Appendix C: Regulatory Compliance Discussion Report

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Regulatory Compliance Discussion Report

Car Park Waste Encapsulation, June 2007

Prepared by Orica Australia Pty Ltd and Thiess Services Pty Ltd

Attachments:

1 Introduction

The proposed Car Park Waste Encapsulation (CPWE) remediation project is governed by a number of environmental conventions, protocols, guidelines, regulations and acts including state, national and international instruments. These and the associated New South Wales (NSW) planning instruments are outlined in Chapter 5 (Statutory Planning) of the Environmental Assessment (EA). NSW and national regulations relevant to impact assessment are also discussed in the PAE Pty Ltd (2007) *Air Quality Impact Assessment* (Appendix E) of the EA.

The following discussion provides further details on regulatory requirements, specifically with respect to the proposed directly-heated thermal desorption (DTD) treatment technology including compliance of the plant design and operation with:

- the Stockholm Convention;
- the national HCB (ANZECC 1996) and PCB Management Plans;
- the national ambient air quality measure;
- NSW stack concentration criteria; and
- NSW chemical control orders.

A description of the DTD Plant and process including a preliminary mass and energy balance by Focus Environmental, Inc. (Focus), is found in **Attachment A**[1]. This document will be updated and refined as the project moves the next phase of planning.

[1] Evaluation of a direct-fired thermal desorption system for treating Orica car park waste encapsulation materials. Submitted to Thiess Services, May 27 2005

2 Regulatory Requirements

2.1 Stockholm Convention

The Stockholm Convention[2] requires (under Article 3 and Annex A) that parties to the covenant eliminate from use and dispose in an environmentally sound manner nominated chemicals including some organochlorine pesticides (OCPs), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs). It also requires (Article 5 and Annex C) that the parties to the convention reduce or eliminate releases from unintentional production of dioxins and furans, HCB and PCBs, by adopting Best Available Techniques and best environmental practices.

The treatment technology proposed for the CPWE remediation (DTD) conforms with the principles of the convention in that it removes and destroys the HCB and PCBs present in the CPWE soil to the maximum extent practicable (i.e. near to or at their limit of detection in soil), while minimising emissions of dioxins and furans, HCB and PCBs by the use of best available techniques and best environmental practices. In this case Best Available Techniques are mainly applicable to the DTD Plant, while best environmental practices are relevant to the associated site works, including dewatering, excavation, transportation, and pre-treatment of soil for the DTD Plant. The latter activities are outlined in the EA and not discussed further here.

Guidelines for best available techniques were issued in 2004 under the Stockholm Convention for various processes and plants[3]. The guidelines focus in particular on minimising or eliminating to the maximum extent possible emissions of dioxins and furans during the destruction of the above chemicals. In the absence of Australian guidance, these guidelines and associated directives of the European Parliament[4] take precedence over other jurisdictions in terms of international regulatory principles applied in Australia. Although none of the above sources deals directly with DTD as a technology, they do deal with the use of thermal oxidisers to destroy chlorinated wastes, and it is this aspect that is relevant to the proposed remediation technology.

Features of the best practice guidelines relevant to the DTD process are:

- good combustion practice, which involves optimising turbulence, temperature and residence time in the DTD Plant thermal oxidiser (TO);
- rapid quenching (or fast gas cooling) to minimise the reformation (or de-novo formation) of dioxins in the TO off-gas, which is achieved in the DTD quench (or evaporative cooler);
- dust separation using cloth filters to remove particulates that may contain adsorbed dioxins in the DTD Plant baghouse;
- cyclones (or multi-clones) to further remove dust from the off-gas; and
- wet scrubbing to remove acid gases from the off-gas in the DTD Plant acid gas scrubber.

Thermal Oxidiser Design: With regard to good combustion practice it should be noted that the Stockholm guidance is for incinerator thermal oxidisers. There are some design and operational differences between an incinerator TO and a DTD Plant TO, mainly due to the nature of the waste treated. Specifically DTD plants treat soil with low organic content and high mineral content relative to incinerator wastes which typically have high organic contents and low mineral contents and may include liquid feeds. This means that the details of the Best Available Techniques of the Stockholm Convention have to be interpreted when applying the principles of the convention to the design and operation of a DTD Plant treating soil.

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[2] Stockholm Convention on Persistent Organic Pollutants, Stockholm, 22-23 May 2001

[3] Guidance on Best Available Techniques and Provisional Guidelines on Best Environmental Practices Relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants, December 2004

[4] Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the Incineration of Waste (EU Waste Incineration Directive)

Thermal Oxidiser Turbulence: The Stockholm Convention does not specifically reference design parameters for turbulence but notes that turbulent mixing is required for complete incineration. The DTD Plant TO would be designed to ensure turbulent mixing by the use of turbulent mixing vanes about the oxidisers flame.

