**UNIVERSITI PUTRA MALAYSIA**

***CHROMIUM AND NICKEL IN PERSONAL AIR AND ITS CORRELATION WITH URINE CHROMIUM AND NICKEL AMONG WORKERS IN A MACHINING INDUSTRY***

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# CHROMIUM AND NICKEL IN PERSONAL AIR AND ITS CORRELATION WITH URINE CHROMIUM AND NICKEL AMONG WORKERS IN A MACHINING INDUSTRY

BY

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Thesis submitted in fulfillment of the requirement for the degree

Bachelor Science (Environmental and Occupational Health)

From the Faculty of Medicine and Health Sciences

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## ABSTRACT

### CHROMIUM AND NICKEL IN PERSONAL AIR AND ITS CORRELATION WITH URINE CHROMIUM AND NICKEL AMONG WORKERS IN A MACHINING INDUSTRY

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**Background:** Metalworking fluids can either be used as lubricant, coolant, cutting fluids, machining fluids or hydraulic oil. Metalworking fluids can helps in preventing metal corrosion and act as a metal scrap remover while undergoes machining process. Application of metalworking fluids produced aerosol that contained metal, chemical residues or physical contaminants such as chips and fines will dispersed into the surrounding during the operation. The aim of the study was to determine the correlation between personal air chromium and nickel with the urine chromium and nickel among workers in machining industry.**Method:** This cross-sectional study was conducted in a machining industry that using metalworking fluid as one of their substances for machine production. 138 workers fulfilled the inclusive criteria were interviewed using administered modified questionnaire. Environmental and personal air concentration was measured using personal inhalable aerosol sample (SKC) for 3 consecutive days for environmental and 8 hours for personal, while urine sample was collected at the end of shift of workers. Both samples were analyzed using ICP-MS for detection of chromium and nickel concentration. **Result:** The level determined for chromium and nickel in air and urine was slightly above the standard by DOSH, 0.05 $mg/m^3$ for chromium and 0.1 $mg/m^3$ for nickel. The significant difference of environmental air concentration between each work section for chromium was$p$= 0.04, while for nickel was$p$ = 0.03. However Pearson correlation result showed significant correlation between personal air chromium with urinary chromium. Linear regression shows there is significant relationship between chromium in personal air and chromium in urine between selected variables. **Conclusion:**There was significant differencein the chromium and nickel concentration in environmental in air between work sections. Personal air chromium concentration of workers was influenced by number of machines in each section while urinary chromium concentration was influenced by chromium concentration in personal air.



***Keywords: Metalworking fluids, Air sampling, Chromium, Nickel, Urine***





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## ABSTRAK

### KROMIUM DAN NIKEL PADA SAMPEL UDARA PERIBADI DAN UJIAN KORELASI DENGAN KROMIUM DAN NIKEL PADA URIN DI KALANGAN PEKERJA DALAM INDUSTRI PERMESINAN.

**NUR SABRINA BINTI NASIRUDDIN LIM**

**Pengenalan**: Bendalir logam juga dikenali sebagai pelincir atau bahan penyejuk ke arah logam untuk mencegah hakisan dan membersihkan serpihan-serpihan logam.Dalam industri pemesinan, bendalir logam digunakan secara meluas semasa proses logam dilakukan. Penggunaan bendalir logam semasa operasi dilakukan akan meghasilkan semburan yang mengandungi logam, sisa pencemaran kimia dan fizikal seperti cip logam dan serpihan halus yang akan tersebar ke persekitaran. Tujuan kajian ini adalah untuk menentukan korelasi antara pendedahan kromium dan nikel pada udara peribadi dengan kromium dan nikel pada urin di kalangan pekerja dalam industri pemesinan.**Medologi**: Kajian keratan rentas telah dijalankan dalam industri pemesinan yang menggunakan bendalir logam sebagai bahan utama untuk meghasilkanpengeluaran. 138 pekerja memenuhi kriteria inklusif telah ditemuramah menggunakan borang kaji soal selidik yang telah diubahsuai. Kepekatan udara persekitaran dan peribadi telah diukur dengan menggunakan alat persampelan udara, manakala sampel urin dikumpul pada waktu akhir syif bekerja. Kedua-dua sampel telah dianalisis dengan menggunakan ICP-MS untuk mengesnalpastikepekatan kromium dan nikel. **Keputusan**: Tahap kepekatan kromium dan nikel di udara dan urin adalah lebih tinggi daripada standard yang diberikan oleh JKKP iaitu 0.05 $mg/m^3$ bagi kromium dan 0.1 $mg/m^3$ bagi nikel. Perbezaan ketara kepekatan udara persekitaran antara setiap seksyentempat bekerja bagi kromium adalah $p = 0.04$, manakala bagi nikel adalah $p = 0.03$. Walau bagaimanapun hasil korelasi Pearson menunjukkan hubungan yang signifikan antara kromium padaurin dengan kromium pada udara peribadi. Regresi linear menunjukkan terdapat hubungan yang signifikan antara kromium pada udara peribadi dan kromium padaurin antara pembolehubah yang terpilih. **Kesimpulan**:Terdapat perbezaan yang signifikan dalam kepekatan kromium dan nikel pada udara persekitaran antara seksyentempat kerja. Kepekatan kromium pada udara peribadi perkerja dipengaruhi oleh jumlah mesin yang terdapat pada seksyen tempat bekerja, manakala kepekatan kromium pada urin dipengaruhi oleh kepekatan kromium pada udara perdibadi.



***Keywords : Bendalir logam , Pensampelan Udara , Kromium , Nikel, Urin***





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## LIST OF ABBREVIATIONS

| | |
|---|---|
| MWFs | Metalworking fluids |
| TLV | Threshold Limit Value |
| TWA | Time-weighted Average |
| NIOSH | National Institute of Safety and Health |
| OSHA | Occupational Safety and Health Act |
| USECHH | Use and Standards of Exposure of Chemicals Hazardous to Health |
| SPSS | Statistical Package Social Science |
| ICP-MS | Inductively Coupled Plasma Mass Spectrometry |
| < | Less than |
| > | More than |
| % | Percentage |
| SD | Standard Deviation |



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# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Machining process is a metal production processwhich carried out by machines such as cutting, milling, turning, drilling, and grinding. (Dahmus and Gutowski, 2004). Machining industry is known as industry that involves with machining process which includes various work process as mention above.

Metalworking fluids can either be used as lubricant, coolant, cutting fluids, machining fluids or hydraulic oil (Ross, 2004). Metalworking fluids can helps in preventing metal corrosion and act as a metal scrap remover while undergoes machining process (NIOSH. 1998). It comprises of four types; straight oil, soluble oil, synthetic and semi-synthetic metalworking fluids (NIOSH. 1998). The usage of



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metalworking fluids potentially produced contaminants such as bacteria and fungi, and also soluble metal ions such as chromium, nickel and cobalt in alloyed steel and hard metal (Suuronen et al, 2007).

The National Occupational Exposure Survey in 1981-1982 of National Institute for Occupational Safety and Health (NIOSH) of United Stated reported that potentially workers exposed to metalworking fluids was estimated around 1.2 million (Wenhai et. al, 2006), while the global demand of metalworking fluids for 2010 was 2.2 million tonsand there was increased consumption of metalworking fluids in Asia reported from 2007 until 2010 with 3.3% annual rate (Byers, 2011). Usually high capacity usage of metalworking fluids was related to automotive, commercial aircraft and heavy machinery industries (Cohen and White, 2006). During the application of metalworking fluids, aerosol of metalworking fluids consists of metal, chemical residues or physical contaminants such as chips and fines will dispersed into the surrounding during the operation (NIOSH, 1998).

Currently, the major priority is emphasized more towards monitoring of chemical exposure to heavy metals. It is due to the pollution of metallic element releasednaturally or through human activity towards the environments. The increasing of heavy metal exposure is mostly due to the increasing of industrial and commercial uses of metals nowadays (Nordberg et. al, 2007). The European



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Standard EN 10088 (EN 2005) reported stainless steel consist of at least 17.2% chromium, and another major alloying element with 10.7% nickel (Santonen et. al, 2010), and stated that chromium have tendency to blend with nickel and causes various side effects such as carcinogenic and allergic reaction (Wu and Liu, 2014).

Nickel is one of substances resistant to corrosion either by air, water and alkali. It been used widely in industrial setting including steel and alloy production, electroplating, and production of metal item such as household utensils (Klein and Costa, 2007). Main sources of environmental nickel exposure are due to combustion of fossil fuel and also pollution from nickel industries, more specifically, steel production industries, mining, and waste and sewage sludge incinerators (WHO, 1991). About 0.2% nickel occupational exposure was exposed to an appreciable amount among workers in mines, factories and chemical plants (Klein and Costa, 2007).

Chromium can be found easily in nature as chromite ore and in a form of trivalent (Cr(III)) used in chromium metal manufacturing (Langard and Costa, 2007). This silvery, hard metal is an invaluable component of alloys such as ferrochrome and stainless steel. It possessed various health effect such as respiratory problem, cancer, and skin condition (Kanzantzis, 1972). Generally, the exposure of chromiumoccurred in stainless steel industry, manufacturing of alloys, and



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production of dichromates. It is estimated about 8-10% of nickel and 18-20% of chromium contains in stainless steel (Langard and Costa, 2007). The accumulation of toxic materials in human body can cause numerous health effects whether acute or chronic. Therefore, in order to evaluate the trace element deficiencies or exposure to toxic metals, biological monitoring was used.

The typical biological monitoring media are such as blood, urine, hair, saliva, and nails, and breast milk for rare cases. The biomonitoring of toxic metals in biological sample was used widely due to metals remaining toxicity of these element can causes health hazards if it exceeded certain limits (Afridi et al, 2011). Analysis of the relevant elements in biological fluids such as serum or plasma, whole blood, or urine specimen provides useful information on disturbances of metabolism that involves metals.

Exposure of metallic or metalloids can result in acute or chronic health effect such as respiratory health problem and skin problem that linked with exposure to heavy metals in environment settings. Exposure to metals in workplace is responsible for several cutaneous problems such as redness, scaling, itching and dryness. About 90% of all cases of work-related cutaneous disorders is due to occupational contact dermatitis, either irritant contact dermatitis or allergic contact dermatitis (Sasseville, 2008). While for respiratory health problems, the symptoms such as cough,



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wheezing, chest tightness and phlegm occurred while handling everyday task in work setting.

## 1.2 Problem Statement

Particles in industrial environment usually in nano sized particles and its concentration are higher compared to ambient and indoor air concentration (Isaxon et. al, 2009). Particles in air can easily affect human because atmospheric emission is probably the most preoccupant to human health, due to its great quantity involved andwide dispersion of air (Dinis and Fiúza, 2011). In machining industries, metalworking fluids is used widely by related sector of industries such as manufacturing and automotive. Previous study stated that there is an increasing used of metalworking fluids since lubricant had initiated along with automobile and aircraft manufacturing in the beginning of the 1990s [Suuronen et. al, 2007]. Based on National Occupational Exposure Survey (NOES) by National Institute for Occupational Safety and Health (NIOSH) reported around 1.2 million workers being potentially exposed to metalworking fluids (NIOSH, 1983). Eventhough the risk of exposure was high, yet the number of human exposed to metalworking fluids was not declined.

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During the machining process with metalworking fluids, substantial aerosol of the fluids was generated during the procedures. The aerosol consistedwith chemical in particular fluids and also contaminants such as microbial organism and their toxicants, metallic particles created during the process and little amounts of dissolved metals from the tools and also from the work pieces (Eisen et. al, 2001). Based from previous study, exposure to hazardous contaminants in metalworking fluids may poses health risk to workers. Contaminants from the chemical and lubricant inadvertently produced from the machining process of metals and alloys part(NIOSH, 1998).

Until now, there were a few studies concerning exposure to metals in metalworking fluids industrial setting (Stridsklev et al., 2007) eventhough the effect of the aerosol of the fluids produced possess various health effect. Metalworking fluids have been used widely in sort of industries for many years, but the information known about metals exposure in metalworking plants is still limited and the data presented in the study was the early challenge to investigate correlation between airborne metals concentration and urinary concentration in metalworking fluids industrial setting (Wu and Liu, 2014).

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## 1.3 Study Justification

The metalworking fluids environment is categorized by multiple exposures, can be either concurrently or/and sequentially through the process, thus, making it difficult to isolate the effect of any one of the agent. Usually most workers are exposed to more than one type of metalworking fluids or various machiningoperations and the exposure to metals is ubiquitous. For workers involved in machining process, there are high possibilities to expose to particulate generated from base metals of part being machined (Sullivan et. al, 1998).

The monitoring exposure of metalworking fluids typically will be done to determine the intake of metalworking fluids aerosol together with other contaminants such as biocides, ethanolamine, nitrite, nitrosamine and chemical or additive from the operation by workers (NIOSH, 1998). Most of the study done previously focused towards the effect of the metalworking fluids bioaerosols, endotoxin-containing particles and also alkanolamines but not heavy metals exposure (Stridsklev et. al, 2007).

This study helped todetermine the metals present in metalworking fluids environment in industrial setting (Stridsklev et al., 2007).Since metalworking fluids



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acted as metal pieces or particles remover, the metals done through the process should be carried away during the presents of metalworking fluids.

The data obtained acted as a baseline data for metal concentration in metalworking fluids setting in occupational safety, health and environment management system in Malaysia since there were few related studies identified but only from other country. Also to increased awareness level regarding the effects of metalworking fluids users to prevent any injuries or accidents occurred in industries.

## 1.4 Study Variables

**Independent variables:**

- Personal air concentration of chromium and nickel among workers in machining industry.

**Dependent variables:**

- Urinary concentration of chromium and nickel among workers in machining industry.

**Confounders:**

- Smoking habit

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## 1.5 Conceptual framework

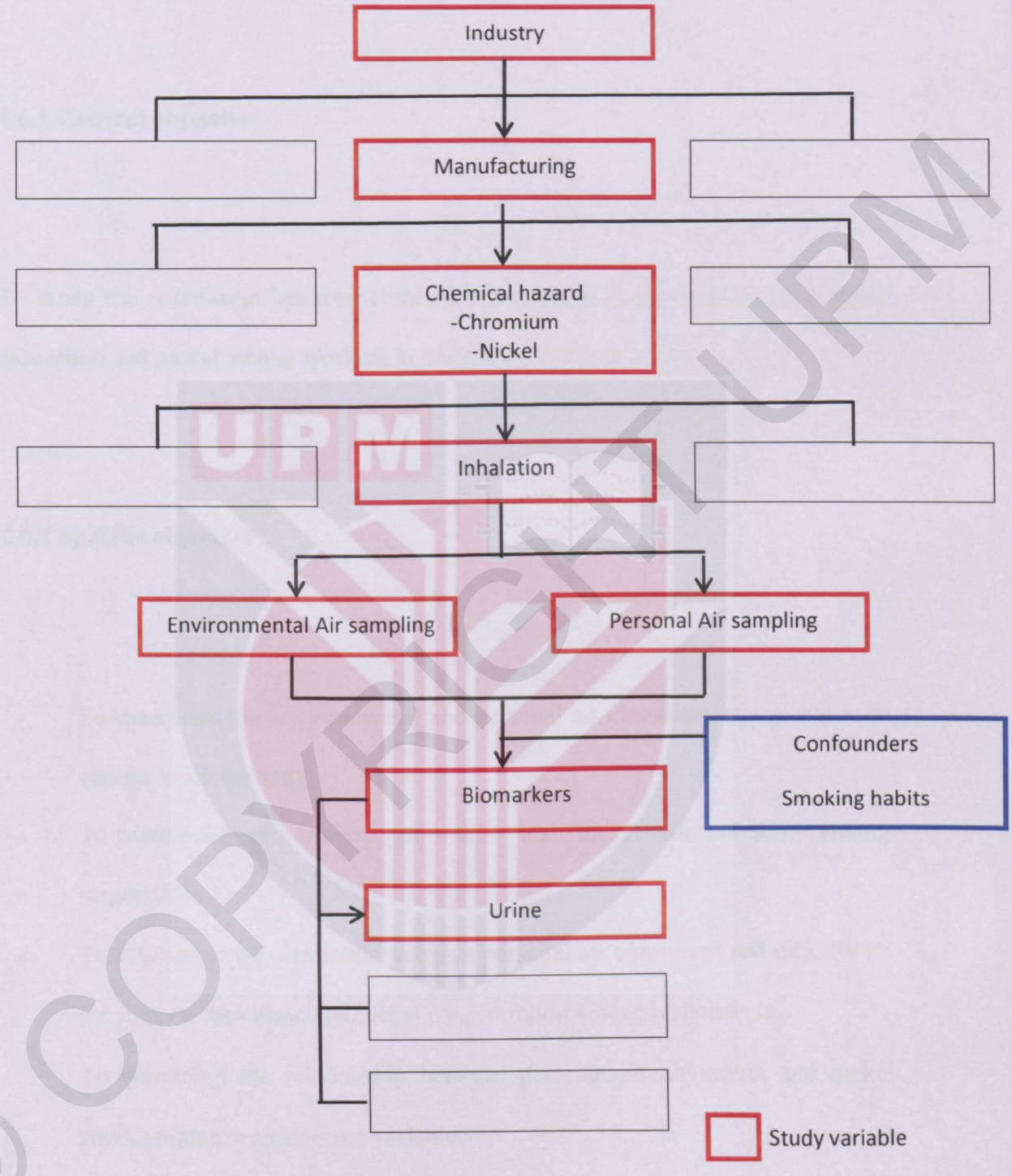


Figure 1: Conceptual framework of chromium and nickel in personal air and its correlation with urine chromium and nickel among workers in machining industry

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## 1.6 Research Objectives

### 1.6.1 General objective

To study the correlation between chromium and nickel in personal air with urine chromium and nickel among workers in machining industry.

### 1.6.2 Specific objective

- To determine the environmental and personal air chromium and nickel in in various work sections.
- To determine the urinary chromium and nickel concentration among respondents
- To determine the correlation between personal air chromium and nickel with the urinary chromium and nickel concentration among respondents.
- To determine the relationship between personal air chromium and nickel concentration with selected variables
- To determine the relationship between urinary chromium and nickel concentration with selected variables.

