



**Occupational Safety and Health Service of the
Department of Labour**

**Risk Evaluation of Dioxin Exposure to
Workers at Dow AgroSciences, New Plymouth**

February 2005

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1. Background

1.1 Introduction

Dow AgroSciences (NZ) Ltd¹ (formerly known as Ivon Watkins-Dow and DowElanco) has a formulation and packaging site based in New Plymouth. At this site, over 70 agrichemical products are formulated and packaged for supply to New Zealand and Australian farmers, horticulturists, and forestry customers. In particular, the Dow AgroSciences Site in Paritutu, New Plymouth undertakes mixing, blending, and packaging of herbicides. Manufacturing of herbicides containing dioxins, notably 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), has been carried out in the past. Periodic high temperature incineration of waste products has been and is still undertaken at the site.

Some former workers and nearby residents to the site have become concerned that they have been exposed to dioxin from activities at the site, and have attributed illnesses to this exposure. The Ministry of Health is currently undertaking a serum dioxin study of selected residents who live or did live at Paritutu, the nearest suburb to the site. The aim of the Ministry of Health survey is to determine the level of dioxin exposure in comparison with the levels found in the Ministry for the Environment's background population study.² However it is unknown whether there are any risks to current workers at the site from present activities.

2. Purpose

This report attempts to evaluate the risks of dioxin exposure to workers at the Dow AgroSciences, New Plymouth from current site activities. It is primarily concerned with the potential routes for exposure to current workers but does not seek to quantify the associated levels of risk.

3. Methodology

A literature search was firstly carried out to identify possible risks and routes of exposure to workers from the manufacture and handling of phenoxy herbicides and high temperature incineration activities.

A meeting was held at the Dow AgroSciences site in Paritutu, New Plymouth on the 30th November. The following persons were present:

- Tony Gellen, Operations Leader Australia/ New Zealand Dow AgroSciences,
- Marie Gibbs, EH&S / Responsible Care Leader Dow AgroSciences,
- Brett Murray, Manager OSH New Plymouth,

¹ Dow AgroSciences (NZ) Limited is a wholly owned subsidiary of the global agricultural chemicals company Dow AgroSciences, based in Indianapolis, Indiana, USA.

² <http://www.moh.govt.nz/dioxins>

- Gail Gilchard, Inspector OSH New Plymouth,
- Mike Lewis, Occupational Hygienist OSH Wellington, and
- Derek Stannard, Scientist MWH NZ Ltd.

A visit of the Paritutu site and the Waireka Closed Secure Landfill site was carried out after the meeting.

As a result of the meeting and visit, further information was requested from Dow AgroSciences and the following information was received on the 9th December 2004:

- Standard Operating Procedure for handling trade waste,
- Safety Standard – Excavations,
- Decontamination procedures for the Phenoxy and Trichlorophenol (TCP) Manufacturing Plants,
- Details on the purity of Nufarm 2,4-D, and
- Details on the Special Medical (October – December 2004).

4. Sources and Exposure Routes

4.1 Sources and Toxicity of Dioxins and Furans

4.1.1 Phenoxy herbicides

According to the International Programme on Chemical Safety (IPCS)³, 2,4,5-T herbicide is composed of approximately 95% 2,4,5-T. The remainder consists of homologous and isomeric acids. These include polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) which are two series of tricyclic aromatic compounds with similar chemical and physical properties. These compounds are not intentionally produced, but are formed as inadvertent by-products, during the production of chlorophenols and chlorophenoxy herbicides, and are considered as contaminants in these products.⁴ They may also be produced as a result of natural combustion such as forest fires and volcanic eruptions.

There are 75 positional isomers of PCDDs and 135 isomers of PCDFs. There are 22 possible tetrachlorodibenzo-*p*-dioxin isomers, but only one isomer that contains chlorines at the 2,3,7, and 8 positions.⁵ This isomer, 2,3,7,8-Tetrachlorodibenzo-*para*-dioxin (TCDD), is the only isomer that has been classified as *carcinogenic to humans (Group 1)* by the International Agency for Research on Cancer (IARC).⁶ The IPCS report⁷ states under good manufacturing conditions,

³ Data Sheets On Pesticides No. 13 2,4,5-T, 1975 (http://www.inchem.org/documents/pds/pds/pest13_e.htm).