Thermal Oxidiser Temperature: The Stockholm Convention Best Available Techniques recommends a minimum thermal oxidiser temperature of 900°C, and states that ash fusion can become a problem in incinerators operated at 980°C or above. The European Union (EU) Waste Incineration Directive specifies a minimum temperature of 850°C for any incinerator, and a minimum of 1,100°C when burning wastes containing more than 1% organic chlorine. The contents of the CPWE contains <1% chlorine, and the DTD Plant TO would be operated above the minimum temperature of 900^{o}C, providing slagging of the TO due to melting of entrained dust was not encountered. Slagging is more likely to be a significant problem in a DTD Plant TO than a high temperature incinerator due to the relatively high dust load passing through it. Slagging would result in an undesirable stop start operation as well as prolonging the duration of the work and creating safety risks due to the requirement to deslag the TO (which would require entry by personnel).

Thermal Oxidiser Residence Time: Residence time is the time that contaminants take to pass through the TO where they are destroyed. It is a function of gas velocity and TO length. Many guidance documents for hazardous waste incineration design recommend a minimum gas residence time of 2 seconds (**Attachment B**). The Stockholm Convention Best Available Techniques document (Section 12.1.1) references "sufficient residence time (for example 2 seconds)" to complete incineration. The recommendation for a 2 second residence time originates with the requirement to treat liquid wastes so that adequate time is provided first for the liquid droplet to evaporate and then for the resulting organic vapour to be oxidised. The rate-limiting step in the process is the evaporation of the liquid droplet. Conversely, fume incinerators treating vapour are typically designed with a minimum gas residence time in the range of 0.5 to 1.0 seconds, with a typical value being 0.75 seconds.

In a DTD Plant equipped with a TO, the organics entering the TO are already in the vapour phase and therefore a relatively short gas residence time is capable of achieving adequate organic destruction efficiency. DTD plants in the United States (US) are typically designed for gas residence times in the TO in the range of 1.0 to 2.0 seconds, with the standard design for an Astec mobile plant being ~ 1.6 seconds. To design an afterburner on a DTD Plant with a gas residence time of > 2 seconds would increase the physical size of the equipment for a marginal or negative environmental benefit given the associated increase in greenhouse gas emissions.

It is also relevant that TO residence time cannot be directly measured since it is determined by a number of continuously varying inputs when treating contaminated soil (such as the moisture content of the soil). In the US, residence time is not a regulated operating parameter for thermal plants, except for high temperature incinerators treating liquid PCB waste.

Quench: The DTD Plant proposed for the CPWE project would be equipped with a quench (or an evaporative cooler) after the TO to quench the TO off-gas from $1{,}000^{o}$C to around 200^{o}C, and thus minimise the potential for reformation of dioxins. The lower temperature limit would be optimised to prevent the condensation of acid in the downstream baghouse.

Dioxin Emissions: The Stockholm Convention Best Available Techniques document considers that dioxin and furan emissions of 0.1 to 0.01 ng TEQ / Nm3 are achievable for incinerators configured as above. DTD plants similar to the plant proposed for the CPWE project have achieved a standard of < 0.1 ng TEQ / Nm3. The plant proposed for the CPWE project would be designed and operated to meet this standard.

Dust Removal. The DTD Plant proposed for the CPWE project would be equipped with a cyclone or multi-clones before the TO and a baghouse after the TO to remove dust from off-gas. The baghouse would be fitted with fabric or cloth filters to remove fine dust. It should be noted that while fabric filters represent Best Available Techniques for the Plant, that absolute dust emissions from DTD plants are typically higher than dust emission from incinerators (although removal efficiencies are similar), because they treat soil and not concentrated organic waste.

Acid Gas Removal: The DTD Plant would be equipped with a wet scrubber to remove hydrochloric acid from the off-gas stream. The off-gas entering the scrubber from the baghouse passes through a pipe quench to protect the fibreglass reinforced plastic vessel from high temperature. Hydrochloric acid, which is the main acid gas present, would be removed with a high efficiency by the wet scrubber.

2.2 National Guidelines

Australia has well developed national guidelines for the management of persistent organic compounds nominated in the Stockholm Convention, which are referred to as Schedule X Wastes in the National Strategy for the Management of Scheduled Waste[5]. The national guidelines relevant to the CPWE include the national HCB Waste Management Plan[6] (WMP) and the national PCB Management Plan[7] (MP). The HCB WMP applies specifically to the Orica Botany site.
The national framework of guidelines also includes National Protocols for Approval/Licensing of Trials of Technologies for the Treatment/Disposal of Schedule X Wastes[8] and/or the National Protocols for Approval/Licensing of Commercial-Scale Facilities for the Treatment/Disposal of Schedule X Wastes[9]. These are implemented in NSW through Environmentally Hazardous Chemicals Act 1985 (EHC Act), which calls up a “Technology Application” conforming to the protocols. This application would be submitted when the detailed design of the DTD Plant is developed or available.

Another national instrument relevant to the proposed remediation is the National Environment Protection Measure (NEPM) for Ambient Air Quality[10], setting out national standards and goals for six common ambient air pollutants (known as the “criteria” air pollutants). The Ambient Air Quality NEPM, was varied in 2003 to expand its scope. The application of the NEPM to the proposal is discussed in Appendix E of the EA and is summarised below.