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## 1.7 Research Hypothesis

- There is significant correlation between the personal air chromium and nickel concentration with urinary concentration among respondents.
- There is significant relationship between personal air chromium and nickel concentration with selected variables
- There is significant relationship between urinary chromium and nickel concentration with selected variables such

## 1.8 Definition Term

### 1.8.1 Conceptual Definition

#### 1.8.1.1 Metalworking Fluids

Metalworking fluids also known as lubricant and cooling agent in machining industry and also provide treatment towards metal components as anti-corrosion agent. (NIOSH, 1998). Metalworking fluids contain four types of fluids starting from



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straight oil, soluble oil, synthetic fluids and semi-synthetic fluids (NIOSH, 1998).Generally, all metalworking fluids are complex mixture with an addition of additives to help improve the performance and stability of the fluids while being operated together with machines. However, each of component mixture in metalworking fluids possesses an adverse health effect and the nature and severity of fluids is based on its composition (Simpson et. al, 2003). The aerosol of metalworking fluids produced during the machining process consist various amount of contaminants (NIOSH, 1998).

### 1.8.1.2 Heavy Metal Exposure

Heavy metals exposure for chromium and nickel occurs through inhalation, skin absorption and also ingestion. Their physical appearance can be either in solid, liquid or gaseous state. Occupational exposure apparently accounted for the great majority of heavy metal poisoning throughout human history (Ada and Wiener, 2013). Usually workers involved in metals operation are more prone to exposed to particles of heavy metals (Liu et al, 2012).

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### 1.8.1.3 Air Monitoring

Air monitoring was conducted to assess the degree of pollution in the air, ensured compliance with national legislation, and evaluated existing controls. The locations for monitoring stations depend on the purpose of the monitoring (USEPA, 2011). Environmental air monitoring was used to verify the ambient air concentration in a specific setting. The air concentration reflects the influences of different nearby and distant sources (ATSDR, 2001). Personal air monitoring was used to verify the air concentration within worker's breathing zone. Different workers introduced to different air concentration based on their job task and unfixed job position (HKDL, 2006).

### 1.8.1.4Biological Monitoring

Biological monitoring is a method in assessed chemical exposure in urine, hair, saliva, blood and nail exposed from various route of entry. The purpose of biological monitoring helped in identified the amount of chemical absorbed by person's body and determined the effectiveness of existing controls and use of personal protective equipment in industries(HSL, 2014).

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### 1.8.2 Operational Definition

#### 1.8.2.1 Metalworking Fluids

Information regarding type of metalworking fluids used for each machining process and work section consist in a factory is collected from questionnaire and interview of workers and management of the factory. Document review of material safety data sheet (MSDS) each of metalworking fluids from management to identified the element of chromium and nickel in the substances.

#### 1.8.2.2 Heavy Metal Exposure

Heavy metal exposure determined by digested the filter paper used in air monitoring and urine collected from workers. The laboratory process for was based from NMAM 7300 and related journal. The liquefied sample was run through Inductively Coupled Plasma Mass Spectrometry (ICPMS) for the concentration result.

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#### 1.8.2.3 Air monitoring

Air concentration in industrial settingwas collected using personal sampling pumps. Environmental air concentration was collected by static sampling method to determine the level of environmental air in workers' workplace setting. The sampling pump for environmental air is located at a fixed point in between workers and sources (Wu and Liu, 2014). Personal air concentration was collected by attached the equipment within workers breathing zone to determine the individual exposure while workers carried out their job task. (HKLD, 2006).

#### 1.8.2.4 Biological Monitoring

Spot urine sampling was collected during post end-shift of workers which was during at the end of working day, to determine the level of exposure towards chromium and nickel by workers. Respondents were asked to urinate in a given container before their work shift over, and provide to the researcher after end of their work shift.

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# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Environmental and Personal Air

Environmental air in occupational setting is regarding workers air in a workplace known as occupational environment usually characterised by wind speed such as ventilation system. Ambient environmental air usually covers range of age including children and elderly. However, in occupational environment, it involves workers in a workplace. The occupational environment generally is the same from day to day since there is a low external factor to interfere with the environment condition since factors such as humidity, wind speed and temperature can be controlled, unlike ambient atmospheric air which determine by various factors such as wind speed, humidity, and temperature that is likely to change everyday since it is an uncontrolled. Until now, measurement of environmental air for aerosol has been carried out by using fixed point or static sampling instrumentation (Vincent, 2007),



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Personal sampling was carried out in order to measured individual exposure received by a person who was not working at fixed position. Therefore exposure of an individual was best reflected by continuous assessment that encompasses all represented work area (Zhang et. al, 1983).

Sampling of occupational environmental and personal air was used to determine the concentration of heavy metal in the air using air sampling pump as personal sampler and also stationary area sampler (Pfaffli et. al, 2002). Existing of metals in air as in form of vapour and particulate forms depends on specification of metal and chemical species. Particle size distribution and chemical properties plays important parts in determining the site of deposition and the degree of absorption of metal (Cornelis and Nordberg, 2007).

Comparing the level of air in occupational setting and ambient setting, higher concentration of air is significantly related with occupational setting for industrial (Cornelis and Nordberg, 2007) since industrial location is where a source of pollutant usually being produced. As concentration of air getting higher, collecting large amount of accurate measurements sufficiently seems easy since the air is mostly filled with an element of metals (Cornelis and Nordberg, 2007).

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## 2.2 Metalworking Fluids (MWFs)

Metalworking fluids has been used widely since 1994, from Independent Lubricant Manufacturers Association (ILMA) from United States estimated production of metalworking fluids annually between 1994 and 1999 was around 95 – 103 million gallons. The demands of industrial users using high volumes of metalworking fluids is ranging from automotive, agricultural, commercial aircraft and heavy machining industries (Cohen and White, 2006).

Metalworking fluids is a broad term covering a wide variety of fluids that being used as lubricants and also coolant in machining industrial or treatment of metal component. Its main function is to cool the metalpiece and tools and to provide lubricant to the machining process. It has been widely used in cutting process due to its abilities to produce and preserve a good surface finish and removing swarf of metals (Simpson et. al, 2003). The other term referred to metalworking fluids are cutting fluids, machining fluids or metalworking coolants.

Metalworking fluids can be divided into two types known as neat mineral oil and water mix fluids. These substances can be further divided into straight oil, soluble oil, semi-synthetic fluids and synthetic fluids. Basically all metalworking



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fluids is a combination from a complex mixture containing additives, used to improve performance and stability of machine operation. Usually water mix fluids known as better coolants while neat oils are considered as better lubricant (Simpson et. al, 2003).

Exposure to metalworking fluids occurred through various route such as contact with skin or by inhalation of aerosol of metalworking fluids droplets (Simpson et. al, 2003). During operation process, while, metalworking fluids in contact with metal, the composition of the fluids is likely to change due to contaminant presence and increase level of bacteria, metal fines and tramp oil and additions of biocide (Simpson et. al, 2003).

Metalworking fluids also include as one of occupational health concerns. Dermatitis is the most important work-related health hazard which caused by water mix rather than minerals oils of metalworking fluids. When the skin as first protective barrier of human was weaken, it is more vulnerable to infections from micro-organism such as bacteria, fungi and yeast, allergens attack such as endotoxin, metals such as chromium and nickel, and fluids components or additives such as biocide and corrosion inhibitors. The other health concerns are respiratory effects such as irritation of the respiratory tract and impairment of lung function. Survey of Work-related and Occupational Respiratory Disease (SWORD) and OPRA reported



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an estimation of annual average of 11 new cases of occupational asthma was related to exposure to cutting oils (Simpson et. al, 2003).

## 2.3 Heavy Metal

Heavy metals is any metallic chemical element that has a relatively high density which superior to 5 g/cm3, and mostly all of them are toxic or carcinogenic even when the amount is at low concentrations, such as mercury, cadmium, arsenic, nickel and chromium (Dinis and Fiúza, 2011). Heavy metals often called as a group name for metals and semimetals which is metalloids (Hoodaji et al, 2012).

Heavy metals in air may result from different activities and sources and may exist in naturally or unnaturally. Unnatural sources exist from human activitiesmainly from industrialization area. The sources from industrialization mostly produced from mining and industrial production such as foundries, smelters, oil refineries, petrochemical plants and chemical industry, untreated sewage sludge, disperse sources such as metal piping, traffic and combustion by-production from coal burning power plants (Dinis and Fiúza, 2011).

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Metals can be presented in a various type of media, such as air, diet, water, soil, and dust, and are major and minor components of medical products like prosthetic materials (Zeiner et al, 2004). All of these metals may cause toxic effect if it occurs excessively, and some of them might even occur at a very low content level of contaminant. Since the element of heavy metal does not decay with time, their emission towards human is a serious problem because of its toxicity and possession of high risk of health effect proportionally to the increasing use of metals worldwide due to rapid growth of population, increasing in fossil fuels and also expansion of industrial activities (Hoodaji et al, 2012).

Heavy metals exposure can be exposed towards various route of entry. Typically in industrial setting, workers are prone to exposed through air since air is essential media for living person to breath. Due to its light mass, the airborne can be easily dispersed to the surrounding and spread quickly to different location in a single time. Airborne metals mostly occur in the form of aerosol and particles can be easily be inhaled by the respiratory tract. Then, the route of exposure followed by skin absorption of metals towards skin due to deposition of metals to skin and direct contact of skin with liquids containing metals. Accidental exposure happens through splash of liquids to parts of human body also included in skin absorption exposure.And lastly through ingestion of food contaminated with metals occurs directly or indirectly. Direct contamination usually happen in environmental situation, while in industrial setting, ingestion of metals takes place indirectly



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because of poor hygiene of worker. Contamination might occur when a person accidentally transferred metals from the exposed body parts to the food being consume (Cornelis and Nordberg, 2007).

The health effect of a person can be affected if they exposed to heavy metals. A well-known effect usually is at central nervous function, damage blood composition, skin problem, lungs, kidneys, liver and other vital organs. But for long term exposure towards heavy metals can cause slower progressing physical, muscular, neurological degenerative processes and allergy (Dinis and Fiúza, 2011).

## 2.4 Biological Monitoring

Biological monitoring of element has become an important function in many clinical, industrial, environmental and laboratories or toxicological studies (Zeiner et al, 2004) by using different specimens to reflect a person body's status. Analysing metals in human body can be done through biological fluids such as serum or plasma, whole blood or urine specimen because it provide a very useful information on disturbances of metabolism that involve metals. All analysis of elements in biological fluids demands a versatile and reliable technique and the analytical method used must be very sensitive, precise, accurate, and relatively fast (Hsiung et



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al, 1997). By the help of biological monitoring, the exposure of continuous or repeated measurement of potentially toxic substances or their metabolites or their biochemical effects in biological fluids. The main purpose of collecting biological fluids is to obtained and integrated estimate of the uptake of metal species by going through all pathways and media of exposure (Cornelis and Nordberg, 2007).

Biological monitoring was used to describe the exposure and internal dose of metals in human body through measurement of biological samples. While biomarker is used as an indicator signalling an event or condition in a biological sample by give a measure of exposure, effect, or susceptibility. Biomarkers are generally being used in metal toxicology, environmental and occupational health field.

Since mostly chemical forms of metals are water soluble, therefore, they can be easily absorbed by human beings. By measuring the metal levels in human specimens, it can reflects the total exposure from all sources possible and is, therefore, a better way to estimate exposure rather than performing environmental analyses by using biological monitoring (Zeiner et al, 2004).

Among all biological samples ranging from hair, blood, serum, nail, saliva and teeth, urine was the most preferable biological fluids taken for monitoring since



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the collection method for urine is much easier and involves non-invasive mode and can be stored without serious risk of contamination (Zeiner et al, 2004). As for Ni and chromium detection level in biological fluids, urine is the most applicable to be taken since the interest in these metals is mainly determine by their toxic potential as industrial and environmental pollutants (Alimonti et al, 2000).

## 2.5 Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

ICP-MS is regarded as one of the most influential techniques to determine trace and ultra-trace analysis of element. Usage of ICP-MS has been used widely in the clinical biology, particularly in toxicological analysis, industrial hygiene and environmental hygiene (Biomonitoring Method, 1999). Analytical method using ICP-MS seems to be the appropriate as it allows simultaneously determination of multi-elementary metals and metalloids with using as low sample volume with high detection limit that can be performed with high accuracy and produce good reproducibility (Goulle´ et al, 2005).

The sample in liquid form will be converted into aerosol by nebulizer system and passed through the central channel of plasma burner known as torch into argon plasma. At this stage, high frequency signal will produced from coil and attached



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together with argon flow and thus generated inductively coupled plasma. Later on, in the plasma, sample is decomposed into atomic components at temperature above 8000 K causes the atom to ionize. Afterward, ion will be separated according their mass to charge ratio (m/e) and quantified by detector (Biomonitoring Method, 1999).

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# CHAPTER 3

# METHODOLOGY

## 3.1 Study Location

This research was conducted at one of the factory in Kawasan Perindustrian Nilai, Negeri Sembilan, among workers exposed to metalworking fluids in machining industry

The factory selected in this study involved with a production of stainless steel known as bearing. Bearing is an item that promotes rotational or linear movement and reduces friction in many types of equipment and machines. Bearingcan be roughly classified into the types produced through the motions allowed by an item, and type of operation or direction of loads applied to the parts. There are two types of bearing can be identified namely the ball bearing and the roller bearing.



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Ball bearing can be easily found in vehicles and also in situations where the load is light to medium. It uses a ball for a movement located between outer and inner ring and the contact between races and ball is at very small points. Compared to roller bearing, it uses cylinders instead of balls which give it more strength in heavy duty applications. For the roller bearing, the contact between the cylinder roller with the outer and inner ring was not in a point such as ball bearing, but rather in a line.

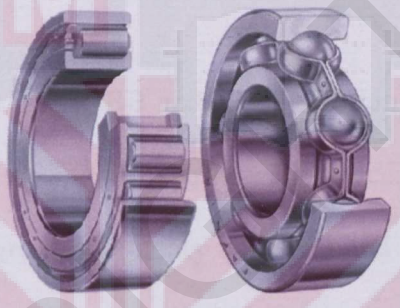

**Figure 4.1: Ball Bearing and Roller Bearing**

A layout plan for the factory studied was divided into 12 sections which cover all types of end products manufactured. There were 4 types of bearing produced which were Deep Groove Ball Bearing (DGBB), Self Aligning Ball Bearing (SABB), Spherical Roller Bearing (SRB), and Large Size Roller (LSR).

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DGBB has a characteristic with such a deep and uninterrupted ring channel grooves, which possess a close contact with the balls and enables the bearing to holds the load in both directions. As for SABB, it consists of two rows of balls and a regular sphered ring channel located in the outer ring with an ability of self-adjusted of ball bearing and produces less friction than other products. In SRB, it consists of two rows of rollers with the inner and outer inner ring, designed to accommodate heavy loads. Meanwhile for LSR, the bearing produced was in a bigger size compared to other products manufactured in the factory.

The production process for DGBB and SABB section was quite similar since both involves with the production of ball bearing. The process involves was cutting, grinding, polishing, washing, greasing, quality checking and packaging. As for SRB and LSR, the process was somewhat different with DGBB and SABB. The flow of the process begin with cutting, washing, heating, grinding, whitening, greasing, quality checking and packaging.

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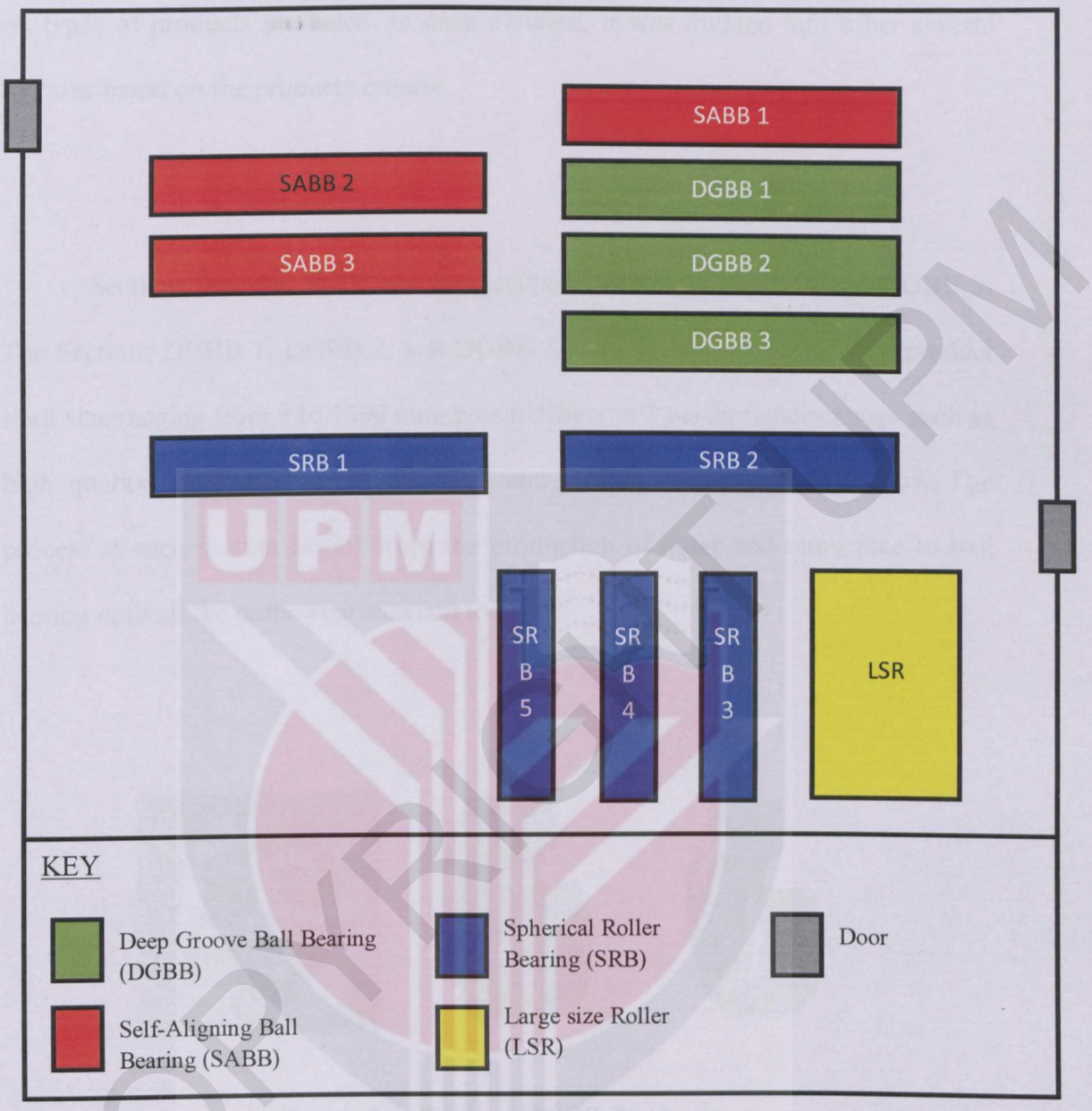


**Figure 4.2: Plant Layout for Each Section and Type of Product**

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From Figure 2, there were 4 divisions in the factory which was divided based on types of products produced. In each division, it was divided into other several sections based on the products criteria.