⁴ WHO; Environmental Health Criteria 88. Polychlorinated dibenzo-*p*-dioxins and dibenzofurans, 1998 (<http://www.inchem.org/documents/ehc/ehc/ehc88.htm>)

⁵ WHO; Environmental Health Criteria 88. Polychlorinated dibenzo-*p*-dioxins and dibenzofurans, 1998 (<http://www.inchem.org/documents/ehc/ehc/ehc88.htm>)

⁶ <http://www-cie.iarc.fr/monoeval/crthgr01.html>

less than 0.1 ppm TCDD is present in 2,4,5-T. The Report of the Ministerial Committee of Inquiry to the Minister of Health on the Possible Health Effects of Manufacture of 2,4,5-T in New Plymouth, 1986⁸, states that the dioxin level in 2,4,5-T made was the lowest ever achieved in any commercial manufacturing process and was at a level of 0.005 ppm. IARC also state that there is *inadequate evidence* in humans for the carcinogenicity of polychlorinated dibenzofurans and *inadequate evidence* in experimental animals for the carcinogenicity of 2,3,7,8-tetrachlorodibenzofuran (TCDF)⁹. The World Health Organisation (WHO) have assigned a toxic equivalency factor for TCDF of 0.1 (TCDD is 1).¹⁰

Many studies have looked at how TCDDs can affect human health. Most of these studies examined workers exposed during the manufacture of chemicals and pesticides contaminated with 2,3,7,8-TCDD. Other studies have looked at American Vietnam veterans and Vietnamese populations exposed to Agent Orange and populations exposed to 2,3,7,8-TCDD as a result of an accident (e.g. Seveso, Italy). Much of the evidence for effects is inconclusive or inconsistent, however the major toxic effects of dioxins include; high acute toxicity, chloracne (a characteristic chronic skin disease), cancer (TCDD has been classified as a proven human carcinogen), and temporary increases in liver enzyme activity. Note that these effects occur at high levels of exposure. For example, in humans exposed to dioxin in the workplace, chloracne has been observed at body burdens of 95 to 3,000 ng dioxin/kg body weight; this corresponds to blood dioxin levels of 432 to 13,400 ppt (lipid-based)¹¹.

The following is an extract from the International Programme on Chemical Safety Environmental Health Criteria 88 Polychlorinated Dibenso- Para-Dioxins and Dibenzofurans¹². Note that these are signs and symptoms manifested from high human exposures.

<u>A. Skin Manifestations</u>	<u>B. Systemic Effects</u>
<ol style="list-style-type: none"> 1. Chloracne 2. Hyperkeratosis 3. Hyperpigmentation 4. Hirsutism 5. Elastosis 	<ol style="list-style-type: none"> 1. Mild fibrosis of liver 2. Raised transaminase values 3. Hypercholesterolaemia 4. Hypertriglyceridaemia 5. Digestive disorders (intolerance to alcohol or fatty food, flatulence, nausea, vomiting, diarrhoea) 6. Swollen lymph glands 7. Loss of appetite and weight loss 8. Muscular aches and pains, joint pain, lower

⁷ Data Sheets On Pesticides No. 13 2,4,5-T, 1975 (http://www.inchem.org/documents/pds/pds/pest13_e.htm).

⁸ [http://www.moh.govt.nz/moh.nsf/0/2C10998DB52CEEF4CC256AAE0072C56A/\\$File/brinkmanreport.pdf](http://www.moh.govt.nz/moh.nsf/0/2C10998DB52CEEF4CC256AAE0072C56A/$File/brinkmanreport.pdf)

⁹ <http://www.inchem.org/documents/iarc/vol69/dibfuran.html>

¹⁰ World Health Organisation Food Additives Series: 48 Safety Evaluation of Certain Food Additives and Contaminants Polychlorinated Dibenzodioxins, Polychlorinated Dibenzofurans, and Coplanar Polychlorinated Biphenyls, 2002. (<http://www.inchem.org/documents/jecfa/jecmono/v48je20.htm>).

¹¹ M.J DeVito, L.S. Birnbaum, W.H Farland, and T.A. Gasiewicz; Comparisons of estimated human body burdens of dioxin-like chemicals and TCDD body burdens in experimentally exposed animals; Environmental Health Perspectives **103**(9) 822-831 (1995) cited by ATSDR. Health Consultation: exposure investigation report. Calcasieu estuary, Lake Charles, Calcasieu Parish, Louisiana, 1999 (http://www.atsdr.cdc.gov/HAC/PHA/calcas/cal_toc.html).

