust (Particulate)
- Total Organic Carbon (TOC)
- Hydrogen Chloride (HCl)
- Sulphur Dioxide (SO₂)
- Nitrogen Oxides (NO_x)
- Carbon Monoxide (CO)

CEM Sampling System



View of CEMS cabinets inside CEMS shelter



Air Quality Warranty: Results of Exova Testing for CEM Monitored Pollutants

Pollutants	Emission Limit Value			Combustion Unit		Pass/Fail
	Waste License	Project Agreement	Units	Line 1	Line 2	
Total Dust	10	9	mg/m ³	1.35	0.83	Pass
TOC	10	9	mg/m ³	2.0	0.29	Pass
HCl	10	9	mg/m ³	0.030	0.072	Pass
SO ₂	50	45	mg/m ³	0.062	0.068	Pass
NO _x	200	180	mg/m ³	103.24	106.70	Pass
CO	50	50	mg/m ³	1.82	0.23	Pass

Air Quality Warranty: Stack Test Monitored Pollutants

- Particulate Matter Less Than 10 Microns (PM₁₀)
- Particulate Matter Less Than 2.5 Microns (PM_{2.5})
- Hydrogen Fluoride (HF)
- Nitrous Oxide (N₂O)
- Cadmium (Cd) and Thallium (Tl)
- Mercury (Hg)
- Arsenic (As)
- Metals (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V)
- Dioxins/Furans

Exova Stack Test Apparatus



Air Quality Warranty: Results of Exova Testing for Stack Test Monitored Pollutants

Pollutant	Emission Limit Value			Combustion Unit		Pass/Fail
	Waste License	Project Agreement	Units	Line 1	Line 2	
PM ₁₀	-	-	mg/m ³	0.18	0.20	-
PM _{2.5}	-	-	mg/m ³	0.14	0.15	-
HF	1	0.9	mg/m ³	<0.04	0.042	Pass
N ₂ O	-	-	mg/m ³	5.7	1.83	-
Cd and Tl	0.05	0.045	mg/m ³	<0.00071	<0.00056	Pass
Mercury	0.05	0.045	mg/m ³	<0.00030	0.00091	Pass
Arsenic	0.2	-	mg/m ³	<0.00065	0.00060	Pass
Metals	0.5	0.45	mg/m ³	0.1590	0.1341	Pass
Dioxin/Furans	0.1	0.09	ng/m ³ TEQ	0.00348	0.00022	Pass

Residue Warranty: Bottom Ash Sampling Process

- 35-40 Kg Samples Collected Every 6 Hours;
- Twenty-Eight, 6-Hour Samples Composited into Weekly Sample;
- Samples Processed Onsite by Crushing and Screening;
- 4-Weekly Samples Sent to Independent Laboratory (SGS Belgium NV);
- Samples Analyzed by SGS for total organic carbon (TOC) and loss on ignition (LOI).

Bottom Ash Sampling Process



Residue Warranty: PDT Test Results

Composite Sample	Percent Moisture	TOC (% By Dry Weight)	TOC Limit (% By Dry Weight)	LOI (% By Dry Weight)	LOI Limit (% By Dry Weight)	Pass/fail
Week 1	10.4	<1.0	<3	3.1	<5	Pass
Week 2	11.2	<1.0		2.2		Pass
Week 3	13.7	<1.0		2.5		Pass
Week 4	13.3	<1.0		2.1		Pass

Waste Water Warranty: Test Requirements

- Maximum Hourly Seawater Cooling Water Flow
- Maximum Total Daily Seawater Cooling Water Flow
- Maximum Seawater Temperature Rise
- Maximum Hourly and Daily Seawater Residual Chlorine Levels

Waste Water Warranty: PDT Test Results

Parameter	Emission Limit Value	Test Value	Pass/Fail
Hourly Seawater Flow (m ³ /hr)	14,040	<14,040	Pass
Total Daily Seawater Flow (m ³ /day)	570,000	<570,000	Pass
Hourly Average Seawater Temperature Rise (°C)	9.5	<9.5	Pass
Hourly Average Seawater Residual Chlorine (mg/l)	0.5	<0.5	Pass
Daily Average Seawater Residual Chlorine (mg/l)	0.2	<0.2	Pass

Noise Warranty: Test Requirements

- Measure Daytime and Night-time Noise Levels
- Daytime Limit: 55 dB (A) L_{Aeq} (30 Minutes)
- Night-time Limit: 45 dB (A) L_{Aeq} (30 Minutes)

Noise Testing Apparatus



Noise Warranty: Daytime Test Results

Location	Date	Average L_{aeq} 30 Minutes	L_{aeq} Limit 30 Minutes
Western Site Boundary – N7	21 September 2017	62	55
Northern Site Boundary – N8		62	
Eastern Site Boundary – N9		68	
Southern Site Boundary – N10		61	

Noise Warranty: Night-time Test Results

Location	Date	Average L_{aeq} 30 Minutes	L_{aeq} Limit 30 Minutes
Western Site Boundary – N7	21-22 September 2017	53	45
Northern Site Boundary – N8		55	
Eastern Site Boundary – N9		60	
Southern Site Boundary – N10		49	

PDT Test Results: 720 Hour Test

- Test Dates: 08 September – 08 October 2017

	Test Result	Project Agreement Requirement	Pass/Fail
Test Duration (Hours)	720	720	Pass
Average % NIC	103.6	-	-
Number Stoppages NIC <60% or LHV <7 MJ/kg	0	-	-
Number Environmental Stoppages	1	-	-
Number NIC <80% Stoppages	1	-	-
Total Stoppages	2	≤5	Pass
Maximum Time/Individual Stoppage (Hours)	1.5	≤10	Pass
Total Duration Stoppages (Hours)	2.7	≤48	Pass

PDT Test Results: 336 Hour Test

- Test Dates: 19 September – 03 October 2017

	Test Result	Project Agreement Requirement	Pass/Fail
Test Duration (Hours)	348	336	Pass
Average % NIC	104.5	≥90	Pass
Number Stoppages NIC <60% or LHV <7 MJ/kg	0	-	-
Number Environmental Stoppages	0	-	-
Number NIC <80% Stoppages	0	-	-
Total Stoppages	0	3	Pass
Maximum Time/Individual Stoppage (Hours)	0	<10	Pass
Total Duration Stoppages (Hours)	0	<24	Pass

Summary & Conclusions

- 48-hour Pre-Commissioning Test run successfully completed 03-05 September 2017;
- 720-hour test run successfully completed 08 September – 08 October 2017;
- 14-day test run successfully completed 19 September – 03 October 2017;
- PPP Co. submitted Performance Demonstration Test Confirmation Certificate on 16 November 2017;
- CDM Smith concludes the PDT was successfully completed, and recommended the Authority issued the PDT certificate;
- Authority issued Performance Demonstration Certificate on 24 November 2017 after verifying all PDT criteria outlined in Schedule 8 were met.