Sections included in DGBB were section DGBB 1, DGBB 2, and DGBB 3. The Sections DGBB 1, DGBB 2, and DGBB 3 were divided based on their product shaft size ranging from 3 to 1500 mm, which differs in 3 performance classes such as high quality, high-load carrying quality and bearing for energy efficiency. The process at each section begins from the production of outer and inner race to ball bearing until all the parts were attached together.

**Figure 4.3: Type of DGBB Products**
**(High Quality, High-Load Quality and Bearing for Energy Efficient)**

The same with the SABB products, which were divided into SABB 1, SABB 2, and SABB 3 Sections based on the design of the bearings, such as open with a basic design, sealed bearing with contact seals on both sides and open bearings with



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an extended inner ring. The process begins with the production of balls to rings until products attachments.

**Figure 4.4: Type of SABB Product**
**(Open With a Basic Design, Sealed Bearing with Contact Seals on Both Sides and Open Bearings with an Extended Inner Ring)**

Different from DGBB and SABB, the SRB Sections were split into 5 sections, which were SRB 1, SRB 2, SRB 3, SRB 4, and SRB 5. For Sections SRB 1 and SRB 2, it produces the ring of the bearing, where Section SRB 1 manufactured inner ring while Section SRB 2 manufactured the outer ring and act as assemble area for SRB products. However, in Sections SRB 3, SRB 4, and SRB 5, the production produces the spherical bearing with different types such as open bearing, sealed bearings and bearing for energy efficiency.

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**Figure 4.5: Type of SRB Product**
**(Open Bearing, Sealed Bearings and Bearing for Energy Efficiency)**

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**Table 4.1: List of MWFs Used At Different Section in a Factory**

| Metalworking Fluids (MWFS) | Work Section | | | |
|---|---|---|---|---|
| | **DGBB** | **SABB** | **SRB** | **LSR** |
| **Coolant** | Hysol X | Hysol X | Hysol X | Hysol X |
| **Lubricant** | ANTICORIT 03W FF | ANTICORIT 03W FF | Hyspin AWS 68 | |
| **Cutting Oil** | | | ILOCUT 603 | ILOCUT 603 |
| **Cleaning agent** | Castrol Solvent D100 | Castrol Solvent D100 | P3-Neutrapon 5088 | Castrol Solvent D100 |
| **Other** | H 460 (Booster) | H 460 (Booster) | Hydraulic VG22 MI<br>H 460 (Booster)<br>SC 388 | H 460 (Booster) |
| **Anti-corrosion** | Biogard 25<br>Koolgard 16 | Biogard 25<br>Koolgard 16 | Rustilo DWX 88 | Biogard 25<br>Koolgard 16 |

*Refer MSDS of each chemical in Appendices.

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## 3.2 Study Design

A cross sectional study was selected for this research in determining the correlation between environmental and personal airheavy metals, and urinary heavy metalsconcentration among workers in machining industry.

## 3.3 Sampling

### 3.3.1 Sample Population

Workers in machining industry exposed to metalworking fluids in machining industry were selected as respondents in this research.

### 3.3.2 Sampling Frame

Respondents of this research were obtained from the name list provided by human resource department of the factory.



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### 3.3.3 Sampling Unit

Only those who fulfilled the criteria will be included in the study. The criteria for selecting respondents in the study were:

Inclusion criteria

- Every respondent must be male with healthy status, free from medical history of diabetes and kidney problems. Respondents also must involve with metalworking fluids environments in machining industry.

Exclusion criteria

- Female respondents and respondents with medical history of diabetes and kidney problems will be excluded from the study.

### 3.3.4 Sampling Method

This research used simple random sampling with inclusion criteria fulfilled.

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### 3.4 Sample Size

The sample study was comprised of 169 workers which fulfilled inclusion criteria using a calculation formula from Yamane (1967) specifically for cross sectional study.

$$n = \frac{N}{1 + N(e)^2}$$

Where n = sample size

N = population size

e = level of precision (0.05)

The calculated was shown as below:

$$N = \frac{250}{1 + 250(0.05)^2}$$

= 154 respondents

However, invalid questionnaire or missing data need to be considered in the sample size because it might affect the representativeness of the sample size if the sample was reduced. Therefore, 10% from the sample size will be added to strengthen the representativeness of the sample.

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After considering a 10% invalid questionnaire or any missing data the final sample size will be 169.

Final sample size = 10% + N

= 15 + 154

= **169 respondents**

### 3.5 Study Instrumentation

#### 3.5.1 Administered Modified Questionnaire

A questionnaire was modified from previous study (Paustenbach et. al, 1997), (Wu and Liu, 2014)and administered by researcher to collect information data from respondents. There were 6 sections consisted in the questionnaire; Section A for socio-demographic information included age, ethnicity, level of education, height, weight and body mass index. Section B for smoking history, Section C for work history included previous job description, employment years, work duration and usage of personal protective equipment. Section D for recent job employment included job description, years of work, work shift, work duration and usage of personal protective equipment. Section E regarding work environment included



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housekeeping, total workers in every section. And Section F for disease history included personal medical and family medical.

### 3.5.2 Environmental and Personal Air Sampling

Standard operating procedure for collecting data of heavy metal in environmental and personal air was used based on NIOSH method 7300.

- The sample was collected using cellulose ester membrane filter with 0.8-$\mu$m pore size, 37 diameters in cassette filter holder with 1 to 4 L/min
- Flow rate of sampling pump used was 2 L/min and the flow rate was checked regularly.
- Air sample was measured for 8 hours of work shift.
- Cassette was sealed using jar band and transported to laboratory for analysis.
- 5 ml acid ashing comprise of 4:1 (v/v) nitric acid (HNO3):perchloric acid (HClO4) added to sample, cover with watchglass and left for 30 minutes at room temperature.
- Sample was heated on hot plate at 120°C until remains 0.5 mL
- 2 mL acid ashing added and heated on hotplate again
- Watchglass was removed and rinsed with distilled water into beaker.



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- Temperature of hotplate increased to 150°C ant take sample when near dryness which was at 0.5 mL.
- Residue in beaker was rinsed with 2 to 3 mL dilution acid and sample was transferred to 25 mL volumetric flask.
- Dilution acid was diluted to the volume of volumetric flask.
- Sample continued by analysed using ICP-MS for concentration reading.

Unit measure from ICP-MS was in ppb or $mg/m^3$. To get the chromium and nickel concentration, the formula stated was followed.

$$C = \frac{CsVs - CbVb}{V}, mg/m^3$$

Where,

C = concentration

$C_s$ = concentration of sample

$C_b$ = average media blank

$V_s$ = volumes of sample

$V_b$ = volume of blank

V = air volume sample

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### 3.5.3 Biological Sampling (Urine)

Sampling of biological sample which is urine was collected based on related journal with same metal exposure (Heitland and Koster, 2004).

- Polyethylene containers were cleaned using 5% (v/v) nitric acid (HNO3) for 24 hours.
- Sample was collected using polyethylene containers at the end of shift of workers
- 20 ml per urine sample was acidified with 100 $\mu$l of 65% (v/v) HNO3
- Sample was stored at 5°C in refrigerator for within 2 weeks analysis, and freeze at -20°C for longer analysis.
- Sample was left at 4°C after taken out from refrigerator/freezer prior to sample digestion
- Sample was shaken vigorously for 2 minutes
- 1 ml of sample was acidified with 100 $\mu$l concentrated HNO3 in 10 ml autosampler polypropylene tube.
- 500 $\mu$l of internal standard added to the sample.
- Distilled water was added to sample until 5 ml is reached.
- Samples were homogenized on magnetic stirrer before analysed using ICP-MS.

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Unit measure from ICP-MS was in ppb or µg/L. The reading therefore followed calculation below.

C = Chromium or nickel concentration in µg/L x Dilution factor

Where,

C = concentration

*Dilution factor = 10

**3.6 Data Analysis**

A statistical analysis was carried out using the Statistical Package for Social Science (SPSS) Version 21. Descriptive analysis was used to analyse descriptive data such as age, ethnicity, smoking status any other variables to determine mean value, standard deviation and frequency. Kolmogorov-Smirnov statistical analysis was used to test normality for all data since the total subjects was more than 50 subjects. Bivariate test such as One Way ANOVA for parametric data and Kruskal-Wallis test for non- parametric data was conducted to determine the significant different of chromium and nickel in air between work section. PearsonCorrelationtest was performed to determine the correlation between chromium and nickel concentration in personal air and chromium and nickel concentration in urine. For multivariate



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analysis among various variables, a multiple linear regression was used to determine the relationship between the selected variables that influenced the personal air chromium and nickel concentration and urinary chromium and nickel concentration of study subjects

### 3.7 Quality Control

#### 3.7.1 Self-Constructed Questionnaire

Pre-test was done on 10% of workers with same inclusion criteria of respondent at other factory. The purpose of pre-test was for better understanding of the question given, also to help in preventing bias and help to strengthen the result when actual respondents answers the question.

#### 3.7.2 Calibration

Calibration of equipment was important for data reliability and sensitivity. Equipment involves in calibration were personal air sampling pump, atomic



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absorption spectrometric, and digital weighting balance. The calibration was done manually or throughmanufacturer of the equipment.

### 3.7.3 Standard Operating Procedure

Standard operating procedure for sample collection and storage and equipment calibration was used in this research as it is internationally approved and reliable.

## 3.8 Ethical Approval

Ethical approved was obtained from board of Committee of Ethical, University Putra Malaysia and from factory in Kawasan Perindutrian Nilai. Respondent approval was acquired to obtained fully cooperation from respondents in providing personal information data and for biological sample collection. All information data collected by researcher will remained undisclosed and confidential throughout the study.

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### 3.9 Study Limitation

Since this was cross sectional study, the exposure and the outcome of the study were simultaneously assessed. The actual relationship cannot be determined between exposure and outcome of the study. The result may be different if another time-framed was chosen to determine the actual urinary chromium and nickel, which in this study, only focused towards end shift urine collection rather than weekly and 24 hour urine collection. Time constrain was also one of the study limitation as sample collection can only be collected during office hour and specified time given by factory management to prevent production delayed.

Workers with smoking habits also included in this study because the impossibilities to excluded the respondents. Almost half of respondents in selected factory were a smoker, and if they were excluded, the sample size might constrain.

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# CHAPTER 4

# RESULT

## 4.1 Study Background

The study was conducted at one of the machining industry located at Nilai, Negeri Sembilan involving 138 respondents classified as exposed based on inclusive criteria of sampling which are male, and working in industrial setting with the present of metalworking fluids in workspace together with exclusion criteria such as free from diabetes and kidney problems [Langard and Costa, 2007]. At first, the initial total respondents fulfil the inclusive criteria were 169, yet only 138 respondents agreed to participate in this study andbring about response rate of 81%.



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## 4.2 Study Location

The factory located at Nilai was involved with production of bearing. The location of sampling in this factory was divided into 12 sections based on each types of bearing produced such as SABB, DGBB, SRB and LSR.

## 4.3 Socio Demographic and Occupational Characteristic of Respondents

Table 4.2 shows a distribution of socio demographic data of respondents in which the respondents' age ranged from 20 to 57 years old, with a mean and standard deviation of 36.22 (10.56%)and majority of participants were Malay which totalled 101 (73.2%), followed by Indian with atotal of 32 (23.2%), and Chinese with a total of5 (3.6%). About less than half of the respondent were smokers 60 (43.5%).

Based on Table 4.3, workemployment which range from 6 months to 5 years was 65 (47.1%), while majority with past work employment was 6 months until 5 years which were 72 (52.2%). For work duration, most of respondents work by shift with 8 hours of exposure 80 (58.0%) compared to 12 hours of exposure. Among all respondents, 131 (94.9%) work as technician while other work as maintenance, engineer and cleaner.



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Referring to Table 4.4, it shows that the total number of respondents'participation from each section at the factory. The majority of respondents were obtained from the Section DGBB 3 with 22 (15.9%) of them and the lowest participation were from Section LSR with a 4 (2.9) respondents. Numbers of machines used for processing the metal were mostly high in SABB 1 and SABB 2 Sections was 10 (11.90%).

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**Table 4.2: Socio Demographic Information of Respondents**

| Variables | n (%) | Mean (SD) | Range |
|---|---|---|---|
| **Age (Years)** | | 36.22 (10.56) | 20 - 57 |
| 20-29 | 56 (40.6) | | |
| 30-39 | 18 (13.0) | | |
| 40-49 | 45 (32.6) | | |
| 50-59 | 19 (13.8) | | |
| **Ethnicity** | | | |
| Malay | 101 (73.2) | | |
| Indian | 32 (23.2) | | |
| Chinese | 5 (3.6) | | |
| **Smoking** | | | |
| Yes | 60 (43.5) | | |
| No | 77 (55.8) | | |
| **Job's Title** | | | |
| Technician | 131 (94.9) | | |
| Maintenance | 2 (1.4) | | |
| Engineer | 2 (1.4) | | |
| Cleaner | 3 (2.2) | | |

N=138

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**Table 4.3: Working Information of Respondents.**

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| **Work Employment** | | |
| 6 months – 5 years | 65 | 47.1 |
| 5 years – 10 years | 13 | 9.4 |
| 10 years – 20 years | 32 | 23.2 |
| >20 years | 28 | 20.3 |
| **Past Work Employment** | | |
| <6 months | 22 | 15.9 |
| 6 months – 5 years | 72 | 52.2 |
| 5 years – 10 years | 11 | 8.0 |
| 10 years – 20 years | 4 | 2.9 |
| 0 month | 29 | 21.0 |
| **Work duration** | | |
| 8 hours | 80 | 58.0 |
| 12 hours | 58 | 42.0 |
| **PPE Used by Workers** | | |
| Yes | 126.96 | 92 |
| No | 11.04 | 8 |

N=138

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**Table 4.4: Work Section of Respondents**

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| **Respondents in Work Section** | | |
| **SABB** | | |
| SABB 1 | 19 | 13.8 |
| SABB 2 | 5 | 3.6 |
| SABB 3 | 10 | 7.2 |
| **DGBB** | | |
| DGBB 1 | 6 | 4.3 |
| DGBB 2 | 13 | 9.4 |
| DGBB 3 | 22 | 15.9 |
| **SRB** | | |
| SRB 1 | 5 | 3.6 |
| SRB 2 | 15 | 10.9 |
| SRB 3 | 5 | 3.6 |
| SRB 4 | 5 | 3.6 |
| SRB 5 | 15 | 10.9 |
| **LSR** | 4 | 2.9 |
| **All Plant** | 14 | 10.1 |
| **Total** | 138 | 100 |

N=138

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**Table 4.4: Work Section of Respondents (Continue)**

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| **No. of Machines** | | |
| **SABB** | | |
| SABB 1 | 10 | 11.90 |
| SABB 2 | 10 | 11.90 |
| SABB 3 | 8 | 9.52 |
| **DGBB** | | |
| DGBB 1 | 6 | 7.14 |
| DGBB 2 | 8 | 9.52 |
| DGBB 3 | 7 | 8.33 |
| **SRB** | | |
| SRB 1 | 7 | 8.33 |
| SRB 2 | 8 | 9.52 |
| SRB 3 | 5 | 5.95 |
| SRB 4 | 6 | 7.14 |
| SRB 5 | 5 | 5.95 |
| **LSR** | 4 | 4.76 |
| **All Plant** | 84 | 100 |

N=84

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## 4.4Level of Environmental and Personal Air Chromium and Nickel Concentration in Work Sections.

In Table 4.5, the highest concentration of chromium in environmental air was at DGBB Section with a mean of 1.64 (1.07) mg/m$^3$ and for personal air was in DGBB Section with a mean of 1.79 (0.54) mg/m$^3$. Meanwhile the highest reading measured for nickel was obtained at SABB Section with a mean of 0.85 (1.33) mg/m$^3$ and nickel in personal air determine at LSR Section was with a mean of 0.74 (0.19)mg/m$^3$.

**Table 4.5: Environmental Air and Personal Air Chromium and Nickel Concentration in Work Sections**

| Variables | Env. Air[mean (SD)] (mg/m$^3$) | | Personal [mean (SD)] (mg/m$^3$) | | TWA (mg/m$^3$) | |
|---|---|---|---|---|---|---|
| | Cr | Ni | Cr | Ni | Cr | Ni |
| SABB | 1.13 (0.35) | 0.85 (1.33) | 1.77 (0.57) | 0.28 (0.12) | | |
| DGBB | 1.64 (1.07) | 0.37 (0.25) | 1.79 (0.54) | 0.32 (0.19) | | |
| SRB | 1.22 (0.54) | 0.32 (0.24) | 1.63 (0.64) | 0.34 (0.19) | 0.05 | 0.1 |
| LSR | 1.17 (0.50) | 0.33 (0.15) | 1.63 (0.34) | 0.74 (0.19) | | |
| All Plant | 1.30 (0.17) | 0.47 (0.21) | 1.75 (0.74) | 0.30 (1.7) | | |

*Standard: Department of Occupational Safety and Health, USECCH 2000

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As shown in Table 4.6, a comparison test was conducted to determine the significant difference of the environmentalair chromium concentration between each section. One way ANOVA test showed that there was asignificant difference for environmental air chromium between work section ($F(12) = 2.24$, $p = 0.04$).

**Table 4.6: Comparison of Environmental Air Chromium Concentration in Work Sections**

| Work section | Mean (SD) ($1mg/m^3$) | df | *F* | *p* |
|---|---|---|---|---|
| **SABB** | | | | |
| SABB 1 | 1.21 (0.35) | | | |
| SABB 2 | 0.77 (0.04) | | | |
| SABB 3 | 1.41 (0.17) | | | |
| **DGBB** | | | | |
| DGBB 1 | 2.11 (0.86) | | | |
| DGBB 2 | 0.82 (0.88) | | | |
| DGBB 3 | 2.01 (1.22) | 12 | 2.24 | **0.04*** |
| **SRB** | | | | |
| SRB 1 | 0.90 (0.24) | | | |
| SRB 2 | 1.94 (0.31) | | | |
| SRB 3 | 0.64 (0.09) | | | |
| SRB 4 | 1.18 (0.63) | | | |
| SRB 5 | 1.41 (0.09) | | | |
| **LSR** | 1.18 (0.50) | | | |
| **All Plant** | 1.30 (0.17) | | | |

One way ANOVA

*significant at $p<0.05$



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As for Table 4.7, comparison of environmental air nickel between section was conducted using Kruskal-Wallis test and the result showed there was a significant difference between work sections (H (12) = 22.66, $p = 0.03$).