¹² International Programme On Chemical Safety Environmental Health Criteria 88 Polychlorinated Dibenso- Para-Dioxins And Dibenzofurans (<http://www.inchem.org/documents/ehc/ehc/ehc88.htm#PartNumber:8>).

	extremity weakness 9. Cardiovascular, urinary tract, respiratory, and pancreatic disorders
<u>C. Neurological Effects</u>	<u>D. Psychiatric Effects</u>
1. Sexual dysfunction 2. Headache 3. Neuropathy 4. Sight disturbance 5. Loss of hearing, taste, and smell	1. Sleep disturbance. 2. Depression in blood 3. Loss of energy and drive 4. Uncharacteristic bouts of anger

Table 1. Signs and symptoms reported in association with human exposure to TCDD or mixtures containing TCDD

4.1.1.1 *Skin manifestations*

Chloracne is a sign of exposure to several chlorinated cyclic organic compounds, the most potent being TCDD. Chloracne thus may serve as a marker of such exposure. The most distinctive lesion in chloracne is the so-called cyst, a skin-coloured elevation that may measure from 1 mm to 1 cm in diameter, with a central opening that may be difficult to detect. Comedones that contain black or black-appearing material in their openings are also present. Chloracne has been observed at body burdens of 95 to 3,000 ng dioxin/kg body weight; this corresponds to blood dioxin levels of 432 to 13,400 ppt (lipid-based)¹³.

There may be a secondary inflammatory reaction, melanosis, and hyperkeratosis, and these skin changes may be preceded by a "cable rash" or "cable itch". These skin lesions resemble photosensitivity reactions and the bearers may suffer severe pruritus. Microscopic examination of the skin lesions shows marked dilatation of the hair follicles which are filled with keratinous material, the sebaceous glands may be partly or completely atrophied and, occasionally, hyperplasia of these glands has also been reported. Hyperkeratosis and acanthosis of the surrounding epidermis usually accompany these lesions. Atrophy of the epithelium and thinning of the epithelial walls surrounding these keratinous cysts are observed at a later stage of the disease. If the follicular cysts rupture, foreign body granulomata may also be observed. Healing of these skin lesions usually results in deeply pitted scars. The distribution of chloracne is predominantly facial, affecting in particular the malar areas, the jaws, and the regions behind the ears. At times it may involve the ear canal and, with increasing severity, also the rest of the face and neck. In more extensive cases, the outer upper arms, neck, back, abdomen, outer thighs, and genitalia may also be involved (Crow, 1970).

While the absence of chloracne does not absolutely rule out exposure to TCDD, it usually indicates that there has been no exposure to a toxic dose of the substance. However, some persons with high body levels of dioxins do not develop chloracne. "Toxic" is used here to indicate both systemic and local effects. Where there has been exposure to TCDD and chloracne

¹³ M.J DeVito, L.S. Birnbaum, W.H Farland, and T.A. Gasiewicz; Comparisons of estimated human body burdens of dioxin-like chemicals and TCDD body burdens in experimentally exposed animals; Environmental Health Perspectives 103(9) 822-831 (1995) cited by ATSDR. Health Consultation: exposure investigation report. Calcasieu Estuary, Lake Charles, Calcasieu Parish, Louisiana, 1999 (http://www.atsdr.cdc.gov/HAC/PHA/calcas/cal_toc.html).

has resulted, it is the only known clinical sign that persists for a long period of time, even for the remainder of the exposed person's lifetime. In a large group of people exposed to mixtures containing TCDD, the absence of chloracne usually indicates that exposure to a toxic dose was unlikely and also makes it unlikely that severe, persistent systemic disorders will result.

Hyperkeratosis is a fairly common phenomenon whereas hyperpigmentation and hirsutism are rare. It should be noted that hyperkeratosis is prominent in the exposed Seveso children who have no affected sebaceous glands. These glands develop only at puberty. Elastosis of the skin has been noted as a long-term effect of TCDD exposure.