The material contained in the CPWE is scheduled HCB Waste because it contains a mean concentration of > 50 mg/kg of HCB. It is also non-scheduled PCB waste because it contains a mean concentration of > 2 mg/kg and < 50 mg/kg of PCBs.

2.2.1 NEPM for Ambient Air Quality

The NEPM sets ambient air standards over various averaging periods for a range of priority pollutants. The assessment of these and other toxic pollutants is discussed in the section below on dispersion modelling and ambient air concentrations under NSW acts and regulations. All emissions are predicted to comply with the relevant ground level concentrations set out in the NEPM. The predictions are based on the proposed design of the Plant and results of a treatability study using representative samples from the CPWE. However, ground level concentrations (GLCs) for nitrogen oxides (NO_x) and sulphur trioxide (SO_3), could exceed their relevant criteria based on a worst case interpretation of the treatability study.

[5] Australian and New Zealand Environment and Conservation Council, 1992. National Strategy for the Management of Scheduled Waste
[6] Australia and New Zealand Environment and Conservation Council, November 1996. Hexachlorobenzene Waste Management Plan
[7] Australia and New Zealand Environment and Conservation Council, July 1999. Polychlorinated Biphenyls Management Plan
[8] Australia and New Zealand Environment and Conservation Council Waste Management Secretariat, 1994. National Protocols for Approval/Licensing of Trials of Technologies for the Treatment/Disposal of Schedule X Wastes
[9] Australia and New Zealand Environment and Conservation Council Waste Management Secretariat, 1994. National Protocols for Approval/Licensing of Commercial-Scale Facilities for the Treatment/Disposal of Schedule X Wastes
[10] National Environment Protection Council (NEPC), 1998. National Environment Protection Measure (NEPM) for Ambient Air Quality

HCB Waste Management Plan: The HCB WMP set out a number of provisions for HCB waste relevant to design and operation of the DTD plant including:

- 5. Emergency Procedures
- 6. Destruction and Disposal of Scheduled HCB Waste
- 7. Car park Waste

Provision 7 states a preference for *in situ* treatment of the material in the CPWE. Orica investigated the possibility of *in situ* biological treatment, but concluded that it was not currently feasible. *In situ* thermal treatment was also considered but discarded because of the potential for adverse environmental impacts. Although the current proposal requires excavation of the material, the works would be fully enclosed, with potential emissions captured and treated.

Provision 5 deals with emergency procedures for the storage and destruction of the HCB waste. Emergency procedures for the destruction phase would be developed as part of the detailed design phase of the project, in accordance with the provision of the HCB WMP and the overlapping requirements of the Department of Planning for Hazardous Industries.

Provision 6 deals with emissions and residues from destruction or disposal of HCB waste. It requires that treated solids must contain < 2 mg/kg in aggregate of chlorinated compounds produced in the destruction process. It is likely that the treated waste would contain < 2 mg/kg of HCB, subject to optimising the soil treatment temperature to minimise emissions of mercury to air. If the aggregate is taken to include all other chlorinated compounds in the waste, then the sum of non-detects could be as high as 4 mg/kg using routine commercially available laboratory techniques.

The remediation proposal does not include the production of non-aqueous liquid wastes. It does include the treatment of free water from the CPWE, surface runoff from the treatment facility and scrubber water (if required) from the thermal treatment plant. Provision 6 of the HCB WMP sets a limit of 0.03 μg/kg for an aggregate of all chlorinated compounds produced in the destruction process. The detection limit for chlorinated compounds in water using routine commercially available laboratory techniques ranges from 1 to 0.01 μg/kg. A limit of 0.03 μg/kg can be demonstrated from HCB. However, the aggregate of all chlorinated compounds in the waste at the limit of detection in water would be > 0.03 μg/kg.

Provision 6 call up a limit of 0.1 ng TEQ/kg of dioxins and furans in emissions to air from any treatment process. The proposed process meets this limit and the limit can be measured using routine commercially available laboratory techniques. Emissions from largely undiluted sources (eg excavation works) must be less than a time weighted exposure average (TWA) of 0.025 mg/m3 for HCB and 0.21 mg/m^3 for HCBD. Emission from point sources must be treated using best practice control technology, such that the 3 minute design level concentration at the site boundary is less than 1/30th of the above TWAs. The thermal plant would use best practice technology to treat emission to air as described the above. Emissions to air from the thermal plant and buildings under normal operating conditions are predicted to meet the above standards.

PCB Management Plan: The PCB MP sets out a number of provisions for PCB waste relevant to the DTD Plant including:

- 8. Emergency Procedures
- 9. Treatment and Disposal of Scheduled PCB Material and Scheduled PCB Waste
- 10. Treatment and Disposal of Non-Scheduled PCB Material and Non-Scheduled PCB Waste

In the absence of any other scheduled contaminants, the CPWE material could be landfilled as non-scheduled PCB waste under Provision 10, which has no associated environmental performance limits. However, because it is scheduled HCB waste it must be treated. The provisions of the PCB MP under Provision 9 are therefore discussed below for completeness.