**Table 4.7: Comparison of Environmental Air NickelConcentration in Work Sections**

| Work section | Mean (SD) ($mg/m^3$) | Mean rank | df | H | *p* |
|---|---|---|---|---|---|
| **SABB** | | | | | |
| SABB 1 | 0.16 (0.07) | 8.00 | | | |
| SABB 2 | 0.21 (0.06) | 14.00 | | | |
| SABB 3 | 2.18 (1.74) | 30.00 | | | |
| **DGBB** | | | | | |
| DGBB 1 | 0.21 (0.10) | 14.00 | | | |
| DGBB 2 | 0.65 (0.24) | 33.67 | | | |
| DGBB 3 | 0.24 (0.07) | 19.33 | 12 | 22.66 | **0.03*** |
| **SRB** | | | | | |
| SRB 1 | 0.60 (0.30) | 29.33 | | | |
| SRB 2 | 0.45 (0.28) | 27.00 | | | |
| SRB 3 | 0.25 (0.09) | 19.00 | | | |
| SRB 4 | 0.15 (0.02) | 8.00 | | | |
| SRB 5 | 0.15 (0.01) | 8.00 | | | |
| **LSR** | 0.33 (0.15) | 23.00 | | | |
| **All Plant** | 0.47 (0.21) | 26.67 | | | |

Kruskal-Wallis test

*significant at $p<0.05$



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## 4.5 Level of Urinary Chromium and Nickel Concentration among Respondents

Based on Figure 4.6, the mean for urinary chromium was 71.71 (28.16)µg/L with the range reading starting from 2.43 µg/L to 129.91 µg/L. The reference value for urinary chromium concentration ranged from 4 µg/L to 30 µg/L. Figure 4.7 shows thaturinary nickel concentration was with a mean of 15.40 (21.32)µg/L with the ranged of 2.43µg/L to 92.45µg/L and reference value for urinary nickel concentration was ranged from 0.032 µg/L to 7.2 µg/L, there was no Biological Exposure Index for nickel.

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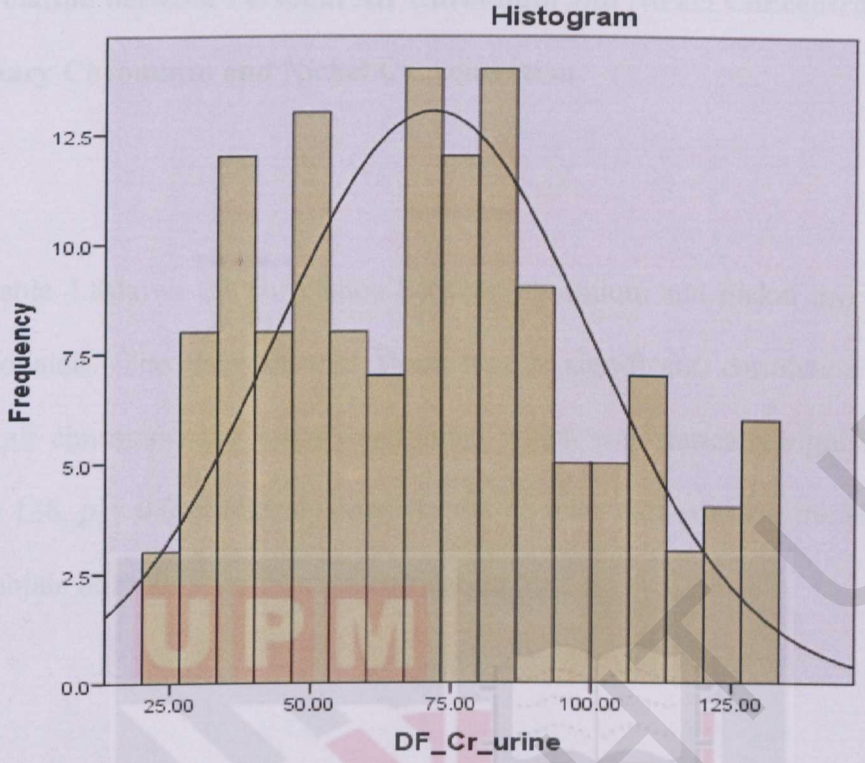


**Figure 4.6: Urinary Chromium Concentration**

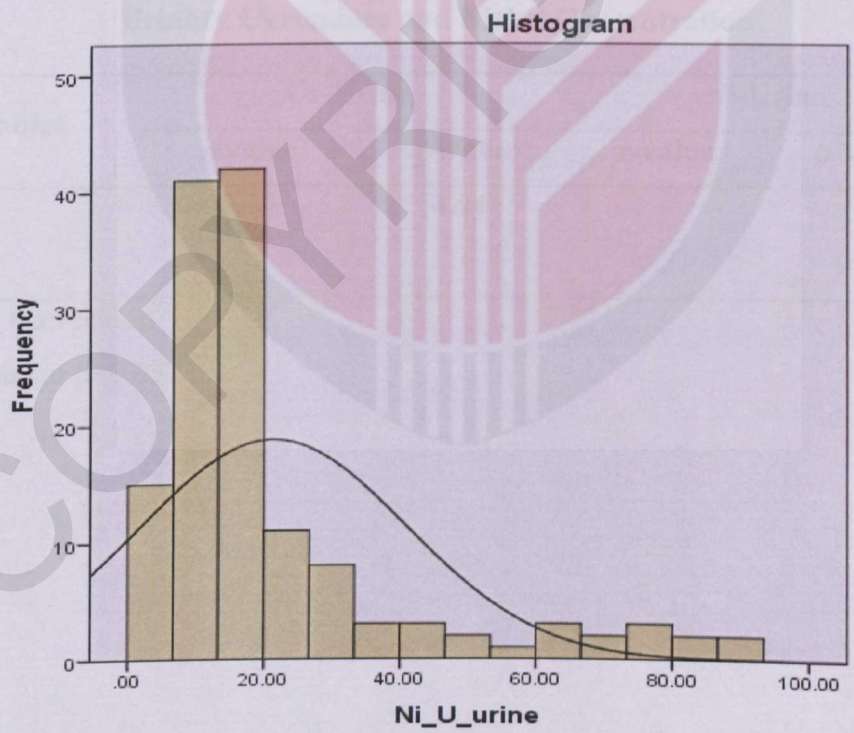


**Figure 4.7: Urinary Nickel Concentration**



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## 4.6 Correlation between Personal Air Chromium and Nickel Concentration and Urinary Chromium and Nickel Concentration

Table 4.8shows the correlation between chromium and nickel level in urine and personalair. The data showed there was a significant correlation between personal air chromium and urinarychromium, which was statically significant ($r = 0.17$, $n = 138$, $p = 0.04$). Nickel concentration in urine data was log transformed in order to obtain normality for Pearson correlation test.

**Table 4.8: Correlation between Personal Air Chromium and Nickel in with Urinary Chromium and Nickel Concentration**

| Variables | Cr-Urine | | Ni-Urine | |
|---|---|---|---|---|
| | r-value | p-value | r-value | p-value |
| **Cr-Air** | 0.17 | **0.04*** | - | - |
| **Ni-Air** | - | - | 0.31 | 0.72 |

Bivariate Correlation

*significant at $p<0.05$

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## 4.7 The Relationship between Selected Variables with Personal Air Chromium and Nickel Concentration.

In Table 4.9, multiple linear regression tests were conducted between selected variables such as chromium concentration in personal air between selected variables such as number of machine for each section, total metalworking fluids used at each section, job section and work duration. These variables statistically significantly predicted chromium in personal air ($p = 0.01$). Only the number of machine had significant relationship with personal air chromium concentration($p < 0.05$). The combination from all variables contributes about 9% of the variation the personal air concentration.

**Table 4.9: Relationship between Selected Variables with Personal Air Chromium Concentration**

| Variables | Coefficients regression $\beta$ | t | *p* | *F* | *p* |
|---|---|---|---|---|---|
| **(Constant)** | | 4.6 | <0.001 | 3.34 | 0.01 |
| **No. Of Machine in Each Section** | 0.41 | 3.30 | **<0.001*** ** | | |
| **Total MWFs Being Used At Each Section** | -0.26 | -1.97 | 0.05 | | |
| **Job Section** | 0.22 | 1.6 | 0.12 | | |
| **Work Duration** | 0.07 | 0.78 | 0.44 | | |

$r^2 = 0.09(r = 0.30)$

***significant at p<0.001



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As for Table 4.10, multiple linear regressions showed no significant relationship between selected variables between the personal air nickel concentration, and it shows that combination from all variables contributed about 3% of the variation of nickel in the air.

**Table 4.10: Relationship between Selected Variables with Personal Air Nickel Concentration**

| Variables | Coefficients regression $\beta$ | t | *p* | *F* | *p* |
|---|---|---|---|---|---|
| **(Constant)** | | 5.17 | <0.01 | 0.92 | 0.46 |
| **No. Of Machine Each Section** | -0.15 | -1.17 | 0.25 | | |
| **Total MWFs Being Used At Each Section** | 0.05 | 0.34 | 0.74 | | |
| **Job Section** | -0.17 | -1.26 | 0.21 | | |
| **Work Duration** | 0.06 | 0.67 | 0.51 | | |

$r^2 = 0.03 (r = 0.16)$,

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### 4.8 The Relationship between Selected Variables with Urinary Chromium and Nickel Concentration

Table 4.11 and Table 4.12 shows the result of multiple linear regression tests between urinary chromium and nickel with selected variables, such as personal air for chromium or nickel, job employment, past job employment, smoking status, work duration and worker's age. In Table 4.11, these variables significantly influenced the urine ($p = 0.54$, $r^2 = 0.04$). Only chromium in personal air was statistically significant to the urinary chromium, $p < 0.05$. The combination from all variables contribute about 4% ($r = 0.19$)of variance on urinary chromium.

**Table 4.11: ReRelationship between Selected Variables with Urinary Chromium Concentration**

| Variables | Coefficients regression $\beta$ | t | *p* | *F* | *p* |
|---|---|---|---|---|---|
| **(Constant)** | | 4.68 | <0.01 | 0.84 | 0.54 |
| **Personal Air Cr** | 0.18 | 2.00 | **0.04*** | | |
| **Job Employment** | -9.01 | -0.04 | 0.97 | | |
| **Past Job Employment** | -0.07 | -0.76 | 0.45 | | |
| **Smoking Status** | -0.04 | -0.50 | 0.62 | | |
| **Work Duration** | -0.06 | -0.64 | 0.52 | | |
| **Worker's Age** | 0.01 | 0.05 | 0.96 | | |

$r^2 = 0.04$ ($r = 0.19$)

*significant at $p<0.05$



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In Table 4.12, the result from multiple linear regressions for urinary nickel concentration with selected variables showed there was no significant relationship occurs between variables. The combination from all variables contribute about 1% (r = 0.09) of variation in urinary nickel.

**Table 4.12: Relationship between Selected Variables with Urinary Nickel Concentration**

| Variables | Coefficients regression $\beta$ | t | *p* | *F* | *p* |
|---|---|---|---|---|---|
| **(Constant)** | | 1.25 | 0.22 | 0.17 | 0.99 |
| **Personal Air Ni** | 0.04 | 0.42 | 0.68 | | |
| **Job Employment** | -0.03 | -0.16 | 0.87 | | |
| **Past Job Employment** | 0.04 | 0.48 | 0.63 | | |
| **Smoking Status** | 0.04 | 0.45 | 0.66 | | |
| **Work Duration** | 0.06 | 0.71 | 0.48 | | |
| **Worker's Age** | 0.04 | 0.26 | 0.80 | | |

$r^2 = 0.01$ ($r = 0.09$)

*significant at $p<0.05$

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# CHAPTER 5

# DISCUSSION, CONCLUSION, RECOMMENDATION

## 5.1 Discussions

### 5.1.1 Socio Demographic Data and Occupational Characteristic

In this study, total of 138 respondents were selected based on the inclusive criteria which was limited only to male respondents, who worked in metalworking fluids environments (Wu. and Liu, 2014). The exclusion criteria were respondents with diabetes and kidney problems (Langard and Costa, 2007).

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The age distribution among respondents who participated ranged from 20 to 57 years old with a mean of 36.22 (28.16). Majority of participant were Malay who made up 101 (73.2%), followed by Indian with a total of 32 (23.2%),and Chinese with a total of 5 (3.6%). The data also showed that the distribution of smoking habits among respondents wereslightly higher than non-smokers with 77 (55.8%) and the smokers with a totalled of 60 (43.5%). As for job designation, almost all respondents were technician while others worked as maintenance worker, engineer and cleaner.

Majority of the respondents in this study were since they were mostly exposed to metalworking fluids when setting the machine most all the time. They were responsible for each job task carried out in the section. The duty for a technician was to operate the machines at early part of their shift according to the setting describe in the job manual, to ensure that every task at each machines accomplish perfectly, inspect any deficiency of the product and conduct daily maintenance and housekeeping of machineries at the end of their shift. As for job designation as maintenance and cleaner, they were also exposed to the heavy metals under the exposure of metalworking fluids setting, but less frequent compared to technician and they works station were different at each time frame. The difference between technician and maintenance workers depends on the degree of impairment of the machines. Maintenance such as removing particulate, cleaning the machines from any chips of metals and removing or changing the metalworking fluids used in every machine were duties of technician. However for maintenance workers, their



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duty were more focus towards heavy maintenance of the machines such as repairing machines, changing for any damage parts of machines, weekly maintenance in maintaining efficiency of machines and resetting of machines. As for the engineers, their works were to test the entire system used in each machines whether it was working properly and to improve any system by redesigning the system used in machines. All the process of building and maintaining a system requires an engineer to spend their time with the machines itself. However, everyday the engineer will conduct site visit to assured every system operate properly. For job designation as a cleaner, most probable exposure occurred when cleaning to remove oil leftover on the floor during the transportation of product on conveyer belt from one machines to another machines.

As for respondents' working information, majority respondents had an experience from 6 months to 5 years (47.1%), The longer the working employment, the higher the bioaccumulation heavy metals in the body. (Rappaport, 1991). Based from respondents' information, the highest data collected was respondents with 8 hours of work duration with a total of 80 (58.0%).

With regard to information of the work section in the factory, the highest number participants were from DGBB 3Section with a number of 22 (15.9%), while the lowest number of participant was from LSR Section. Less participant from LSR



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Section was due to the presence of less machineries in completing the daily jobs at LSR section and the job demand in LSR was lower compare to other section. The LSR Section produced a large size of products which were unsuitable for human to handle it. The total of machines used during metal process was mostly high in SABB 1 and SABB 2 Sections with 10 (11.90%). Different numbers of machines were required in producing different type of products with different work process.

All respondents were controlled their representativeness based on the administrative questionnaire, however, factor such as smoking habits were not controlled due to limited numbers of workers without smoking habits involved in metalworking fluids environments. Exclusion of respondents with smoking habit might reduce the response rate in this study. Previous study proved that there was no significant difference between non-smoker and smoker with the urinary nickel concentration (Kiilunen et. al, 1996). Therefore, smokers were also selected to participate in this study. However, representativeness' of respondents in this study were not controlled by selection of respondents, butthroughthe statistical analysis test. Statistical analysis test, helped to determineeither smoking habits might influence the urinary chromium and nickel concentration.

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### 5.1.2 Level of Chromium and Nickel in Environmental and Personal Air Exposure between Work Sections.

With regards to the result based on Table 4.5 , it can be concluded that the highest reading for chromium in environmental air was measured at DGBB Section with the mean 1.64 (1.07) mg/m$^3$, while the highest reading for nickel was obtained at SABB Section with a mean 0.85 (1.33) mg/m3. As for highest concentration level of chromium in personal air was determined at DGBB Section with a mean of 1.79 (0.54) mg/m$^3$, while nickel concentration in personal air shows a higher result at LSR Section with a mean of 0.74 (0.19%)mg/m$^3$. Based from the descriptive result in Table 4.5, both chromium concentration for environmental and personal air which showed the highest result was from the DGBB section.

Based on Malaysian Standard, Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations 2000, the 8-hour time-weighted average airborne concentration for chromium is 0.05 mg/m$^3$ while for nickel is 0.1 mg/m$^3$ (DOSH, 2000). As mentioned in the Table 4.5, both chromium and nickel level in the environmental and personal air exceeded the limits given by DOSH and none of the concentration in every sections complied with the standard.

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The high concentration level of chromium and nickel in the air was most probably due to the present of both metals in the stainless steel used in the bearing production. From the laboratory test conducted at the factory, the stainless steel used in producing a bearing contained chromium (18%) and nickel (9%) followed by other compound such as carbon, iron, nitrogen, and phosphorus. (Siti Sarah, Personal Communication, March 5, 2014). Therefore, higher concentration of chromium and nickel present in the steel were released into the air during the machining process which caused the air to be contaminated with these metals. Based on Material Safety Data Sheet (MSDS) of each metalworking fluids used together during the job process, there was no evidence of any presence of chromium and nickel in the metalworking fluids. The other influencing factor might due to the factory condition, whereby all the work processes were conducted in enclosed areaswith air condition and ventilation system. Since the job task was performed in closed area, the metals tend to accumulate in the air without any natural ventilation that can disperse the metals in outdoor air. However, in this study location, eventhough ventilation systems installed, they were not sufficient to eliminate chromium and nickel present in the air and thus caused the metals to concentrate in the air of the work environment.

Further test was conducted to determine the significant difference of heavy metals level in air between work sections using one way ANOVA for parametric result and Kruskal-Wallis test for non-parametric result. One way ANOVA was



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conducted for chromium concentration in air since the distribution was normal ($p>0.05$), proved the data is parametric, and the result showed there were significant between work section and chromium in environmental air ($p = 0.04$), but turkey post hoc test showed no significant value for work section with the environmental air chromium. As for nickel concentration in air, Kruskal-Wallis test was used since the distribution was abnormal ($p<0.05$) and concluded the data as non-parametric. The comparison mean test for nickel in air provide a result which showed there was a statistically significant difference of nickel in environmental air between work sections ($p = 0.03$).

The different concentration of air chromium and nickel could be different because of the job process involves for every products and the total number of machines in each section due to different exposure and dispersion of aerosol produced. The concentration of air chromium and nickel also could be affected by the existence of ventilation system. The general ventilation system was used to ventilate the air at the factory; however the additional ventilation system such as fan was found at the SABB Section. The location for each section also plays important part in determining the metal concentration in the air. Based from Figure 4.2, DGBB Section was located near each otherand in a group compared to SRB Section and SABB Section which were located further and not grouped as DGBB Section. The size area in DGBB Section and SABB Section were more compact compare to SRB Section and LSR Section which were more spacious.