4.1.1.2 *Systemic effects*

Liver effects following exposure to PCDDs have been diagnosed even by histological examination, and account for temporarily raised transaminases in blood, hypercholesteraemia, and hypertriglyceridaemia. Bauer et al. (1961) and Risse-Sundermann (1959) do not however exclude viral hepatitis as a cause of such findings in their patients exposed to TCDD. Loss of appetite, weight loss, and digestive disorders are common complaints from humans exposed to either TCDD itself, or to technical mixtures containing TCDD. Muscular aches and pain and weakness in extremities have been reported, particularly after exposure to technical mixtures containing TCDD.

Swollen lymph nodes have also been reported, both after exposure to "pure" TCDD and to mixtures. The cardiovascular, urinary tract, respiratory, and pancreatic disorders reported are of doubtful significance with regard to a causal relationship to TCDD exposure.

Porphyria cutanea tarda has been reported in two cases of occupational exposure where chlorinated organic compounds were manufactured in addition to trichlorophenol. These were the incidents at the factory of Diamond Alkali, Newark, New Jersey, USA, in 1956 (Poland et al., 1971) and at Spolana, Czechoslovakia, between 1964 and 1969 (Pazerova-Vejlupkova et al., 1981). The porphyria cutanea tarda observed in these cases was very unlikely to have been induced by exposure to TCDD but rather by exposure to other chlorinated organic compounds manufactured in these sites (Jones & Chelsky, 1986).

4.1.1.3 *Neurological effects*

Sexual dysfunction (lack of libido and impotence) has been reported after acute exposure to both "pure" TCDD and technical mixtures (Schulz, 1968). The frequency of its occurrence may have been underestimated to date. Headache is a frequent symptom after exposures to technical mixtures containing TCDD.

Sensory neuropathy has been noted in many instances. Usually workers in the initial stages of exposure will complain of pains in their joints after they have very acute severe chloracne; however, there are usually no abnormal physical findings in the joints, but the complaints may continue. In early studies of workers affected by TCDD, no attempts were made to objectively measure the effects on the sensory nervous system. Tests have now been developed that evaluate sensory nerves and that can be used in future field studies. The nerve conduction tests, which primarily have been used so far, are actually not very useful to measure neuropathy. Differences in nerve conduction were shown among residents from Seveso, Italy, who had

chloracne and those who did not (Richert, von, 1962; Fillipini et al., 1981). Note that the residents in the Seveso study were accidentally exposed to high levels of TCDD.

Sight disturbance may be related to alkaline exposure or to conjunctivitis related to effects on the glands of Meibom. Loss of hearing, taste, and smell have been reported in a few cases, but a causal relationship to TCDD exposure is doubtful.

4.1.1.4 Psychiatric effects

The symptoms have been listed in Table 1 in what is believed to be their order of frequency and degree of severity.

For a more complete discussion on the effects of dioxin see the World Health Organisation (WHO) Food Additives Series: 48 Safety Evaluation of Certain Food Additives and Contaminants Polychlorinated Dibenzodioxins, Polychlorinated Dibenzofurans, and Coplanar Polychlorinated Biphenyls, 2002¹⁴

4.1.2 Incineration

PCDDs and PCDFs may also be produced in thermal processes such as incineration. The relative amounts of PCDD and PCDF congeners produced depend on the production or incineration process and vary widely.¹⁵ It is commonly accepted today that formation of dioxin-like compounds in flue gases happens in a temperature range of 200 to 400°C, especially in poor combustion conditions leading to incomplete conversion and the formation of carbon in the fly ashes. Low levels of dioxins in flue gases of incinerators are achieved using the well known 3 T rule:

- Temperature above 850°C,
- Time (residence) typically greater than 2 seconds, and
- Turbulence optimised by furnace geometry and secondary air.¹⁶

4.1.3 Other sources of dioxins and furans

Other sources of PCDDs and PCDFs include:

- contaminated commercial chemical products, such as chlorinated phenols and their derivatives, and PCBs,
- incineration of municipal, hazardous, and hospital wastes, and of sewage sludges,
- automobile operation especially those powered with leaded fuel,
- fossil fuel combustion,

¹⁴ (<http://www.inchem.org/documents/jecfa/jecmono/v48je20.htm>).