Provision 9 deals with emissions and residues from treatment or disposal of PCB waste. It requires that treated solids must be PCB free (i.e. contain < 2 mg/kg of total PCBs) unless it is not practicable using existing technologies. Based on the results of treatability trials it is expected that the treated material will be PCB free.

Provision 9 call up a limit of 0.1 ng TEQ/kg of dioxins and furans in emissions to air from any treatment process. The proposed process meets this limit and the limit can be measured using routine commercially available laboratory techniques. Emissions from largely undiluted sources (eg excavation works) must be less than a time weighted exposure average (TWA) of 1 $\mu g/m^3$ for PCBs. Emission from point sources must be treated using best practice control technology, such that the 3 minute design level concentration at the site boundary is less than 1/30th of the above TWA. The thermal plant would use best practice technology to treat emission to air as described the above. Emissions to air from the thermal plant and buildings are predicted to meet the above standards under all operating conditions.

2.2.2 NSW Legislation and Regulations

NSW has well developed acts and regulations for the management of persistent organic compounds nominated in the Stockholm Convention and Schedule X Wastes in the National Strategy for the Management of Scheduled Waste.

They include principally the Protection of the Environment Operations Act 1997 (POEO Act) and the EHC Act and their subordinate regulations (principally the POEO (Clean Air) Regulation (2002)) and other instruments. The proposed CPWE remediation project would require an Environment Protection Licence (EPL) under the POEO Act. The project would also require to be licensed under the EHC Act, which includes provision for submission of a Technology Application in conformance with the National Protocols for Approval/Licensing of Commercial-Scale Facilities for the Treatment/Disposal of Schedule X Wastes. The Technology Application would be submitted once the detailed design for the project has been developed and a Plant selected. Further a number of chemicals present in the CPWE are declared chemical wastes under the EHC Act and are subject to Chemical Control Orders (CCOs). The CCOs contain environmental performance standards for emissions and residues from treatment of declared chemical wastes, which are discussed below.

Clean Air Regulation: The Clean Air Regulation (CAR), which came into force in September 2005, specifies stack emission concentration limits for a range of industries and processes, as well as operational parameters for some thermal operations. It classifies plant in terms of Groups 1 to 6, with Group 6 being plant approved after September 2005. Although Group 1 to 5 plant may be is subject to less stringent emission limits than Group 6 plant, they are subject to periodic reclassification and thus progressively more stringent limits. The thermal plant proposed for the CPWE remediation would be classified and regulated as Group 6 plant.

CAR Stack Concentrations: The table below shows a comparison of stack emission concentration limits for Group 6 thermal plants under the CAR (Schedules 2 and 4), and limits applicable to Group 1 to 5 plant under the CAR (which were previously licensed unde the Clean Air Plant and Equipment Regulation (CAPER)). The CAR applies the stack emission concentration limits at the native oxygen content for a particular process. Historical stack oxygen data for similar DTD plants (including the DTD Plant on the Allied Feeds project) range from 8.7 % to 14.3% over four projects with a mean of 10.8%. For the proposed technology a stack oxygen concentration of 11% has been assumed, which is higher then the default oxygen concentration of 3% in the CAR. It should be noted that if the 3% oxygen correction was applied it would effectively halve the maximum allowable concentrations (compared with an 11% oxygen correction) and that the stack concentrations for the proposed plant would irretrievably exceed the allowable maximum stack concentration limits for several pollutants (e.g. NOx).

From the table it can be seen that the limits for solid particles, hazardous substances (aggregate metals including cadmium and mercury) and cadmium and mercury (separately) have been reduced significantly compared with previous limits in the CAPER.

The two right hand columns of the table show historical results (corrected to 11% oxygen and standard conditions) for similar DTD plants treating soil contaminated by chlorinated compounds, including the DTD Plant currently operating on the Allied Feeds site in Sydney and three DTD plants in the US. Values for Hazardous Substances are approximate because of difference in methodologies between Australia and the US. Looking at the results it can be seen that the stack concentration limits have generally been achieved by the technology, although there have been some exceptions. The middle column shows predicted concentrations for the proposed CPWE DTD Plant, where sufficient waste characterisation data were available to make a reasonable estimate.

For the Orica CWPE remediation project, mercury, nitrogen and sulphur emissions have been identified as of potential concern. The waste to be treated contains a significant amount of nitrogen and sulphur in organic matter, which would probably lead to elevated but complying nitrogen oxide and sulphuric acid mist emissions. A similar situation can be seen in stack test results for the Allied Feeds project DTD Plant which is treating high sulphur waste. Compliance for nitrogen and sulphur would be assessed during the plant commissioning phase and corrective action taken if compliance problems were notified (assuming the limits are applied at 11% and not 3% oxygen).