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### 5.1.3 Level of Chromium and Nickel in Urine among Respondents

As shown in the result, the mean and standard deviation for both urinary chromium and nickel in respondents' was 31.98 (79.23) µg/L and 21.32 (19.54) µg/L respectively. The minimum concentration measured for chromium in urine was 2.43 µg/L until the highest reading obtained which is 129.91 µg/L. As for nickel, the minimum concentration measured in urine was 2.43 µg/L until 92.45 µg/L.

Based on previous study found that, urinary chromium concentration in occupationally exposed workerswas reported, ranged from 4 µg/L to 30 µg/L, and for urinary nickel concentration, the range was reported from 0.032 µg/Lto 7.2 µg/L (Goulle et. al, 2005). The concentration of chromium and nickel in this study shows that most of the respondents exceeded the range stated Goulle et al (2005). Based on the biological exposure index (BEI) by American Conference of Industrial Hygienists (ACGIH) which stated the limit for urinary chromium was 25 µg/L, however there is no BEI stated for nickel (ACGIH 2012). Eventhough the concentration of metals in urine in this study was compared between BEI and reference value from other studies, they still exceeded the limits which showed that respondents were exposed to the chromium and nickel through their environment since urine concentration usually correlatedwith the chromium and nickel uptake.

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The concentration of urinary chromium and nickel werepossibly affected by the presence of chromium and nickel in the workplace due to inhalation of metals in the air, absorption through the skin and least through ingestion. Since the workplace setting of respondents was in a closed environment, therefore the accumulation of chromium and nickel present in air exceeded the TWA. The major exposure towards chromium and nickel could be from the inhalation route since air provides oxygen and keeps human alive, therefore none can escape from inhaling the air inside the factory where they spend most of their working time inside. As for exposure through skin absorption, respondents were exposed when they did not wear glove or protective equipment when conducting maintenance and housekeeping of the machines. They have contact with the metalworking fluids and machines' part and also when doing quality assurance and checking of product performed by respondents. The very least exposure was through ingestion which were mainly due to accidental ingestion or cross contaminants of heavy metals in foods or poor hygiene practised among respondents.

The main reason workers were exposed to high concentration of chromium and nickel could be because of the lack of awareness among workers regarding the dangerous of chromium and nickel towards human health. Eventhough workers being provided personal protective equipment (PPE) such as mask and glove by the management, the lack of understanding regarding importance of the PPE causes them to expose their body part to the metals. The purpose of the PPE was to prevent



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respondents from being exposed to high concentration of chromium and nickel in the environment, however, since the PPE was not being used, therefore, the chance for exposure towards the metals increased. In this study, majority of them were not using the PPE provided. More than half of the population, 127 (92%) were not using PPE provided by the management. In their daily work, they were not using mask to protect themselves from inhaling contaminants in the air, and while during the daily maintenance conducted at every end of shift, they preferred to use bare hand rather than wearing glove in completing their tasks.

This study was supported by other related study which defined that the level of chromium in urine increased during work hour due to the increasing of airborne chromium aerosols in respondents' work place [Liu et. al, 2012]. As mentioned in results above, the concentration of chromium and nickel in the air was quite high, which then corresponded with high concentration of chromium and nickel in urine.

### 5.1.4 Correlation between Level of Chromium and Nickel in Urine and Personal Air.

Pearson correlation was run to determine the association between chromium and nickel concentration in urine and in personal air. The non-parametric data of



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nickel concentration of urine were log transformed in order to normalize the data for the Pearson correlation test. The results from the correlation test showed that there were only direct statistically significant correlation between chromium in personal air and urinary chromium concentration ($r = 0.17$, $p = 0.04$).

However, as for nickel concentration, there was no significant correlation obtained from the test conducted which is supported by other studies which stated the difficulties in correlating between concentrations of nickel in air with nickel in biological fluids (Stridsklev et. al, 2006). Moreover, the concentration of nickel in the air was low.

The purpose of taking urine was to conduct biological monitoring of exposure and to evaluate the internal dose of chemical recently absorbed with the short half-life of chromium which is approximately 7 hours (Aitio et. al, 1988) or less than 2 days (Paustenbach et. al, 1997), while for nickel the half-life was 20 – 60 hours (Vladimir et. al, 2007). Recognizing the connection between occupational exposures and concentration of substance in urine help in determining the effects to the respondents as the dose-effect relationship could be evaluated.

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Correspond with other study from Taiwan where there is positive correlation between airborne and urine concentration of chromium occurred among all exposed workers towards heavy metals in metalworking fluids setting and stated workers were at risk of occupational chromium exposure (Liu et. al, 2013).

These results showed that chromium and nickel present in environment was not the only source of chromium and nickel in urinary to be increased. This study suggested that other sourced might contribute to the presence of chromium and nickel in the urine. From other study, eventhough urine assessment sometimes showedthe environmental exposure, other factors also such as dietary factors can also influenced the intake [Skarping et. al, 2010] which are not being controlled in this study. The determination of relationship between selected variables towards its concentration in urine was conducted in a multivariate test.

### 5.1.5 The Relationship between Selected Variables with Chromium and Nickel in Personal Air

Statistical test for linear regression was conducted between chromium and nickel concentration in personal air with selected variables such as number of machines in every work sections, total amount of metalworking fluids used for each



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work sections, job sections at the factory itself and work duration in order to predict chromium concentration in personal air between selected variables. Statistic showed significant relationship between chromium in personal air and selected variables ($p = 0.01$, $r^2 = 0.09$). Selected variables such as the number of machines involves in each sections, amount of metalworking fluids being used for each section and also job section only explain 4% of the variation on concentration of chromiumin personal air.

Coefficients regression $\beta$ of number of machines used in each section was 0.49 ($p<0.01$). The data showed increased number of machines ina section were perpendicularly increased with personal air chromium. However in this study, the highest chromium concentration was at DGBB Section, however, the highest total number of machines which was at SABB 1 and SABB 2 Sections with a total of 10 machines. The reason was based on the location of the sections and also the existence of additional ventilation system. In SABB Section, the number of machines was the highest; however the personal air chromium concentration in SABB Section given was not the highest. This may be due to the presence of additional ventilation system installed at the section. As for DGBB Section, the total number of machines was average which was 8 machines in each section, but the personal air chromium concentration was the highest. This happened because the location of DGBB Section was near to other sections, thus, metal tend to accumulated in air between sections.

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Dispersion of metals from nearby machines can also influence the metal concentration in personal air.

As for relationship between personal air nickel concentration with selected variables shows there were no significant relationship occurs, ($p = 0.46$, $r^2 = 0.03$). Meanwhile, the selected variables only explain 3% of the variation on concentration of nickel in personal air.

Currently, there were no studies related to the relationship between numbers of metalworking fluids used and number of machines allocated in every section with the personal air chromium and nickel. However, there was a study regarding contaminants such as biocideswith number of machines involved. It stated in the study thatas the number of machines used increased, the presence of contaminants in the surrounding also increased (Baltzer et. al, 1989).

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### 5.1.6 The Relationship between Selected Variables with Urinary Chromium and Nickel.

The relationship result based from Table 4.11 and 4.12 showed linear regression tests between urinary chromium and nickel concentration with selected variables. A linearregression was conducted between urinary chromium with selected variables such as personal air chromium concentration, age, job employment, previous job history, smoking status and work duration. The statistic showed significant relationship with urinary chromium concentration ($p = 0.54$, $r^2 = 0.04$). All selected variables mentioned above was only contributed about 4% ($r = 0.19$)of variance on urinary chromium concentration.

The results in this study correspond with other studies that stated urinary chromium concentration acted as indicator for occupational exposure since majority of foreign substances in human body were excreted through urinary system (Wu and Liu, 2013). The degree of inhalation, absorption, and ingestion of heavy metals during work duration can be presented through urinary system since urine acted as a medium for recent exposure determination(Chia, 2013).

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The relationship between selected variables with urinary nickel concentration, the result showed no significant relationshipbetweenurinary nickel($p = 0.99$, $r^2 = 0.01$), as all selected variables shows $p>0.05$. The selected variables contribute about 1% of the variation in urinary nickel concentration.

Previous studies reported there was no relation between heavy metal concentrations in urine with the personal information such as age, smoking habits, job employment duration of respondents (Bonde and Christensen, 1991). The result also supported from other study that mentioned no significant influence of gender, age, smoking and alcohol intake with their urinary chromium and nickel concentration, however dietary factors might contributed to the increased in urinary nickel concentration (Kristiansen et. al, 1997). Other factorthat may also affect theurinary chromium concentration was heavy metals bioaccumulation in other organ, tissue or blood in human body and thus, excreted through urine and caused metals concentration in urine increased (Gil et. al, 2011).

## 5.2 Conclusion

There is significant correlation determined during the study between personal air chromium concentrations with the urinary chromium concentration. The study



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also proved there is significant relationship between personal air chromium concentrations with number of machines in each section. A significant relationship determined between the chromium concentrations in urine with the chromium concentrations in personal air. For each work section, the study showed there was significant different of environmental air chromium and nickel concentration between various sections.

## 5.3 Recommendations

### 5.3.1 Recommendation for future studies

There were several recommendations can be done to enhance this type of study in the future. One of the recommendations was to allocate more time for the data collection and laboratory work. Rather than doing cross sectional study, cohort study was much better to determine the effect of the exposure and the outcome of the study since researcher will monitor respondents' performance continuously and information was updated from time to time.

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A comparison between exposed and control group was done in order to determine the difference urinary concentration. The presence of control group can help in proper interpretation of the study result because it acted as a comparator between concentration of exposure to the heavy metals under exposed and unexposed condition (Paustenbach et. al, 1997).

In order to strengthen the study, more related studies from other location were needed to determine the pattern of the heavy metal in metalworking fluids work setting. The result from the studies can help improve the safety and occupational health management system to be more aware about the impact of metalworking fluids reactions.

### 5.3.2 Recommendation for the factory management

Some recommendation can be done by the factory managementto improvetheir safety and health work setting was throughventilation system. Since the result showed the metal concentration was different from each section, local ventilation system can be installed to enhance the ventilation in the factory. The current general ventilation system existed was not sufficient to ventilated the air in the factory since there the metal concentration in air was exceeding the limits.



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Better protection equipment for workers should be provided to improve the quality of health of workers. Rather than providing a surgical mask which is not very effective in protecting workers from inhaled metals in the air, management should provide a respirator with a specific filter to reduce the personal air chromium and nickel concentration. As for route of entry through absorption, management should provide gloves with high resistance of chemical and liquid. The gloves should covers workers' hand and arms, since the current gloves providedwere only covered their hands, but when splashing of the fluids occurred, the uncovered arms of workers were exposed.

By providing personal protective equipment to workers only was not sufficient to reduce the degree of hazard exposure. Management should trained and provided knowledge to workers regarding the personal protective equipment given. Training regarding chemical safety must be given in order to enhanced the awareness among workers regarding the effect and risk possessed by each chemical in their work surrounding.

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# APPENDIX 1

# ETHIC COMMITTEE APPROVAL LETTER

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# APPENDIX 2

# RESPONDENT'S INFORMATION SHEET

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JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

## FORM B1: RESPONDENT'S INFORMATION SHEET AND CONSENT

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

### 1. STUDY TITLE:

Chromium and Nickel Exposure in Personal Air and its Correlation with Urine among Workers in Machining Industry.

### 2. INTRODUCTION:

Workers in machining industry exposed towards varies of contaminants that can lead to health effect, the exposure of metals towards skin is equally important with respiratory. The purpose of this questionnaire is to determine the Chromium, and Nickel exposure level and its correlation with urine level among workers in machining industry.

### 3. WHAT WILL YOU HAVE TO DO?

The respondents are asked to answer the questionnaire to obtain the data information regarding on the study during the face to face interview. 20 minutes will be given to complete the questionnaire. Urine sample will be collected from respondent to determine the concentration of Chromium, and Nickel in urine and all the result will be inform later to the respondents.

### 4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Workers in machining industry who is not exposed to Chromium, and Nickel

### 5. WHAT WILL BE THE BENEFITS OF THE STUDY:

**(a) TO YOU AS THE SUBJECT?**

It will helps the workers to be aware about the health status especially urine level for chromium and nickel when workers exposed to certain hazardous chemical.

**(b) TO THE INVESTIGATOR?**

It will help the investigator to identify the level of Chromium and Nickel level in environmental, personal air and in urine level together when workers perform their daily jobs under exposure of Chromium and Nickel.



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**6. WHAT ARE THE POSSIBLE RISKS?**

There is no risks available in the study.

**7. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?**

The information and identity used in this study will remain confidential.

**8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?**

If you have any additional questions, you may contact to Profesor Zailina bt Hashim, Supervisor of the research at 03-89472396 or Nur Sabrina bt Nasiruddin Lim, the researcher at 013-2035287.

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*Please initial here if you have read and understood the contents of this page*_____

**9. CONSENT**

I ..... Identity Card No. .....

address.....

.....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature .....
(Respondent)

Date :.....

Signature .....
(Witness)

Name :.....

I/C No. :.....

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date .....

Signature .....
(Researcher)

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# APPENDIX 3

# STUDY GANNT CHART

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| Year | 2013 | | | | 2014 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Planning/Month** | **SEPT** | **OCT** | **NOV** | **DEC** | **JAN** | **FEB** | **MAC** | **APR** | **MAY** |
| Propose title for the project | | | | | | | | | |
| Submission of the proposal | | | | | | | | | |
| Proposal Presentation | | | | | | | | | |
| Permission letter to factory | | | | | | | | | |
| Receive Approval letter from the company | | | | | | | | | |
| Pre-tested questionnaire | | | | | | | | | |
| Submission of proposal to Ethical Committee for approval | | | | | | | | | |
| Presentation for Ethical Committee | | | | | | | | | |
| Approval letter from Ethical Committee | | | | | | | | | |
| Visit the factory | | | | | | | | | |
| Get consent from respondents and | | | | | | | | | |
| Data collection | | | | | | | | | |
| Data analysis | | | | | | | | | |
| Thesis writing | | | | | | | | | |
| Submission of thesis | | | | | | | | | |

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# APPENDIX 4

## QUESTIONNAIRE FORM

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**UNIVERSITI PUTRA MALAYSIA**

**FACULTY OF MEDICINE AND HEALTH SCIENCES**

## SECTION A: SOCIO-DEMOGRAFIC INFORMATION

*Instruction: Please fill in the information below and tick ( / ) in a box given.*

1. Name: _____

2. Sex

   ☐ Male ☐ Female

3. Age: _____ years old.

4. Race

| | |
|---|---|
| | Malay |
| | Chinese |
| | Indian |
| | Others |

5. Nationality

   ☐ Malaysian ☐ Foreign

6. Marital status

   ☐ Married ☐ Single

7. Weight ☐ Kg

8. Height ☐ cm

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## Section B: Smoking History

*Instruction: Please fill in the information below and tick ( / ) in a box given.*

1. Do you smoking?

   (At least 1 cigarettes a day or 20 packs per year)

   Yes ☐ No ☐

   **If 'Yes' go to the next question. If 'No', go to Section C.**

2. Do you still smoking last month?

   Yes ☐ No ☐

3. Average: how many cigarettes do you smoke a day?

   ☐☐ Cigarettes

## SECTION C: WORK HISTORY

*Instruction: Please fill in the information below and tick ( / ) in a box given.*

I. Previous Job : _____

II. Job Description : _____

III. Years of Work :

☐ < 6 month
☐ 6 month – 2 year
☐ 2years – 4 years
☐ > 5 years

IV. Work Duration :

☐ < 5 hours
☐ 11 – 15 hours
☐ 6 – 10 hours
☐ >16 hours

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## SECTION D: RECENT WORKING INFORMATION

*Instruction: Please fill in the information below and tick ( / ) in a box given.*

1. Job Description : _____
2. Work Section : _____
3. Years of work

| | | | |
|---|---|---|---|
| ☐ | < 6 month | ☐ | 3 years – 5 years |
| ☐ | 6 month – 3 year | ☐ | > 5 years |

4. Shift work

| | | | |
|---|---|---|---|
| ☐ | Yes | ☐ | No |

5. How long do you working per day?

| | | | |
|---|---|---|---|
| ☐ | < 5 hours | ☐ | 6 – 10 hours |
| ☐ | 11 – 15 hours | ☐ | >16 hours |

6. How many days are you working per week?

☐ day/days

## SECTION E: WORK ENVIRONMENT

*Instruction: Please fill in the information below and tick ( / ) in a box given.*

1. Is your workplace clean?

| | | | |
|---|---|---|---|
| ☐ | Yes | ☐ | No |

2. How many people work at your work section? ☐

3. Does the custodial team do a good job of housekeeping?

| | | | |
|---|---|---|---|
| ☐ | Yes | ☐ | No |

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4. Is your workspace or area:

| | | | |
|---|---|---|---|
| | Too humid | | Excessive moisture |
| | Too hot | | Mold growth |
| | Too dry | | Too cold |

**SECTION F: DISEASE HISTORY**

*Instruction: In this section contain questions about family disease history and any other health problems. Please tick ( / ) in the box given. If you do not remember or not sure, please tick ( / ) in 'No' box.*

1. Is there any of your family members parents or siblings being inform having those disease:

| | | **1. Yes** | **2. No** | **3. Do not Know** |
|---|---|---|---|---|
| i. | Chronic Bronchitis | ☐ | ☐ | ☐ |
| ii. | Emphysema | ☐ | ☐ | ☐ |
| iii. | Asthma | ☐ | ☐ | ☐ |
| iv. | Lung Cancer | ☐ | ☐ | ☐ |
| v. | Cardiovascular Disease | ☐ | ☐ | ☐ |
| vi. | Heart Attack | ☐ | ☐ | ☐ |

2. Do you have history of disease as follow:

☐ Asthma
☐ Bronchitis
☐ Pneumonia
☐ Cardiovascular Disease
☐ Other health problem: _____

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| | Excellent | Good | Poor |
|---|---|---|---|
| 3. What is your present health status? | ☐ | ☐ | ☐ |

4. What health symptoms have you experienced:-

- Dry or sore throat ☐
- Dizziness ☐
- Dry, flaking skin ☐
- Skin irritation ☐
- Itching ☐
- Nausea ☐
- Sinus congestion ☐
- Sneezing ☐
- High stress levels ☐
- Chest tightness ☐
- Eye irritation ☐
- Fainting ☐
- Shortness of breath ☐
- Headache ☐
- Fatigue/drowsiness ☐
- Other (specify) ☐

5. When did the symptoms begin?

☐ < 6 month
☐ 6 month – 1 year
☐ 1years – 3 years
☐ > 3 years

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# APPENDIX 5

# MSDS FOR METALWORKING FLUIDS

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*The Leading Lubricant Specialist*

# SAFETY DATA SHEET

## 1: IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY / UNDERTAKING

Product Name: **Ilocut 603**

Application: Metalworking fluid - Neat

Company: **Castrol (U.K.) Limited**

Address: Burmah Castrol House, Pipers Way, Swindon, Wiltshire, SN3 1RE

Telephone (24 hours): 01793 512712 Fax: 01793 432872

## 2: COMPOSITION/INFORMATION ON INGREDIENTS

Composition: Highly refined mineral oil and additives

All constituents of this product are listed in EINECS (European Inventory of Existing Commercial Chemical Substances) or ELINCS (European List of New Chemical Substances) or are exempt.