¹⁵ <http://www-cie.iarc.fr/htdocs/monographs/vol69/dioxin.html>

¹⁶ UNEP Report - Dioxins and Furans in the Chemical Industry
(http://www.chem.unep.ch/pops/POPs_Inc/proceedings/bamako/eng/delattre.html)

- overheating and emissions from fires involving PCBs,
- chlorophenol wood treatment,
- use of PCB fluids in electrical equipment, and
- wastes from pulp and paper processing.¹⁷

4.2 Sources and Exposure Routes from Dow AgroSciences Activities

4.2.1 Phenoxy herbicides

At its New Plymouth site, Dow AgroSciences (NZ) Ltd (formerly known as Ivon Watkins-Dow and DowElanco) manufactured phenoxy herbicides. The trichlorophenol (TCP) site ceased operations in 1987, production of 2,4,5-T ceased in 1988 and 2,4-D in 1998. There is no production of phenoxy herbicides currently being undertaken at the site, although mixing and blending activities of 2,4-D (sourced from a manufacturer in Australia) is currently carried out. 2,4-D may contain traces of dioxins depending on the manufacturing process (although this is not common). Accordingly an analysis of the 2,4-D was requested and this was supplied by Dow AgroSciences as additional documentation in a letter from the manufacturer. The letter stated that there is a regular programme for internal testing for the presence of dioxins and furans during the manufacturing process of 2,4-D and also external testing is undertaken by an independent accredited laboratory that has specialist skills in dioxin and furan analyses (AgriQuality). The letter also stated that the results of the testing indicated that all 2,4-D and formulations of 2,4-D met internationally accepted standards (FAO, Industry Task Force II, and individual country standards) for dioxins and furans.

4.2.2 Decommissioned TCP/phenoxy manufacturing plants

The TCP and 2,4,5-T plants were decommissioned when manufacturing stopped (1987 and 1988 respectively). The 2,4,5-T & TCP plants were decontaminated in 1987 and 1988 respectively using hot water and detergent and pressure washing. The 2,4-D site was decontaminated in 1998/99 using hot water and detergent and pressure washing.

The TCP building is no longer being used for any purpose. The phenoxy manufacturing building is now being used to blend methylchlorophenoxyacetic acid (MCPA) and methylchlorophenoxybutyric acid (MCPB) for packing in the formulations plant.

¹⁷ <http://www.inchem.org/documents/ehc/ehc/ehc88.htm#SubSectionNumber:1.1.1>



Figure 1: Phenoxy plant.

4.2.3 High Temperature Incineration

Dow AgroSciences currently carries out high temperature incineration of on-site waste and incineration of contaminated leachate from the closed secure landfill site at Waireka. The leachate is the only dioxin contaminated waste that is incinerated. The incinerator is not run continually but operated on an as needed basis. The waste is exposed to a temperature of 650 - 800°C in the primary chamber and then to a temperature of greater than 1100°C for a minimum period of 3 seconds in the secondary chamber. The incinerator is operated within strict guidelines and strictly monitored and documented. Documentation was sighted during the site inspection.

The discharge to air is subject to a resource consent and this is monitored by the Taranaki Regional Council. An independent, appropriately qualified laboratory carries out the monitoring (Watercare Services Ltd (Lab Services Air Quality Group)). Monitoring reports were sighted during the site inspection.

The ash is manually extracted into 200 litre drums, sealed, stored on site, and then disposed of at an approved site (Redvale) when logistically viable quantities have been accumulated. The ash is analysed for dioxin content prior to disposal, as a condition of disposal. The ash must meet specific acceptance criteria.



Figure 2: High temperature incineration plant.

4.2.4 Waireka Landfill

A secure landfill at Waireka was closed and capped in 1985. The leachate from this landfill is pumped into a secure storage tank at the landfill, collected by tanker approximately twice a year, transported to the Paritutu site, stored, and then incinerated in the high temperature incinerator. The amount of leachate has been steadily decreasing over the years. The leachate was last tested four years ago and the dioxin level was not significant for concern.



Figure 3: Waireka landfill.

4.2.5 Trade Waste

Some of the original trade waste system may have residuals contaminated with dioxins from previous manufacturing activities. Dow AgroSciences is going through an extensive process to close off or reline trade waste pipelines as part of its Cleaner Production Plan. All discharges to trade waste are monitored (tested by AgriQuality, an independent competent analytical testing laboratory) as a condition of the trade waste consent to ensure that dioxins are not discharged above the consent requirements.

4.2.6 Storage

The contaminated leachate is secured and stored in the former liquids incinerator building. Ash from the incinerator is secured and stored in a disused building on site. Dow AgroSciences stated that there is no storage of any other substances containing dioxins or furans on site.



Figure 4: Ash storage.