The value of 1,006 $\mu g/Nm^3$ shown in Table 1 for the CPWE DTD Plant assumes a zero capture efficiency. The average mercury concentration in the CPWE is ~2 mg/kg, which is low in terms of soil reuse criteria. The origin of the mercury is likely to be power station boiler ash, which was once used as general fill in the area. Recent treatability trials have shown that at soil treatment temperature of 350^oC about 50% of the mercury is volatilised and at a temperature of 450^oC 100% is volatilised. For the Plant under consideration this would lead to mercury concentrations in the stack of 503 $\mu g/Nm^3$ at 350^oC and 1,006 $\mu g/Nm^3$ at 450^oC (relative to a standard of 200 $\mu g/Nm^3$) if none of the mercury was captured in the emission control system (**Attachment C**). These stack concentrations, although exceeding the CAR limit would not exceed ambient air standards at the nearest sensitive receptor (i.e. the residential area in Denison Street).

Some of the mercury would however be captured in the emission control system due to the presence of carbon and hydrogen chloride. However the chemistry of mercury interaction is complex and poorly known and efficiency of removal is not predictable. Therefore we propose to fit a mercury control device consisting of powdered activated carbon (PAC) injected into the plant dust filter to capture mercury. The performance of this technology is poorly documented at this time, because it has been applied to few project and few results have been published. Therefore there remains some uncertainty as to whether the mercury stack concentration limit in the CAR can be met. Because Hazardous Substances by definition includes mercury in the aggregate, it is subject to the same uncertainty for the same reason.

CAR Operating Parameters: The CAR specified operational parameters for some thermal plants. For the purpose the CAR divides Group 6 plant into two classes depending on whether it is treating Principal Toxic Air Pollutants (PTAPs) or not. PTAPs are a list of nominated organic compounds and inorganic species. Because the CPWE contains several listed PTAPs (including several that are naturally occurring metals) more stringent operational parameters apply. The operational requirements of the CAR are:

- a gas residence time of > 2 seconds in any afterburner (i.e. TO);
- a combustion temperature of > 980^oC in any afterburner; and
- a destruction efficiency of > 99.9999%.

Gas residence time and combustion temperature have been discussed under the Stockholm Convention above. The Stockholm Convention has identified 980^oC as the temperature above which slagging may occur in a TO. Treatability testing suggests that this would not be an issue for the CPWE remediation, so subject to the outcome of full scale operations it is likely that this requirement can be met.

Table 1 Stack Emission Standards from Recent Hazardous Waste Treatment Consents

Pollutant	Units of measure	Stack emission concentration				
		CAPER[1] @ 11% O_2	CAR[2] @ 11% O_2	Predicted CPWE DTD plant @ 11% O_2	Allied Feeds[3] plant @ 11% O_2	US plants Historical[4] @ 11% O_2
Sulphuric acid mist (H_2SO_4), sulphur trioxide (SO_3), or both (as SO_3)	mg/m^3	100	100	84[6]	88, 50, 26, 23, 9, 65, 15	NA
Chlorine	mg/m^3	200	200	7.2	1.3, 0.9, 0.4, <0.4, 0.3, <0.3, <0.5	18, 0.2, 0.03
Hydrogen chloride (HCl)	mg/m^3	100	100	40	0.1, 0.1, <0.1, <0.1, <0.1<0.1, <0.1	54, 5, 3
Any fluorine compound (HF)	mg/m^3	50	50	?[5]	3, 2, 1, 1, 0.2, 5, 3	Na
Nitrogen dioxide (NO_2) or nitric oxide (NO), or both AS NO2	µg/m^3	2000[5]	350	213[6]	174, 144, 142, 142, 120, 173, 190	149
Hazardous subs. Types 1 and 2	µg/m^3	5000	1000	>101[5]	70, 70, 54, 23, 16, 0.1, 0.1	**1093**, 59, 54
Cadmium	µg/m^3	1000	200	3.6	8, 5, 4, 3, <3, 0.02, 0.002	<1, <0.1
Mercury	µg/m^3	1000	200	**1060**	29, 12, 8, 7, 3, 0.02, 0.0003	**1054**, 44
Solid particles	mg/m^3	100[5]	50	30	28, 21, 11, 9, 2, 12, 6, 5	**71**, 28, 9, 7
Dioxins and furans @ 11% O2	pg/m^3	100	100	50	**190**, 60, 38, 23, 10, 20, 20	**650**, 6, 6, 5
Carbon monoxide	mg/m^3	-	125	40	10, 8, 7, 4, 4, 8, 5	5, 0, 0

Notes: All results rounded for convenience, bold = exceeds limit
1 CAPER = Clean Air (Plant & Equipment) Regulation 1997.
2 CAR = POEO (Clean Air) Regulation 2002 (released Sept 2005)
3 Allied Feeds Plant Pre-test and Pop Tests
4 Historical US projects including Aberdeen, Madisonvill Creosote Works, Missouri Electric Works and Woods Industries
5 Inadequate waste characterisation data to estimate a concentration
6 Concentrations would exceed maximum allowable based on worst case interpretations or treatability study

The best practice gas residence time for a mobile DTD plant is ~1.6 seconds, which is less than that specified in the CAR. The CAR is based on best practice for a high temperature incinerator treating liquid waste (one second to evaporate and one second to combust). The DTD Plant TO is treating vaporised contaminants, so a shorter gas residence time is required for the same destruction as a high temperature incinerator with a gas residence time of 2 seconds. In detail the gas residence time in a DTD Plant would also vary depending on soil treatment temperature and soil moisture content.