Refer to Section 8 for Occupational Exposure Limits.

## 3: HAZARDS IDENTIFICATION

This product is NOT classified as hazardous

## 4: FIRST AID MEASURES

Eyes: Irrigate immediately with copious quantities of water for several minutes

Skin: Wash thoroughly with soap and water or suitable skin cleanser as soon as possible

Inhalation: Remove from exposure

Ingestion: Obtain medical attention. Do NOT induce vomiting.

## 5: FIRE FIGHTING MEASURES

Suitable Extinguishing Media: Carbon dioxide, powder,foam or water fog - Do not use water jets

Special Exposure Hazards: None

Special Protective Equipment: None

## 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions: Spilt product presents a significant slip hazard

Environmental Precautions: Prevent entry into drains, sewers and water courses

Decontamination Procedures: Soak up with inert absorbent or contain and remove by best available means

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## 7: HANDLING AND STORAGE

Handling: To avoid the possibility of skin disorders, repeated or prolonged contact with products of this type must be avoided. It is essential to maintain a high standard of personal hygiene Avoid breathing spray mist.

Storage: No special precautions

## 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits:-

Engineering Control Measures: Local exhaust ventilation is recommended. Mechanical methods to minimise exposure must take precedence over personal protective measures.

Personal Protective Equipment: Safety glasses. Plastic apron. Wear impervious gloves (eg of PVC), in case of repeated or prolonged contact. Change contaminated clothing and clean before re-use.

## 9: PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| Physical State: | Liquid |
| Colour: | Amber |
| Odour: | Mild |
| Kinematic Viscosity @ 40°C (cSt): | 33 |
| Flash Point (opened, °C) | Above 200 |
| Autoignition (°C): | Above 250 |
| Explosive Properties (%): | Not determined |
| Relative Density (at 20°C): | Below 1.0 |
| Water Solubility: | Insoluble |
| Fat Solubility: | Not determined |

## 10: STABILITY AND REACTIVITY

| | |
|---|---|
| Stability: | Stable. Hazardous polymerisation will not occur. |
| Conditions to Avoid: | Temperatures (°C) above 100 |
| Materials to Avoid: | Strong oxidising agents |
| Hazardous Decomposition Products: | None |

## 11: TOXICOLOGICAL INFORMATION

The following toxicological assessment is based on a knowledge of the toxicity of the product's components Expected oral $LD_{50}$, rat > 2g/kg. Expected dermal $LD_{50}$, rabbit > 2g/kg.

### Health Effects

On Eyes: May cause transient irritation

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| | |
|---|---|
| On Skin: | Unlikely to cause harm on brief or occasional contact |
| By Inhalation: | Mist and vapours may cause irritation to nose and respiratory tract |
| By Ingestion: | May cause nausea, vomiting and diarrhoea |
| Chronic: | Repeated and prolonged skin contact may lead to skin disorders |
| Other: | None known |

## 12: ECOLOGICAL INFORMATION

| | |
|---|---|
| Environmental Assessment: | When used and disposed of as intended, no adverse environmental effects are foreseen |
| Mobility: | Involatile. Mobile liquid. Insoluble in water. |
| Persistence and Degradability: | Inherently biodegradable |
| Bioaccumulative Potential: | Bioaccumulative based on logP values of constituents |
| Ecotoxicity: | Not determined |

## 13: DISPOSAL CONSIDERATIONS

Disposal must be in accordance with local and national legislation.

| | |
|---|---|
| Unused Product: | May be sent for reclamation<br>Dispose of through an authorised waste contractor to a licensed site |
| Used/Contaminated Product: | As for Unused Product<br>For further information see Section 16 |
| Packaging: | Must be disposed of through an authorised waste contractor<br>May be steam cleaned and recycled |

## 14: TRANSPORT INFORMATION

This product is NOT classified as dangerous for transport

## 15: REGULATORY INFORMATION

**Hazard Label Data:-**

This product is NOT classified as dangerous for supply in the UK

| | |
|---|---|
| EC Directives: | Waste Oil Directive, 87/101/EEC<br>Framework Waste Directive, 91/156/EEC |
| Statutory Instruments: | Health & Safety at Work, etc. Act 1974<br>Consumer Protection Act 1987<br>Environmental Protection Act 1990 |
| Codes of Practice: | Waste Management. The Duty of Care |
| Guidance Notes: | Occupational skin diseases: health and safety precautions (EH 26)<br>Occupational exposure limits (EH 40)<br>Carcinogenicity of mineral oils (EH 58)<br>Metalworking fluids - health precautions (EH 62)<br>Skin cancer caused by oil [MS(B)5]<br>Save your skin! - Occupational Contact Dermatitis [MS(B)6]<br>Dermatitis - cautionary notice [SHW 367]<br>Effects of mineral oil on the skin [SHW 397] |

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The above publications are available from HMSO or HSE

## 16: OTHER INFORMATION

Castrol publication: Talking About Health and Safety - Lubricants and Allied Products
Castrol Advice Sheet: The Disposal of Used Metalworking Fluids
Castrol publication: Talking about Cutting Fluids

The data and advice given apply when the product is sold for the stated application or applications. The product is not sold as suitable for any other application. Use of the product for applications other than as stated in this sheet may give rise to risks not mentioned in this sheet. You should not use the product other than for the stated application or applications without seeking advice from us.

If you have purchased the product for supply to a third party for use at work, it is your duty to take all necessary steps to secure that any person handling or using the product is provided with the information in this sheet.

If you are an employer, it is your duty to tell your employees and others who may be affected of any hazards described in this sheet and of any precautions which should be taken.

Further copies of this Safety Data Sheet may be obtained from Castrol (U.K.) Limited.

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# Material Safety Data Sheet

## 1. Chemical product and company identification

| | |
|---|---|
| Product name | CASTROL HYSPIN AW 68 |
| MSDS# | 12017-AE |
| Code | 12017-AE |
| Product use | Lubricant |
| Manufacturer | CASTROL INDUSTRIAL NORTH AMERICA INC.<br>1001 WEST 31ST STREET<br>DOWNERS GROVE, IL 60515-1280<br>TEL.: 1 - 630-241-4000 (USA) |
| Supplier | CASTROL INDUSTRIAL NORTH AMERICA INC.<br>1001 West 31St Street<br>Downers Grove, IL 60515-1280<br>U.S.A.<br>1 (630) 241-4000 (USA) |
| EMERGENCY SPILL INFORMATION: | 1 (800) 424-9300 CHEMTREC (USA) |

## 2. Composition/information on ingredients

| Ingredient name | CAS # | % by weight | Exposure limits |
|---|---|---|---|
| Distillates (petroleum), solvent-refined heavy paraffinic | 64741-88-4 | 95-100 | **ACGIH (United States).**<br>TWA: 5 mg/m³ 8 hour(s). Form: Mist<br>STEL: 10 mg/m³ 15 minute(s). Form: Mist<br>**OSHA (United States).**<br>TWA: 5 mg/m³ 8 hour(s). Form: Mist |

## 3. Hazards identification

| | |
|---|---|
| Physical state | Liquid. |
| Color | Clear. Yellow. Color |
| Emergency overview | CAUTION!<br><br>MAY CAUSE EYE IRRITATION.<br>MAY CAUSE SKIN IRRITATION.<br>MAY CAUSE RESPIRATORY TRACT IRRITATION.<br><br>Avoid prolonged or repeated contact with skin. Keep container closed. Wash thoroughly afte handling. Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis Use with adequate ventilation. In accordance with good industrial hygiene and safety wor practices, airborne exposures should be controlled to the lowest extent practicable. |
| Routes of entry | Dermal contact. Eye contact. Inhalation. Ingestion. |
| Potential Health Effects | |
| Eyes | May cause eye irritation. |

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| | |
|---|---|
| **Skin** | May cause skin irritation. Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis. |
| **Inhalation** | May cause respiratory tract irritation. |
| **Ingestion** | Ingestion may cause gastrointestinal irritation and diarrhea. |
| **Medical conditions aggravated by overexposure:** | None identified. |

**See toxicological Information (section 11)**

## 4. First aid measures

| | |
|---|---|
| **Eye Contact** | In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Ge medical attention if irritation develops. |
| **Skin Contact** | Immediately wash exposed skin with soap and water. Remove contaminated clothing and shoes Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention irritation develops. |
| **Inhalation** | If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficul give oxygen. Get medical attention. |
| **Ingestion** | Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything b mouth to an unconscious person. Get medical attention if symptoms appear. |

## 5. Fire-fighting measures

| | |
|---|---|
| **Flammability of the product** | May be combustible at high temperature. |
| **Flash point** | 226 °C (Open cup) Cleveland. |
| **Products of combustion** | These products are carbon oxides (CO, $CO_2$). |
| **Unusual fire/explosion hazards** | This material is not explosive as defined by established regulatory criteria.<br><br>Non-explosive in presence of open flames, sparks and static discharge, of shocks, of heat, c oxidizing materials. |
| **Fire fighting media and instructions** | In case of fire, use water fog, foam, dry chemicals, or carbon dioxide. |
| **Protective clothing (fire)** | Fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and fu turnout gear. |

## 6. Accidental release measures

| | |
|---|---|
| **Personal Precautions** | Immediately contact emergency personnel. Keep unnecessary personnel away. Use suitabl protective equipment (Section 8). Follow all fire fighting procedures (Section 5). |
| **Environmental precautions and clean-up methods** | If emergency personnel are unavailable, contain spilled material. For small spills ad absorbent (soil may be used in the absence of other suitable materials) scoop up material an place in a sealed, liquid-proof container for disposal. For large spills dike spilled material c otherwise contain material to ensure runoff does not reach a waterway. Place spilled materia in an appropriate container for disposal. Minimize contact of spilled material with soils t prevent runoff to surface waterways. See Section 13 for Waste Disposal Information. |
| **Personal protection in case of a large spill** | Splash goggles. Full suit. Boots. Gloves. Suggested protective clothing might not b sufficient; consult a specialist BEFORE handling this product. |



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## 7. Handling and storage

**Handling** Avoid prolonged or repeated contact with skin. Avoid contact with eyes. Use only with adequat ventilation. Wash thoroughly after handling. In accordance with good industrial hygiene an safety work practices, airborne exposures should be controlled to the lowest extent practicable.

**Storage** Keep container tightly closed. Keep container in a cool, well-ventilated area. Empty container may contain harmful, flammable/combustible or explosive residue or vapors. Do not cut, grinc drill, weld, reuse or dispose of containers unless adequate precautions are taken against thes hazards.

## 8. Exposure controls/personal protection

**Occupational exposure limits**

| Ingredient name | Occupational exposure limits |
|---|---|
| Distillates (petroleum), solvent-refined heavy paraffinic | **ACGIH (United States).**<br>TWA: 5 mg/m³ 8 hour(s). Form: Mist<br>STEL: 10 mg/m³ 15 minute(s). Form: Mist<br>**OSHA (United States).**<br>TWA: 5 mg/m³ 8 hour(s). Form: Mist |

**Control Measures** Provide exhaust ventilation or other engineering controls to keep the airborne concentrations c vapors below their respective occupational exposure limits.

**Hygiene measures** Wash hands after handling compounds and before eating, smoking, using lavatory, and at th end of day.

**Personal protection**

| | |
|---|---|
| **Eyes** | Avoid contact with eyes. Safety glasses with side shield or chemical goggles. |
| **Skin and Body** | Avoid prolonged or repeated contact with skin. Wear suitable protective clothing. |
| **Respiratory** | Use only with adequate ventilation. |
| **Hands** | Wear suitable gloves. |

**Consult local authorities for acceptable exposure limits.**

## 9. Physical and chemical properties

| | |
|---|---|
| **Physical state** | Liquid. |
| **pH** | Not applicable |
| **Odor** | Oily Odor (Slight.) |
| **Color** | Clear. Yellow. Color |
| **Specific Gravity** | 0.89 |
| **Density** | 890 kg/m³ (0.89 g/cm³) at 15.6°C |
| **Solubility** | Insoluble in cold water, hot water. |



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| | |
|---|---|
| **Viscosity** | Kinematic: 61.2 to 74.8 $mm^2/s$ (61.2 to 74.8 cSt) at 40°C |

## 10. Stability and reactivity

| | |
|---|---|
| **Stability and Reactivity** | The product is stable. |
| **Conditions to avoid** | None known. |
| **Incompatibility with various substances** | Reactive with oxidizing agents. |
| **Hazardous Decomposition Products** | Carbon Dioxide ($CO_2$). nitrogen oxides (NO, $NO_2$...) |
| **Hazardous polymerization** | Will not occur. |

## 11. Toxicological information

**Chronic toxicity**

| | |
|---|---|
| **Carcinogenic effects** | No component of this product at levels greater than 0.1% is identified as a carcinogen by ACGIH or the International Agency for Research on Cancer (IARC). No component of this product present at levels greater than 0.1% is identified as a carcinogen by the U.S. National Toxicology Program (NTP) or the U.S. Occupational Safety and Health Act (OSHA). |
| **Mutagenic effects** | No component of this product at levels greater than 0.1% is classified by established regulatory criteria as a mutagen. |
| **Reproductive effects** | No component of this product at levels greater than 0.1% is classified by established regulatory criteria as a reproductive toxin. |
| **Teratogenic effects** | No component of this product at levels greater than 0.1% is classified by established regulatory criteria as teratogenic or embryotoxic. |

## 12. Ecological information

| | |
|---|---|
| **Ecotoxicity** | No testing has been performed by the manufacturer. |

## 13. Disposal considerations

| | |
|---|---|
| **Waste information** | Waste must be disposed of in accordance with federal, state and local environmental control regulations. |
| **RCRA Waste Code(s)** | USED OIL |

**Consult your local or regional authorities.**

## 14. Transport information

**International transport regulations**

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| Regulatory Information | UN number | Proper shipping name | Class | Packing group | Label | Additional information |
|---|---|---|---|---|---|---|
| DOT Classification | Not regulated. | Not available. | Not available. | Not available. | | Not available. |
| TDG Classification | Not regulated. | ----- | ----- | Not available. | | Not available. |
| IMDG Classification | Not available. | Not available. | Not available. | Not available. | | Not available. |
| IATA Classification | Not available. | Not available. | Not available. | Not available. | | Not available. |

## 15. Regulatory information

**U.S. Federal regulations**

US INVENTORY (TSCA): In compliance.

This product is not regulated under Section 302 of SARA and 40 CFR Part 355.

**SARA 313**

**Form R - Reporting requirements**

This product does not contain any hazardous ingredients at or above regulated thresholds.

**Supplier notification**

This product does not contain any hazardous ingredients at or above regulated thresholds.

CERCLA Sections 102a/103 Hazardous Substances (40 CFR Part 302.4):: This material is not regulated under CERCLA Sections 103 and 107.

**State regulations**

No products were found.

California Prop 65: WARNING! This product contains trace amounts of the following chemicals which the State of California has found to cause cancer, birth defects or other reproductive harm. Ethyl acrylate; Ethylene oxide; Dioxane

**Inventories**

AUSTRALIAN INVENTORY (AICS): In compliance.

CANADA INVENTORY (DSL): In compliance.

CHINA INVENTORY (IECS): Not determined.

EC INVENTORY (EINECS/ELINCS): In compliance.

JAPAN INVENTORY (ENCS): Not determined.

KOREA INVENTORY (ECL): In compliance.

PHILIPPINE INVENTORY (PICCS): In compliance.

## 16. Other information

**Label Requirements**

CAUTION!

MAY CAUSE EYE IRRITATION.
MAY CAUSE SKIN IRRITATION.
MAY CAUSE RESPIRATORY TRACT IRRITATION.

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| | | | |
|---|---|---|---|
| **HMIS® Rating :** | **Health** | **1** | **National Fire Protection Association (U.S.A.)** |
| | **Flammability** | **1** | |
| | **Physical Hazard** | **0** | |
| | **Personal protection** | **B** | |

**Other special considerations**

PETROLEUM OIL: STEL = 10 mg/M3. Using terminology of the International Agency for Research on Cancer (IARC), the petroleum distillates listed in Section II are classified by the supplier as severely processed. Not all those listed in Section II may be present. The supplier has stated that these distillates do not require a carcinogen label as defined by OSHA 29 CFR 1910.1200. No component known to be present in this product at >0.1% is presently listed as a carcinogen by IARC, NTP or OSHA.

**History**

**Date of issue** 03/03/2004.

**Date of previous issue** No Previous Validation.

**Prepared by** Product Stewardship

**Notice to reader**

*NOTICE : This Material Safety Data Sheet is based upon data considered to be accurate at the time of its preparation. Despite our efforts, it may not be up to date or applicable to the circumstances of any particular case. We are not responsible for any damage or injury resulting from abnormal use, from any failure to follow appropriate practices or from hazards inherent in the nature of the product.*

*This Material Safety Data Sheet conforms to the requirements of ANSI Z400.1.*

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# SAFETY DATA SHEET

## SECTION 1: Identification of the substance/mixture and of the company/undertaking

### 1.1 Product identifier

| | |
|---|---|
| **Product name** | Solvent D 100 |
| **Product code** | 463151-DE03 |
| **SDS no.** | 463151 |
| **EC number** | 265-149-8 |
| **CAS number** | 64742-47-8 |
| **Product type** | Liquid. |

### 1.2 Relevant identified uses of the substance or mixture and uses advised against

| | |
|---|---|
| **Use of the substance/mixture** | Hydrocarbon solvent. Neat Oil.<br>For specific application advice see appropriate Technical Data Sheet or consult our company representative. |

### 1.3 Details of the supplier of the safety data sheet

| | |
|---|---|
| **Supplier** | Nordic Lubricants AB<br>Castrol Industrial Lubricants and Services<br>Box 49104<br>S-100 28 Stockholm<br>Sweden<br><br>Tel.: +46 (0)8-441 11 00<br>Fax.: +46 (0)8-651 01 35 |
| **E-mail address** | MSDSadvice@bp.com |

### 1.4 Emergency telephone number

| | |
|---|---|
| **EMERGENCY TELEPHONE NUMBER** | Carechem: +44 (0) 208 762 8322 (24 hours) |

## SECTION 2: Hazards identification

### 2.1 Classification of the substance or mixture

**Product definition** Mono-constituent substance

**Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]**

Asp. Tox. 1, H304

**Classification according to Directive 67/548/EEC [DSD]**

Xn; R65
R66

See Section 16 for the full text of the R phrases or H statements declared above.