4.2.7 Miscellaneous

No other sources of dioxin and furans (see 4.1.3) were identified that related directly to the operations at the site.

4.3 Potential risks to workers from current activities

4.3.1 Possible route of human exposure

Occupational exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin may occur through inhalation and dermal contact¹⁸. Oral ingestion could occur, but would be unlikely unless as a result of poor hygiene practices, e.g. not washing hands before smoking a cigarette or eating food.

4.3.2 Phenoxy herbicides

4.3.2.1 2,4,5-T

No 2,4,5-T is currently, manufactured, used, stored, or packaged on site. Risks to workers are assessed as negligible.

¹⁸ Schecter A; Tiernan T; Environ Health Perspect 60: 305-13 (1985) cited by HSDB

4.3.2.2 2,4-D

2,4-D is not manufactured on site. However 2,4-D is mixed, blended, and packaged. The 2,4-D imported has been independently assessed to contain negligible dioxin. An enclosed process is used and all workers wear appropriate PPE. Workers shower and get out of work clothing prior to going home. Laundering is done on site and effluent is sent to the trade waste system. Risks to workers from these activities are assessed as being negligible.

4.3.3 High temperature incineration

The high temperature incinerator is operated at a suitable temperature, the contact time is sufficient, and turbulence is created. These operating conditions are monitored. The air emissions are also monitored and subject to a Resource Consent. The risks to workers from emissions from the incinerator are assessed as being negligible.

The process of operating the incinerator involves physically raking out the ash and physically depositing it into a 200 litre drum. Although there is a negative pressure system generated by the flue which helps minimise dust, appreciable quantities of dust can still be generated, especially in certain wind conditions. This dust contaminates the inside of the building. Workers wear overalls, gloves, boots, and respiratory protection. Although this protection is appropriate, the workers wear the same overalls for removing ash as all other duties. The overalls could spread dioxin containing ash around site. However the amount of dust would be very small. It was also observed during the site visit that the respiratory protection was lying unsealed in its box. It should be in a sealed container between uses. The risk to workers is assessed as being negligible for acute effects but there is a potential for cumulative effects. This would depend on the number of times that the dust removal activity takes place.

There is also a potential for the dust to affect any person in the vicinity when this activity is taking place (e.g. passers by). Again acute effects from this exposure would be negligible, but there is the potential for cumulative effects. However because of the physical location of the high temperature incinerator plant, it is unlikely that any workers other than those concerned with the incinerator would frequent the vicinity.

4.3.4 Trade waste Pipelines

The trade waste is monitored, is subject to a consent, and has written operating procedures. However there may be contaminated pipes and leakage from pipes into land surrounding the pipes. This is primarily a hazard to contractors excavating the pipes or around the pipes. Dow AgroSciences have a permit to work system for any excavation and set policy procedures to ensure that contractors are aware of the hazards and the control measures to undertake. With the controls in place, the risks to workers are assessed as being negligible.

5. Monitoring

Biological health monitoring of workers is often undertaken by employers to establish:

- A base line level for comparison with occupational exposure at a later date, and

- Whether an employee has been exposed to a particular hazardous substance.

Dow AgroSciences have a voluntary comprehensive health assessment programme which includes a periodic routine medical examination and a special one off medical examination which is currently running.

No specific tests for exposure to dioxin have been conducted in the past. However the special medical examination currently being undertaken contains tests which may be indicative of dioxin exposure, but would require further investigation to confirm the likely cause.

5.1 Pre-screening

There was no evidence supplied by Dow AgroSciences of medical screening of prospective staff to indicate background levels of dioxins prior to employment. This would only be deemed necessary if exposure routes have been identified and personal protective equipment was used as a control.

5.2 Routine

Dow AgroSciences is undertaking periodic biochemistry tests for lipids (cholesterol, triglycerides, high density lipids) and fasting glucose for workers. Additional tests include prostate specific antigen (PSA) for men over 40 and blood iron for women. These medicals are voluntary and occur every two years. The results of the tests in themselves are not indicative of dioxin exposure without the corresponding lipid TCDD levels. Elevated glucose and insulin levels may be a product of lifestyle alone, however hypertriglyceridaemia and hypercholesteraemia may be indicators of exposure but would need to be followed up with more definitive tests.