The Destruction Efficiency (DE) requirement is a performance based requirement modelled on the US Environmental Protection Agency (USEPA) Destruction and Removal Efficiency (DRE) requirement for treatment of PCBs and dioxin wastes, under the USEPA Resource Conservation and Recovery Act (RCRA) regulations for hazardous waste incinerators, 40 Code of Federal Regulations, Part 60, Subpart O, Section 264.343. As such it reflects a different approach to regulation than that under the Stockholm Convention (which focuses on operation parameters including residence time, temperature and turbulence).

The DE requirement is measured across the plant and compares the mass of a selected contaminant emitted to air with the mass of the same contaminant introduced in the feed soil, to determine the mass of contaminant removed and destroyed in the process. It is not a direct measure of the destruction efficiency of the TO.

It is unlikely that the DE specified in the CAR will be demonstrable using the material in the CPWE because the mass of contaminant in the feed soil is too small compared with the mass in the stack gas and the commercially feasible detection limits for both media to allow the calculation to be made to the required number of decimal points.

Environmentally Hazardous Chemicals Act: Several EHC Act CCOs are relevant to the CPWE remediation proposal. They include the Scheduled Chemical Waste (SCW) CCO and the PCB CCO.

The SCW CCO nominates a list of 24 scheduled compounds including HCB. Several other SCW compounds are also present in the CPWE at concentrations above the limit defining SCW (2 mg/kg aggregate). The SCW CCO specified a maximum aggregate level of SCW compounds in treated material of < 2 mg/kg unless it is not practicable (technically and economically) to do so. It should be possible to comply with this level based on HCB alone, and subject to optimising the soil treatment temperature, to minimise emission to air of mercury.

The PCB CCO also requires that residues (e.g. soil and water) from the treatment of PCB waste contains < 2 mg/kg of PCBs. Based on the treatability study results the proposed thermal treatment technology will meet this level for treated soil.

Dispersion Modelling and Ambient Air Concentrations: The NEPM for Ambient Air Quality and sets ambient air standards over various averaging periods (10 minute average to annual average) for a range of priority pollutants including sulphur dioxide (SO_2), particulate matter (PM_{10}), carbon monoxide (CO), lead (Pb), ozone (O_3) and nitrogen dioxide (NO_2).

PAE Pty Ltd (2007) have estimated GLCs for compounds emitted from the site works and the thermal treatment plant, at identified sensitive receptors in the area (Appendix E). The latter is discussed here. The estimates are based on modelled dispersion of predicted mass emissions for the DTD Plant stack.

Table 2 shows maximum stack concentration limits under the CAR, stack concentration estimates used in the EA modelling and predicted stack concentrations in the DTD Plant proposed for the CPWE remediation. Concentrations and mass flow rates of various compounds in the DTD Plant stack were selected for air dispersion modelling purposes using a number of methods including:

- Stack concentration limits from the CAR as a conservative basis for assessing compliance (HCl, dioxins and furans);

- Stack concentration limits from previous licences where these were less than the CAR limits (CO, mercury, solid particles)
- Back calculation from ambient GLCs where either of the methods above yielded GLCs that exceeded the GLCs allowable under the NEPM (SO_3, H_2SO_4, chlorine, fluorine and cadmium); and
- For minor compounds that do not have stack concentration limits in the CAR, the design DE for the plant (i.e. 0.0001% of the mass feed rate) was used.

Hazardous substances were not modelled because they comprise an aggregate of concentrations for several metals. The value used for NO_X was set higher than the CAR in error, reflecting the Allied Fees licence which appears to have been based on a an EU standard corrected to 10% oxygen and later converted to 11% oxygen.

Table 2 Stack Emission Standards and Predicted Concentrations for the CPWE DTD Plant

Pollutant	Units of measure	Stack emission concentration		
		CAR[2] @ 11% O_2	EA[3] input @ 11% O_2	Predicted CPWE DTD plant[1] and EA input @ 11% O_2
Sulphuric acid mist (H_2SO_4), sulphur trioxide (SO_3), or both (as SO_3)	mg/Nm³	100	84	84 [5]
Chlorine	Mg/m³	200	7.2	7.2
Hydrogen chloride (HCl)	mg/Nm³	100	40	40
Any fluorine compound (HF)	mg/Nm³	50	40	?[4]
Nitrogen dioxide (NO_2) or nitric oxide (NO), or both AS NO2	mg/Nm³	350	213	213[5]
Hazardous subs. Types 1 and 2	µg/Nm³	1000	Na[8]	>101[4]
Cadmium	µg/Nm³	200	3.6	3.6
Mercury	µg/Nm³	200	1060	1060
Solid particles	mg/Nm³	50	30	30
Dioxins and furans @ 11% O2	pg/Nm³	100	50	50
Carbon monoxide	mg/Nm³	125	40	40