See sections 11 and 12 for more detailed information on health effects and symptoms and environmental hazards.

### 2.2 Label elements

**Hazard pictograms**

| | |
|---|---|
| **Signal word** | Danger |
| **Hazard statements** | May be fatal if swallowed and enters airways. |

**Precautionary statements**

| | |
|---|---|
| **Prevention** | Not applicable. |
| **Response** | IF SWALLOWED: Immediately call a POISON CENTER or physician. Do NOT induce vomiting. |
| **Storage** | Store locked up. |
| **Disposal** | Not applicable. |
| **Supplemental label elements** | Repeated exposure may cause skin dryness or cracking. |

**Special packaging requirements**

| | |
|---|---|
| **Containers to be fitted with child-resistant fastenings** | Not applicable. |
| **Tactile warning of danger** | Not applicable. |

### 2.3 Other hazards

| | |
|---|---|
| **Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII** | No. |

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## SECTION 2: Hazards identification

| | |
|---|---|
| **Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII** | No. |
| **Other hazards which do not result in classification** | Prolonged or repeated contact may dry skin and cause irritation. |

## SECTION 3: Composition/information on ingredients

**Substance/mixture** Mono-constituent substance

Hydrocarbon solvent

| Product/ingredient name | Identifiers | % | Classification 67/548/EEC | Classification Regulation (EC) No. 1272/2008 [CLP] | Type |
|---|---|---|---|---|---|
| Kerosine - unspecified | EC: 265-149-8<br>CAS: 64742-47-8 | 100 | Xn; R65<br>R66 | Asp. Tox. 1, H304 | [A] |

**See section 16 for the full text of the R-phrases declared above**

**See Section 16 for the full text of the H statements declared above.**

Type

[A] Constituent
[B] Impurity
[C] Stabilising additive

Occupational exposure limits, if available, are listed in Section 8.

## SECTION 4: First aid measures

### 4.1 Description of first aid measures

| | |
|---|---|
| **Eye contact** | In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Check for and remove any contact lenses. Get medical attention. |
| **Skin contact** | Wash skin thoroughly with soap and water or use recognised skin cleanser. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention if irritation develops. |
| **Inhalation** | If inhaled, remove to fresh air. Get medical attention if symptoms appear. |
| **Ingestion** | Do not induce vomiting. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Aspiration hazard if swallowed. Can enter lungs and cause damage. Get medical attention immediately. |
| **Protection of first-aiders** | No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. |

### 4.2 Most important symptoms and effects, both acute and delayed

See Section 11 for more detailed information on health effects and symptoms.

### 4.3 Indication of any immediate medical attention and special treatment needed

| | |
|---|---|
| **Notes to physician** | Treatment should in general be symptomatic and directed to relieving any effects.<br>Product can be aspirated on swallowing or following regurgitation of stomach contents, and can cause severe and potentially fatal chemical pneumonitis, which will require urgent treatment.<br>Because of the risk of aspiration, induction of vomiting and gastric lavage should be avoided.<br>Gastric lavage should be undertaken only after endotracheal intubation. Monitor for cardiac dysrhythmias. |

## SECTION 5: Firefighting measures

### 5.1 Extinguishing media

| | |
|---|---|
| **Suitable extinguishing media** | In case of fire, use foam, dry chemical or carbon dioxide extinguisher or spray. |
| **Unsuitable extinguishing media** | Do not use water jet. |

### 5.2 Special hazards arising from the substance or mixture

| | |
|---|---|
| **Hazards from the substance or mixture** | In a fire or if heated, a pressure increase will occur and the container may burst. |
| **Hazardous combustion products** | Combustion products may include the following:<br>carbon oxides (CO, $CO_2$) (carbon monoxide, carbon dioxide) |

### 5.3 Advice for firefighters

| | |
|---|---|
| **Special precautions for fire-fighters** | Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. |
| **Special protective equipment for fire-fighters** | Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents. |
| **Additional information** | Not considered to be a product presenting a risk of explosion. Vapours may form explosive mixtures with air. |



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## SECTION 6: Accidental release measures

**6.1 Personal precautions, protective equipment and emergency procedures**

| | |
|---|---|
| **For non-emergency personnel** | No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Floors may be slippery; use care to avoid falling. Avoid breathing vapour or mist. Provide adequate ventilation. Put on appropriate personal protective equipment. Contact emergency personnel. |
| **For emergency responders** | Entry into a confined space or poorly ventilated area contaminated with vapour, mist or fume is extremely hazardous without the correct respiratory protective equipment and a safe system of work. Wear self-contained breathing apparatus. Wear a suitable chemical protective suit. Chemical resistant boots. See also the information in "For non-emergency personnel". |
| **6.2 Environmental precautions** | Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). |

**6.3 Methods and materials for containment and cleaning up**

| | |
|---|---|
| **Small spill** | Stop leak if without risk. Move containers from spill area. Absorb with an inert material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor. |
| **Large spill** | Stop leak if without risk. Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations. Contaminated absorbent material may pose the same hazard as the spilt product. Dispose of via a licensed waste disposal contractor. |
| **6.4 Reference to other sections** | See Section 1 for emergency contact information.<br>See Section 5 for firefighting measures.<br>See Section 8 for information on appropriate personal protective equipment.<br>See Section 12 for environmental precautions.<br>See Section 13 for additional waste treatment information. |

## SECTION 7: Handling and storage

**7.1 Precautions for safe handling**

| | |
|---|---|
| **Protective measures** | Put on appropriate personal protective equipment (see Section 8). Do not swallow. Aspiration hazard Can enter lungs and cause damage. Never siphon by mouth. Avoid contact with eyes, skin and clothing. Avoid breathing vapour or mist. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Do not reuse container. Empty containers retain product residue and can be hazardous. |
| **Advice on general occupational hygiene** | Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Wash thoroughly after handling. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures. |
| **7.2 Conditions for safe storage, including any incompatibilities** | Do not store above the following temperature: 50°C (122°F). Store in accordance with local regulations. Store in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Store locked up. Keep container tightly closed and sealed until ready for use. Store and use only in equipment/containers designed for use with this product. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Keep away from heat and direct sunlight. |

**7.3 Specific end use(s)**

| | |
|---|---|
| **Recommendations** | See section 1.2 and Exposure scenarios in annex, if applicable. |

## SECTION 8: Exposure controls/personal protection

**8.1 Control parameters**

Occupational exposure limits

| Product/ingredient name | Exposure limit values |
|---|---|
| Kerosine - unspecified | **AFS (Sweden).**<br>KTV: 500 mg/m³ 15 minute(s). Form: decanes and other aliphatic hydrocarbons<br>NGV: 350 mg/m³ 8 hour(s). Form: decanes and other aliphatic hydrocarbons |
| **ACGIH TLVs** | |
| Kerosine - unspecified | **ACGIH TLV (United States). Absorbed through skin.**<br>TWA: 200 mg/m³ 8 hour(s). Issued/Revised: 1/2003 |

For information and guidance, the ACGIH values are included. For further information on these please consult your supplier.

Whilst specific OELs for certain components may be shown in this section, other components may be present in any mist, vapour or dust produced. Therefore, the specific OELs may not be applicable to the product as a whole and are provided for guidance only.

| | |
|---|---|
| **Recommended monitoring procedures** | If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to European Standard EN 689 for methods for the assessment of exposure by inhalation to chemical agents and national guidance documents for methods for the determination of hazardous substances. |

Derived No Effect Level

No DELs available.

Predicted No Effect Concentration



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## SECTION 8: Exposure controls/personal protection

No PNEC available.

### 8.2 Exposure controls

**Appropriate engineering controls**

Provide exhaust ventilation or other engineering controls to keep the relevant airborne concentrations below their respective occupational exposure limits.
All activities involving chemicals should be assessed for their risks to health, to ensure exposures are adequately controlled. Personal protective equipment should only be considered after other forms of control measures (e.g. engineering controls) have been suitably evaluated. Personal protective equipment should conform to appropriate standards, be suitable for use, be kept in good condition and properly maintained.
Your supplier of personal protective equipment should be consulted for advice on selection and appropriate standards. For further information contact your national organisation for standards.
The final choice of protective equipment will depend upon a risk assessment. It is important to ensure that all items of personal protective equipment are compatible.

**Individual protection measures**

**Hygiene measures**

Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Ensure that eyewash stations and safety showers are close to the workstation location.

**Respiratory protection**

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary.
The correct choice of respiratory protection depends upon the chemicals being handled, the conditions of work and use, and the condition of the respiratory equipment. Safety procedures should be developed for each intended application. Respiratory protection equipment should therefore be chosen in consultation with the supplier/manufacturer and with a full assessment of the working conditions.

**Eye/face protection**

Safety glasses with side shields.

**Skin protection**

**Hand protection**

Wear suitable gloves. The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Gloves should therefore be chosen in consultation with the supplier/manufacturer and with a full assessment of the working conditions.

**Skin and body**

Use of protective clothing is good industrial practice.
Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
Cotton or polyester/cotton overalls will only provide protection against light superficial contamination that will not soak through to the skin. Overalls should be laundered on a regular basis. When the risk of skin exposure is high (e.g. when cleaning up spillages or if there is a risk of splashing) then chemical resistant aprons and/or impervious chemical suits and boots will be required.

**Environmental exposure controls**

Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

## SECTION 9: Physical and chemical properties

### 9.1 Information on basic physical and chemical properties

**Appearance**

| | |
|---|---|
| **Physical state** | Liquid. |
| **Colour** | Colourless. |
| **Odour** | Hydrocarbon. |
| **Odour threshold** | Not available. |
| **pH** | Not available. |
| **Melting point/freezing point** | Not available. |
| **Initial boiling point and boiling range** | 230°C (446°F) |
| **Flash point** | Closed cup: >101°C (>213.8°F) [Pensky-Martens.] |
| **Evaporation rate** | Not available. |
| **Flammability (solid, gas)** | Not available. |
| **Upper/lower flammability or explosive limits** | Lower: 0.6%<br>Upper: 7% |
| **Vapour pressure** | <0.01 kPa (<0.075 mm Hg) at 20°C |
| **Vapour density** | Not available. |
| **Relative density** | Not available. |
| **Density** | <1000 kg/m$^3$ (<1 g/cm$^3$) at 20°C |
| **Solubility(ies)** | insoluble in water. |
| **Partition coefficient: n-octanol/water** | Not available. |
| **Auto-ignition temperature** | >230°C (>446°F) |
| **Decomposition temperature** | Not available. |
| **Viscosity** | Kinematic: <3 mm$^2$/s (<3 cSt) at 40°C<br>Kinematic: 3.5 mm$^2$/s (3.5 cSt) at 20°C |



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## SECTION 9: Physical and chemical properties

| | |
|---|---|
| **Explosive properties** | Not considered to be a product presenting a risk of explosion. Vapours may form explosive mixtures with air. |
| **Oxidising properties** | Not available. |

**9.2 Other information**

No additional information.

## SECTION 10: Stability and reactivity

| | |
|---|---|
| **10.1 Reactivity** | No specific test data available for this product. Refer to Conditions to avoid and Incompatible materials for additional information. |
| **10.2 Chemical stability** | The product is stable. |
| **10.3 Possibility of hazardous reactions** | Under normal conditions of storage and use, hazardous reactions will not occur.<br>Under normal conditions of storage and use, hazardous polymerisation will not occur. |
| **10.4 Conditions to avoid** | High temperatures |
| **10.5 Incompatible materials** | Reactive or incompatible with the following materials: oxidising materials. |
| **10.6 Hazardous decomposition products** | Under normal conditions of storage and use, hazardous decomposition products should not be produced. |

## SECTION 11: Toxicological information

**11.1 Information on toxicological effects**

Aspiration hazard

| Product/ingredient name | Result |
|---|---|
| Kerosine - unspecified | ASPIRATION HAZARD - Category 1 |

| | |
|---|---|
| **Conclusion/Summary** | May be fatal if swallowed and enters airways. Classification on basis substance is a hydrocarbon and has a kinematic viscosity of 20.5 mm2/s or less, measured at 40°C. |

Specific target organ toxicity

| | |
|---|---|
| **Information on the likely routes of exposure** | Routes of entry anticipated:Oral, Dermal, Inhalation. |

Potential acute health effects

| | |
|---|---|
| **Inhalation** | Vapour inhalation under ambient conditions is not normally a problem due to low vapour pressure. |
| **Ingestion** | Aspiration hazard if swallowed – harmful or fatal if liquid is aspirated into lungs. |
| **Skin contact** | No known significant effects or critical hazards. |
| **Eye contact** | No known significant effects or critical hazards. |

Symptoms related to the physical, chemical and toxicological characteristics

| | |
|---|---|
| **Inhalation** | No specific data. |
| **Ingestion** | Adverse symptoms may include the following:<br>nausea or vomiting |
| **Skin contact** | Adverse symptoms may include the following:<br>irritation<br>dryness<br>cracking |
| **Eye contact** | No specific data. |

Delayed and immediate effects and also chronic effects from short and long term exposure

| | |
|---|---|
| **Inhalation** | Overexposure to the inhalation of airborne droplets or aerosols may cause irritation of the respiratory tract. |
| **Ingestion** | Ingestion of large quantities may cause nausea and diarrhea. |
| **Skin contact** | Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis. |
| **Eye contact** | Potential risk of transient stinging or redness if accidental eye contact occurs. |

Potential chronic health effects

| | |
|---|---|
| **General** | Prolonged or repeated contact can defat the skin and lead to irritation, cracking and/or dermatitis. |
| **Carcinogenicity** | No known significant effects or critical hazards. |
| **Mutagenicity** | No known significant effects or critical hazards. |
| **Developmental effects** | No known significant effects or critical hazards. |
| **Fertility effects** | No known significant effects or critical hazards. |

## SECTION 12: Ecological information

**12.1 Toxicity**

| | |
|---|---|
| **Environmental hazards** | Not classified as dangerous |

**12.2 Persistence and degradability**

Inherently biodegradable

**12.3 Bioaccumulative potential**

This product may bioaccumulate through food chains in the environment.



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## SECTION 12: Ecological information

**12.4 Mobility in soil**

| | |
|---|---|
| **Soil/water partition coefficient ($K_{OC}$)** | Not available. |
| **Mobility** | Non-volatile. Liquid. insoluble in water. |

**12.5 Results of PBT and vPvB assessment**

| | |
|---|---|
| **PBT** | No. |
| **vPvB** | No. |

**12.6 Other adverse effects** No known significant effects or critical hazards.

## SECTION 13: Disposal considerations

**13.1 Waste treatment methods**

Product

**Methods of disposal** The generation of waste should be avoided or minimised wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

**Hazardous waste** Yes.

European waste catalogue (EWC)

| Waste code | Waste designation |
|---|---|
| 13 08 99* | wastes not otherwise specified |

However, deviation from the intended use and/or the presence of any potential contaminants may require an alternative waste disposal code to be assigned by the end user.

Packaging

**Methods of disposal** Where possible, arrange for product to be recycled. Dispose of via an authorised person/ licensed waste disposal contractor in accordance with local regulations.

| Type of packaging | European waste catalogue (EWC) | |
|---|---|---|
| Steel drum | 15 01 10* | packaging containing residues of or contaminated by dangerous substances |

**Special precautions** This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Empty containers represent a fire hazard as they may contain flammable product residues and vapour. Never weld, solder or braze empty containers. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

**Methods of disposal** The regulations regarding manufacturers' responsibility for packaging material waste is regulated in "Förordningen om producentansvar för förpackningar". Packaging materials are to be reused or recycled in accordance with the goals outlined in this regulation. The company complies with this manufacturer's responsibility through its association with REPA, which is a subsidiary company of four materials handling companies. The materials handling companies collect, remove and process used and sorted packaging materials through the employment of contractors. Questions regarding collection of packaging materials on a local basis may be directed to the materials company and its contractors. For further information, contact REPA, www.repa.se.

## SECTION 14: Transport information

| | ADR/RID | ADN/ADNR | IMDG | IATA |
|---|---|---|---|---|
| **14.1 UN number** | Not regulated. | Not regulated. | Not regulated. | Not regulated. |
| **14.2 UN proper shipping name** | - | - | - | - |
| **14.3 Transport hazard class(es)** | - | - | - | - |
| **14.4 Packing group** | - | - | - | - |
| **14.5 Environmental hazards** | No. | No. | No. | No. |
| **14.6 Special precautions for user** | Not available. | Not available. | Not available. | Not available. |
| **Additional information** | - | - | - | - |



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## SECTION 15: Regulatory information

**15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture**

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Substances of very high concern

None of the components are listed.

| | |
|---|---|
| **Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles** | Not applicable. |

Other regulations

| | |
|---|---|
| **United States inventory (TSCA 8b)** | All components are listed or exempted. |
| **Australia inventory (AICS)** | All components are listed or exempted. |
| **Canada inventory** | All components are listed or exempted. |
| **China inventory (IECSC)** | All components are listed or exempted. |
| **Japan inventory (ENCS)** | All components are listed or exempted. |
| **Korea inventory (KECI)** | All components are listed or exempted. |
| **Philippines inventory (PICCS)** | All components are listed or exempted. |

| | |
|---|---|
| **15.2 Chemical Safety Assessment** | This product contains substances for which Chemical Safety Assessments are still required. |

## SECTION 16: Other information

**Abbreviations and acronyms**

ADN/ADNR = European Provisions concerning the International Carriage of Dangerous Goods by Inland Waterway
ADR = The European Agreement concerning the International Carriage of Dangerous Goods by Road
ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
CAS = Chemical Abstracts Service
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
CSA = Chemical Safety Assessment
CSR = Chemical Safety Report
DMEL = Derived Minimal Effect Level
DNEL = Derived No Effect Level
DPD = Dangerous Preparations Directive [1999/45/EC]
DSD = Dangerous Substances Directive [67/548/EEC]
EINECS = European Inventory of Existing Commercial chemical Substances
ES = Exposure Scenario
EUH statement = CLP-specific Hazard statement
EWC = European Waste Catalogue
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
OECD = Organisation for Economic Co-operation and Development
PBT = Persistent, Bioaccumulative and Toxic
PNEC = Predicted No Effect Concentration
RID = The Regulations concerning the International Carriage of Dangerous Goods by Rail
RRN = REACH Registration Number
SADT = Self-Accelerating Decomposition Temperature
SVHC = Substances of Very High Concern
STOT-RE = Specific Target Organ Toxicity - Repeated Exposure
STOT-SE = Specific Target Organ Toxicity - Single Exposure
UN = United Nations
UVCB = Complex hydrocarbon substance
VOC = Volatile Organic Compound
vPvB = Very Persistent and Very Bioaccumulative

| | | |
|---|---|---|
| **Full text of abbreviated H statements** | H304 | May be fatal if swallowed and enters airways. |
| **Full text of classifications [CLP/GHS]** | Asp. Tox. 1, H304 | ASPIRATION HAZARD - Category 1 |

| | |
|---|---|
| **Full text of abbreviated R phrases** | R65- Harmful: may cause lung damage if swallowed.<br>R66- Repeated exposure may cause skin dryness or cracking. |
| **Full text of classifications [DSD/DPD]** | Xn - Harmful |

History

| | |
|---|---|
| **Date of issue/ Date of revision** | 12/11/2010. |
| **Date of previous issue** | No previous validation. |
| **Prepared by** | Product Stewardship |

**Indicates information that has changed from previously issued version.**

Notice to reader



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## SECTION 16: Other information

All reasonably practicable steps have been taken to ensure this data sheet and the health, safety and environmental information contained in it is accurate as of the date specified below. No warranty or representation, express or implied is made as to the accuracy or completeness of the data and information in this data sheet.