As mentioned in section 4.1.1.1 Chloracne, although not an exclusive sign of exposure to dioxins, would normally be present in an exposure to dioxins that resulted in systemic or local effects. As it usually persists for a long period of time and is predominately facial, it is likely that it would be noticed on examination.

5.3 Special

Dow AgroSciences has recently offered 'Special Medicals' for all workers at the site over and above the current routine medicals. This medical is a very comprehensive programme

The special medical is extended to include the following;

1. The Dow Periodic Questionnaire
2. General medical examination (height, weight, pulse)
3. Clinical examination of vital organs (heart, lungs, liver, nervous system, blood system, skin).
4. Laboratory investigations.
5. Spirometry; forced vital capacity and forced expiry volume.
6. Chest X-Ray
7. Electro-cardio gram (ECG)
8. Cervical smear (at the discretion of the female staff).

The 20 tests cover haematology, biochemistry and microbiology levels associated with general health, but are not definitive (as mentioned above) to be directly linked to the assessment of dioxin exposure (past or present), with the exception of the skin examination (includes an examination for chloracne and soft tissue sarcomas). However it is appropriate to undertake such an initial screening programme and then further investigations as warranted.

5.4 Results

James Collins (Dow Chemical's Technical Leader of Epidemiology) stated that no cases of chloracne have occurred at Dow AgroSciences, New Plymouth.

6. Conclusions

Dow AgroSciences (NZ) Ltd has a formulation and packaging site based in New Plymouth. This site undertakes mixing, blending, and packaging of herbicides. Manufacturing of herbicides containing dioxin, notably 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), has been carried out in the past, but has been discontinued. Periodic high temperature incineration of waste products has been and is still undertaken at the site.

Some former workers and nearby residents to the site have become concerned that they have been exposed to dioxin from activities at the site, and have attributed illnesses to this exposure. The Ministry of Health is currently undertaking a serum dioxin study of selected residents who live or did live at Paritutu, the nearest suburb to the site. However it is unknown whether there are any risks to current workers at the site from present activities.

This report assesses the potential for dioxin exposure to workers at the Dow AgroSciences, New Plymouth from current site activities. It is primarily concerned with the routes for exposure to current workers and does not seek to quantify the associated levels of risk. This report is primarily concerned with acute exposure, but does consider possible cumulative (chronic) exposure routes as well. It should be recognised, however, that it is more difficult to determine the risk of chronic exposure from cumulative effects of small amounts.

The following possible sources and exposure routes from current Dow AgroScience activities were identified:

- Decommissioned phenoxy/TCP manufacturing plants
- Phenoxy herbicides
- Waireka closed landfill leachate
- High temperature incinerator plant
- Trade waste system
- Storage

The manufacturing plants have been decontaminated and no phenoxy herbicides have been manufactured since.

The only phenoxy herbicide currently processed is 2,4-D which is imported ready manufactured from Australia. This is tested independently to ensure compliance with internationally accepted standards for dioxins.

The Waireka secure closed landfill leachate is incinerated in the high temperature incinerator.

The high temperature incinerator is monitored for air emissions and independently tested to ensure compliance with its resource consent. Residual ash is stored prior to being disposed of in an approved landfill. The ash is independently analysed prior to disposal as a condition of disposal. The ash must meet specific acceptance criteria.

The trade waste system is independently monitored to ensure compliance with its resource consent. The pipelines are being upgraded and procedures have been put in place to control and monitor any excavations around the pipelines.

All risks, with the current controls in place, were identified as negligible apart from risks associated with the removal of dust from the high temperature incinerator plant. This risk is one from cumulative effects rather than acute effects, and relates primarily to the workers removing the ash. The current operating procedures for the removal of the ash from the high temperature incinerator generates dioxin containing dust. Although the workers wear PPE, it was observed that the respiratory protective equipment was inadequately stored.

Routine medicals are undertaken on consenting workers. The routine medical is not designed to directly assess for dioxin exposure apart from visible identification of cases of chloracne.

A special medical regime is currently being conducted for consenting workers. This is a comprehensive programme and is suitable as a screening programme with further investigations being undertaken as necessary.

Dow AgroSciences have stated that no cases of chloracne have occurred at the New Plymouth site.

7. Recommendations

It is recommended that Dow AgroSciences review the procedures for removal of the ash from the high temperature incinerator. This should include procedures for minimising the amount of dust generated, minimising exposure of workers to the dust, monitoring exposure of workers to the dust, and keeping surfaces dust free.