Notes: All results rounded for convenience
1 Based on mass and energy balance by Focus Environmental, Inc.
2 CAR = POEO (Clean Air) Regulation 2002 (released Sept 2005)
3 Values based on MEB for NOx, HCl, Cl_2, metals (see 6 also), others on historical and judgement
4 No or insufficient data to estimate reliably
5 Waste characterisation data variable (URS 2007). Estimate based on most likely interpretation of treatability study

Comparing the predicted stack estimates (based on historical performance and the mass and energy balance), it is apparent that there is a large margin of safety for chlorine, HCl and cadmium, with respect to the CAR stack limit. Smaller but acceptable margins exist for CO, dioxins and furans and solid particles. NO_x, SO_3 and H_2SO_4 are predicted to meet stack criteria and relevant GLCs based on a most likely interpretation of treatability data, but may exceed based on a worst case interpretation. There are no data for fluorine. However, it is not predicted to be an issue based on the performance of other plants. Following the results of a treatability trial, the outcome with respect to stack concentrations for mercury and Hazardous Substances (which contains mercury) is uncertain and unpredictable, as is discussed separately, although even worst case GLCs are predicted to meet the relevant criteria.

Attachment A Description of the DTD Plant and Process

EVALUATION OF A DIRECT FIRED THERMAL DESORPTION SYSTEM FOR TREATING ORICA CAR PARK WASTE ENCAPSULATION MATERIALS

SUBMITTED TO:

THIESS SERVICES

THIESS SERVICES
43 FOURTH AVENUE
BLACKTOWN NSW 2148
AUSTRALIA

MAY 27, 2005
FOCUS PROJECT NO. 120405

PREPARED BY:

Focus Environmental, Inc.

ENGINEERING SOLUTIONS TO ENVIRONMENTAL PROBLEMS

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List of Acronyms

acfm	actual cubic feet per minute
Btu	British thermal unit
C	Centigrade
CHCs	Chlorinated hydrocarbons
Cl_2	chlorine
CPWE	Car Park Waste Encapsulation
F	Fahrenheit
Focus	Focus Environmental, Inc.
GHD	GHD Pty Ltd
GJ	giga joules
gpm	gallons per minute
HCB	hexachlorobenzene
HCE	hexachloroethane
HCBD	hexachlorobutadiene
HCl	hydrogen chloride
HF	hydrogen fluoride
ID	induced draft
in. w.c.	inches water column
kg	kilogram
l	liter
lb or lbs	pounds
mg	milligram
MM Btu/hr	million British thermal units per hour
NaOH	sodium hydroxide
NSW	New South Wales
Orica	Orica Australia Pty Ltd
SCW	Scheduled Chemical Waste
SO_2	sulfur dioxide
Thiess	Thiess Services Pty Ltd
VOC	volatile organic compound
w.c.	water column
µg	microgram

1.0 EXECUTIVE SUMMARY

1.1 OVERVIEW

Orica Australia Pty Ltd (Orica) has retained Thiess Services Pty Ltd (Thiess) in conjunction with GHD Pty Ltd (GHD) and Focus Environmental, Inc. (Focus) to provide advice on the feasibility of remediation options for their Car Park Waste Encapsulation (CPWE). This report has been prepared to provide design information relevant to evaluating the feasibility of using a directly heated thermal desorption system.

The CPWE is located at the northeastern corner of the Botany Industrial Park (BIP), Matraville, NSW. The CPWE was constructed in 1980 and consists of a Hypalon lined cell that contains mainly sandy soil with ash and minor peat contaminated by a variety of semi-volatile chlorinated hydrocarbons (CHCs) and some volatile CHCs. Volatile CHCs are present in soil and groundwater around the CPWE and permeating through the CPWE liner. The primary contaminants at the site include hexachlorobutadiene (HCBD), hexachloroethane (HCE), and hexachlorobenzene (HCB). The estimated quantity of contaminated soil and debris contained within the CPWE liner is approximately 69,750 tonnes (76,725 tons).

Additional potentially contaminated material includes the CPWE cap, berms around the encapsulation, and soil beneath the liner. The total quantity of these additional materials may be as much as 81,384 tonnes (89,522 tons). At this stage it is likely that this soil would not require thermal treatment, subject to development and approval of site clean up criteria. If it did require thermal treatment, the total quantity of contaminated soil and debris may be as high as 151,150 tonnes (166,265 tons).

This evaluation includes the following components:

- Waste characterization summary
- Design basis summary
- Process description
- Process development status
- Process flow diagram
- Mass and energy balance
- Emissions estimate
- Process implementation issues
- Project schedule
- Capital and operating cost estimate.

1.2 SUMMARY

The direct-fired thermal desorption technology that was evaluated for this application has been in use for approximately 15 years. A total of 44 projects have been conducted by U.S. based contractors that used this type of technology (direct fired thermal desorber with a thermal oxidizer, baghouse, and wet scrubber) to treat soils that were contaminated with chlorinated organic compounds. These projects have included treating 739,000 tonnes (813,000 tons) of contaminated soils. Based on similarities between some of these projects and the Orica project, it appears that the use of a directly fired thermal desorption system for the Orica application is both technically feasible and cost effective.

The estimated hopper-to-hopper thermal treatment cost is [redacted]. This cost includes thermal treatment equipment mobilization, erection, startup, performance testing, operations, decontamination, disassembly, and demobilization. This cost is based on treating 66,263 tonnes (72,889 tons) of contaminated soil in a direct-fired rotary dryer and disposing of 3,488 tonnes (3,836 tons) of debris in an offsite hazardous waste landfill. Some metal and concrete may need washing and disposal. Other concrete and timber may require crushing or shredding and treatment. The estimated average daily soil treatment rate during production operations would be 550 tonnes/day (605tons/day) at a 72% operating factor. The estimated duration of the performance test plus production phases of the project would be approximately 130 days.

Any additional soil that is processed above the baseline amount of 66,263 tonnes would be thermally treated at a unit cost of approximately [redacted] The total project schedule would be extended one day per every 550 tonnes (605 tons) of soil treated.

2.0 DESIGN BASIS

2.1 OVERVIEW

This section presents a summary of the design basis assumptions for this report, including the following items:

- Waste characterization
- Process battery limits
- Utilities
- Site preparation
- Regulatory requirements.

2.2 WASTE CHARACTERIZATION

There have been a number of waste characterization studies conducted for the CPWE materials. A summary of results from these studies are presented in the Basis of Design Report prepared by Thiess. Information from that report was further evaluated, summarized and reduced to develop a "typical" waste composition as a basis for process engineering calculations. This waste composition assumes that the Hypalon liner is shredded and blended into the feed material. A summary of these data are presented in Table 2-1. This information includes: waste volume, waste density, waste mass, concentrations of specific organic chemicals and metals, physical parameters (moisture, TOC, COD, pH), particle size analysis, ultimate analysis (C, H, O, N, S, Cl), proximate analysis (volatiles, ash, moisture), and calorific value. These analyses include only materials that are enclosed within the Hypalon lined cell, including the Hypalon liner. For the purpose of this analysis, it has been assumed that materials outside of the cell liner (cap, berms, soil under the cell) have the same chemical composition as materials within the cell. This assumption results in a conservative analysis since the material outside of the liner likely has a lower moisture content and significantly lower concentrations of contaminants than the material contained within the liner.

Table 2-2 presents physical and chemical property parameters for key contaminants of concern. The chemical composition data was used to develop a design basis for the chemical composition of the soil feed to the thermal desorber.

2.3 PROCESS EQUIPMENT BATTERY LIMITS

The battery limits include all components of the thermal treatment system from the feed hopper through the stack. Feed preparation (screening, blending, shredding etc.) equipment will be provided by others and is not included in the battery limits.

2.4 UTILITIES

The cost estimates presented in this report assume that all utilities will be connected to supply points at the process equipment battery limits. Required utilities include electric power, process water, and natural gas. An estimate of utility requirements was prepared by developing a mass and energy balance for the system as shown in Appendix A.

2.5 SITE PREPARATION

The cost estimate assumes that site preparation will be performed by others. A detailed list of required site preparation activities is presented in Appendix B, Table B-3.

2.6 REGULATORY REQUIREMENTS

2.6.1 Soil Treatment Standards

Section 6.3 of the Basis of Design report describes a range of potential performance standards for treated soil. The soil in the CPWE contains HCB, and possibly other Scheduled Chemical Waste (SCW) compounds. A treatment standard of less than 2 mg/kg for HCB (and associated chlorinated compounds produced by the destruction process) is called up in the HCB Waste Management Plan (ANZECC, 1996), which applies to the CPWE waste. A standard of less than 2 mg/kg aggregate for SCW compounds is required by the New South Wales (NSW) SCW CCO. Effectively, this is likely to translate into a requirement of less than 0.1 mg/kg to less than 0.25 mg/kg for individual compounds to achieve a "non-waste" status, depending on the number of SCW compounds present. This is the preferred treatment standard. A lesser standard may be negotiable if it represents a best practice outcome for the technology.

2.6.2 Stack Gas Emission Standards

Table 2-3 presents a summary of stack emission standards from recent hazardous waste treatment consents in Australia. Table 2-3 also presents a summary of Australian (CAPER) and European Union (2000/76/EC) regulations. The project from Table 2-3 with characteristics most similar to the Orica project is the Allied Feeds project. The Allied Feeds project involves the use of a direct-fired rotary dryer system to treat soils containing high concentrations of chlorinated compounds.

The unit operations included in each case are generally considered to represent best available technology for the control of the following types of pollutants:

• Nitrogen oxides	Low NO_x burner
• Carbon monoxide	Thermal oxidizer
• Dioxins/furans	Thermal oxidizer
• Total organic substances (expressed as TOC)	Thermal oxidizer

- Total VOCs — Thermal oxidizer
- Particulates (including SO_3) — Baghouse
- Metals (excluding mercury) — Baghouse
- Mercury — Baghouse with carbon injection
- Acid gases (Cl_2, HCl, HF, SO_2, and H_2SO_4) Packed scrubber.