The data and advice given apply when the product is sold for the stated application or applications. You should not use the product other than for the stated application or applications without seeking advice from us.

It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. The BP Group shall not be responsible for any damage or injury resulting from use, other than the stated product use of the material, from any failure to adhere to recommendations, or from any hazards inherent in the nature of the material. Purchasers of the product for supply to a third party for use at work, have a duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet. Employers have a duty to tell employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken.

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# Material Safety Data Sheet

## 1. Product and company identification

| | |
|---|---|
| **Product name** | Hysol X |
| **MSDS #** | 450877 |
| **Historic MSDS #:** | 01006-AE |
| **Code** | 450877-US03 |
| **Product use** | Lubricant |
| **Manufacturer** | Castrol Industrial North America, Inc.<br>150 W. Warrenville Road<br>Naperville, IL 60563 |
| **Supplier** | Castrol Industrial North America, Inc.<br>150 W. Warrenville Road<br>Naperville, IL 60563<br>Product Information: 1-800-621-2661 |
| **EMERGENCY SPILL INFORMATION:** | 1 (800) 424-9300 CHEMTREC (USA) |

## 2. Hazards identification

| | |
|---|---|
| **Physical state** | Liquid. |
| **Color** | Yellow. |
| **Emergency overview** | WARNING!<br><br>CAUSES EYE AND SKIN IRRITATION.<br>MAY CAUSE ALLERGIC SKIN REACTION.<br>MAY CAUSE RESPIRATORY TRACT IRRITATION.<br>HARMFUL IF SWALLOWED.<br><br>Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis. Do not breathe vapor or mist. Do not ingest. Do not get on skin or clothing. Avoid contact with eyes. Use only with adequate ventilation. Keep container tightly closed and sealed until ready for use. Wash thoroughly after handling. Harmful if swallowed. |
| **Routes of entry** | Dermal contact. Eye contact. Inhalation. Ingestion. |
| **Potential health effects** | |
| **Eyes** | Causes eye irritation. |
| **Skin** | Causes skin irritation. May cause allergic skin reaction. Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis. |
| **Inhalation** | May cause respiratory tract irritation. |
| **Ingestion** | Harmful if swallowed. Ingestion may cause gastrointestinal irritation and diarrhea. |

**See toxicological information (section 11)**

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## 3. Composition/information on ingredients

| Ingredient name | CAS # | % |
|---|---|---|
| Base oil - highly refined | 64742-52-5 &/or 64742-53-6 | 40 - 45 |
| Alkanolamine PEG alkyl ether phosphate salt | Not available. | 5 - 10 |
| Boric acid | 10043-35-3 | 1 - 5 |
| 2,2',2"-(hexahydro-1,3,5-triazine-1,3,5-triyl)triethanol | 4719-04-4 | 1 - 5 |
| Sodium sulfonate | 68608-26-4 | 1 - 5 |
| Base oil - highly refined Mixture. | 64741-88-4 &/or 64742-54-7 &/or 64741-96-4 &/or 64742-52-5 | 1 - 5 |

## 4. First aid measures

**Eye contact**

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

**Skin contact**

Immediately wash exposed skin with soap and water. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. In the event of any complaints or symptoms, avoid further exposure. Get medical attention.

**Inhalation**

If inhaled, remove to fresh air. Get medical attention if symptoms occur.

**Ingestion**

Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If potentially dangerous quantities of this material have been swallowed, call a physician immediately. Get medical attention.

## 5. Fire-fighting measures

**Flash point**

Water content interferes with flash point determination.

**Fire/explosion hazards**

In a fire or if heated, a pressure increase will occur and the container may burst.

**Unusual fire/explosion hazards**

Non-explosive in the presence of the following materials or conditions: open flames, sparks and static discharge, heat, shocks and mechanical impacts and oxidizing materials.

**Extinguishing media**

**Suitable**

Use an extinguishing agent suitable for the surrounding fire.

**Not suitable**

Do not use water jet.

**Fire-fighting procedures**

Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

**Hazardous combustion products**

Combustion products may include the following:
metal oxide/oxides
carbon oxides (CO, $CO_2$) (carbon monoxide, carbon dioxide)
sulfur oxides ($SO_2$, $SO_3$ etc.)
nitrogen oxides (NO, $NO_2$ etc.)

**Protective clothing (fire)**

Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

## 6. Accidental release measures

**Personal precautions**

No action shall be taken involving any personal risk or without suitable training. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. In accordance with good industrial hygiene and safety work practices, airborne exposures should be controlled to the lowest extent practicable. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see section 8).

**Environmental precautions**

Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).



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**Methods for cleaning up**

**Large spill**

Stop leak if without risk. Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see section 1 for emergency contact information and section 13 for waste disposal.

**Small spill**

Stop leak if without risk. Move containers from spill area. Dilute with water and mop up if water-soluble or absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

## 7. Handling and storage

**Handling**

Put on appropriate personal protective equipment (see section 8). Workers should wash hands and face before eating, drinking and smoking. Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Do not get in eyes or on skin or clothing. Do not breathe vapor or mist. Do not ingest. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate.

**Storage**

Store in accordance with local regulations. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see section 10). Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

**Other information**

DO NOT ADD NITRITES TO THIS FLUID.

## 8. Exposure controls/personal protection

**Occupational exposure limits**

| Ingredient name | Occupational exposure limits |
|---|---|
| Base oil - highly refined | **ACGIH (United States).**<br>STEL: 10 mg/m³ 15 minute(s). Form: Oil mist, mineral<br>TWA: 5 mg/m³ 8 hour(s). Form: Oil mist, mineral<br>**OSHA (United States).**<br>TWA: 5 mg/m³ 8 hour(s). Form: Oil mist, mineral |
| Boric acid | **ACGIH TLV (United States, 1/2007).**<br>STEL: 6 mg/m³ 15 minute(s).<br>TWA: 2 mg/m³ 8 hour(s). |
| Base oil - highly refined Mixture. | **OSHA (United States).**<br>TWA: 5 mg/m³ 8 hour(s). Form: Mist<br>**ACGIH (United States).**<br>TWA: 5 mg/m³ 8 hour(s). Form: Mist<br>STEL: 10 mg/m³ 15 minute(s). Form: Mist |

While specific OELs for certain components may be shown in this section, other components may be present in any mist, vapor or dust produced. Therefore, the specific OELs may not be applicable to the product as a whole and are provided for guidance only.

**Some states may enforce more stringent exposure limits.**

**Control Measures**

Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

**Hygiene measures**

Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing.

**Personal protection**

**Eyes**

Avoid contact with eyes. Safety glasses with side shields or chemical goggles.

**Skin and body**

Do not get on skin or clothing. Wear suitable protective clothing.



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| | |
|---|---|
| **Respiratory** | Use adequate ventilation. In accordance with good industrial hygiene and safety work practices, airborne exposures should be controlled to the lowest extent practicable. |
| **Hands** | The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Gloves should therefore be chosen in consultation with the supplier/manufacturer and with a full assessment of the working conditions. |

## 9. Physical and chemical properties

| | |
|---|---|
| **Physical state** | Liquid. |
| **Color** | Yellow. |
| **Flash point** | Water content interferes with flash point determination. |
| **Specific gravity** | 0.97 to 0.99 |
| **Volatility** | 10% (v/v) |
| **Evaporation rate** | <1 (Butyl acetate. = 1) |
| **VOC** | 218.75 g/l |
| **Solubility** | Soluble in water. |

## 10. Stability and reactivity

| | |
|---|---|
| **Stability and reactivity** | The product is stable. |
| **Conditions to avoid** | Not available. |
| **Incompatibility with various substances** | Reactive or incompatible with the following materials: oxidizing materials. |
| **Hazardous decomposition products** | Under normal conditions of storage and use, hazardous decomposition products should not be produced. |
| **Hazardous polymerization** | Under normal conditions of storage and use, hazardous polymerization will not occur. |

## 11. Toxicological information

**Other information**

Alkanolamine: This product contains an alkanolamine. In all metalworking fluids containing amines, there is a potential for forming nitrosamines which are animal carcinogens. Therefore, no nitrites or related nitrosating agents should be added to such compositions.

Reproduction/Developmental: Animal ingestion studies in several species, at high doses, indicate that boric acid and certain inorganic borates can cause reproductive and developmental effects. A human study of occupational exposure to borate dust showed no adverse effect on reproduction.

Target organs: No target organ has been identified in humans. High Dose animal ingestion studies indicate the testes are the target organ in male animals.

These industrial products are not intended for ingestion.

This product contains a preservative that may release trace amounts of formaldehyde during use.

This product contains a preservative that may release trace amounts of formaldehyde during use. Employers are required under 29 CFR 1910.1048, Formaldehyde, to determine if formaldehyde levels exceed 0.1 ppm in the workplace. Employers may be required to provide employee information and training regarding the hazards of formaldehyde, unless the employer can show, using objective data, that the employees are not exposed to formaldehyde at or above 0.1 ppm. This regulation also requires routine monitoring if exposure levels exceed OSHA's action level of 0.5 ppm. Employers should consult OSHA's Formaldehyde Standard for additional information. ACGIH STEL=0.3 ppm.

**Potential chronic health effects**

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| | |
|---|---|
| **Carcinogenicity** | No known significant effects or critical hazards. |
| **Reproductive effects** | See Other Information |
| **Medical conditions aggravated by over-exposure** | Pre-existing skin disorders may be aggravated by over-exposure to this product. |

## 12. Ecological information

No testing has been performed by the manufacturer.

## 13. Disposal considerations

**Waste information**

The generation of waste should be avoided or minimized wherever possible. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe way. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

**NOTE: The generator of waste has the responsibility for proper waste identification (based on characteristic(s) or listing), transportation and disposal**

## 14. Transport information

Not classified as hazardous for transport (DOT, TDG, IMO/IMDG, IATA/ICAO)

## 15. Regulatory information

**U.S. Federal regulations**

**United States inventory (TSCA 8b):** All components are listed or exempted.

**SARA 302/304/311/312 extremely hazardous substances**: No products were found.
**SARA 302/304 emergency planning and notification**: No products were found.
**SARA 302/304/311/312 hazardous chemicals**: Boric acid
**SARA 311/312 MSDS distribution - chemical inventory - hazard identification**: Hysol X: Immediate (acute) health hazard, Delayed (chronic) health hazard

**SARA 313**

| | |
|---|---|
| **Form R - Reporting requirements** | This product does not contain any hazardous ingredients at or above regulated thresholds. |
| **Supplier notification** | This product does not contain any hazardous ingredients at or above regulated thresholds. |
| **CERCLA Sections 102a/103 Hazardous Substances (40 CFR Part 302.4):** | CERCLA: Hazardous substances.: sodium dodecylbenzene sulfonate: 1000 lbs. (454 kg); Formaldehyde.: 100 lbs. (45.4 kg); 1,4-dioxane: 100 lbs. (45.4 kg); Ethylene oxide: 10 lbs. (4.54 kg); |

**State regulations**

| | |
|---|---|
| **Massachusetts Substances** | **Massachusetts Substances**: None of the components are listed. |
| **New Jersey Hazardous Substances** | **New Jersey Hazardous Substances**: None of the components are listed. |
| **Pennsylvania RTK Hazardous Substances** | **Pennsylvania RTK Hazardous Substances**: None of the components are listed. |

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| | |
|---|---|
| **California Prop. 65** | **WARNING:** This product contains a chemical known to the State of California to cause cancer. 1,4-dioxane; Formaldehyde.<br><br>**WARNING:** This product contains a chemical known to the State of California to cause cancer and birth defects or other reproductive harm.<br>Ethylene oxide |
| **Inventories** | **Canada inventory:** All components are listed or exempted.<br><br>**Europe inventory:** All components are listed or exempted.<br><br>**Australia inventory (AICS):** All components are listed or exempted.<br><br>**China inventory (IECSC):** All components are listed or exempted.<br><br>**Japan inventory (ENCS):** Not determined.<br><br>**Korea inventory (KECI):** All components are listed or exempted.<br><br>**Philippines inventory (PICCS):** All components are listed or exempted. |

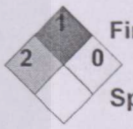
## 16. Other information

| | |
|---|---|
| **Label requirements** | WARNING!<br><br>CAUSES EYE AND SKIN IRRITATION.<br>MAY CAUSE ALLERGIC SKIN REACTION.<br>MAY CAUSE RESPIRATORY TRACT IRRITATION.<br>HARMFUL IF SWALLOWED. |

**HMIS® Rating :**

| | | |
|---|---|---|
| **Health** | * | 1 |
| **Flammability** | | 1 |
| **Physical Hazard** | | 0 |
| **Personal protection** | | B |

**National Fire Protection Association (U.S.A.)**




| | |
|---|---|
| **History** | |
| **Date of issue** | 02/06/2008. |
| **Date of previous issue** | 10/02/2007. |
| **Prepared by** | Product Stewardship |

**Notice to reader**

*All reasonably practicable steps have been taken to ensure this data sheet and the health, safety and environmental information contained in it is accurate as of the date specified below. No warranty or representation, express or implied is made as to the accuracy or completeness of the data and information in this data sheet.*

*The data and advice given apply when the product is sold for the stated application or applications. You should not use the product other than for the stated application or applications without seeking advice from us.*

*It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. The BP Group shall not be responsible for any damage or injury resulting from use, other than the stated product use of the material, from any failure to adhere to recommendations, or from any hazards inherent in the nature of the material. Purchasers of the product for supply to a third party for use at work, have a duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet. Employers have a duty to tell employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken.*

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## Section 1. Identification

| | |
|---|---|
| **GHS product identifier** | Rustilo DWX 88 IV |
| **Product code** | 465017-TH04 |
| **SDS no.** | 465017 |

**Relevant identified uses of the substance or mixture and uses advised against**

| | |
|---|---|
| **Use of the substance/ mixture** | Rust preventive / Water displacement fluid<br>For specific application advice see appropriate Technical Data Sheet or consult our company representative. |
| **Manufacturer** | |
| **Supplier** | BP-Castrol (Thailand) Limited<br>Samut Sakon Industrial Estate, 39/77-78 Moo 2 Rama II Road,<br>Bangkachao Amphur Muang, Samut Sakorn 74000<br>Tel. +66 34 419666, Fax. +66 34 419666 |
| **EMERGENCY TELEPHONE NUMBER** | Carechem: 001800 1 2066 6751 (tollfree, access from Thailand only) |
| **OTHER PRODUCT INFORMATION** | Please contact at Technical Service Section<br>Tel no.+662-684-3430 |

## Section 2. Hazards identification

**GHS Classification**

FLAMMABLE LIQUIDS - Category 3
SKIN CORROSION/IRRITATION - Category 3
ASPIRATION HAZARD - Category 1

**GHS label elements**

**Hazard pictograms**

**Signal word**

Danger

**Hazard statements**

H226 - Flammable liquid and vapour.
H316 - Causes mild skin irritation.
H304 - May be fatal if swallowed and enters airways.

**Precautionary statements**

**Prevention**

P280 - Wear protective gloves. Wear eye or face protection.
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P241 - Use explosion-proof electrical, ventilating, lighting and all material-handling equipment.
P242 - Use only non-sparking tools.
P243 - Take precautionary measures against static discharge.
P233 - Keep container tightly closed.

**Response**

P301 + P310 + P331 - IF SWALLOWED: Immediately call a POISON CENTER or physician. Do NOT induce vomiting.
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower.
P332 + P313 - If skin irritation occurs: Get medical attention.

**Storage**

P405 - Store locked up.
P403 - Store in a well-ventilated place.
P235 - Keep cool.

**Disposal**

P501 - Dispose of contents and container in accordance with all local, regional, national and international regulations.

**Other hazards which do not result in classification**

Defatting to the skin.

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## Section 3. Composition/information on ingredients

**Substance/mixture** Mixture

Hydrocarbon solvent, film forming corrosion preventives and additives

| Ingredient name | % | CAS number |
|---|---|---|
| Low boiling point hydrogen treated naphtha | 50-100 | 64742-48-9 |
| Base oil - unspecified | 10-20 | Varies |
| 2-Butoxyethanol | 1-5 | 111-76-2 |

**There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.**

**Occupational exposure limits, if available, are listed in Section 8.**

## Section 4. First-aid measures

**Description of necessary first aid measures**

**Inhalation** If inhaled, remove to fresh air. Get medical attention if symptoms occur.

**Ingestion** Do not induce vomiting. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Aspiration hazard if swallowed. Can enter lungs and cause damage. Get medical attention immediately.

**Skin contact** In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash skin thoroughly with soap and water or use recognised skin cleanser. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention if symptoms occur.

**Eye contact** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Check for and remove any contact lenses. Get medical attention.

**Most important symptoms/effects, acute and delayed**

See Section 11 for more detailed information on health effects and symptoms.

**Indication of immediate medical attention and special treatment needed, if necessary**

**Specific treatments** No specific treatment.

**Notes to physician** Treatment should in general be symptomatic and directed to relieving any effects. Product can be aspirated on swallowing or following regurgitation of stomach contents, and can cause severe and potentially fatal chemical pneumonitis, which will require urgent treatment. Because of the risk of aspiration, induction of vomiting and gastric lavage should be avoided. Gastric lavage should be undertaken only after endotracheal intubation. Monitor for cardiac dysrhythmias.

**Protection of first-aiders** No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

## Section 5. Fire-fighting measures

**Extinguishing media**

**Suitable extinguishing media** Use dry chemical, $CO_2$, water spray (fog) or foam.

**Unsuitable extinguishing media** Do not use water jet.

**Specific hazards arising from the chemical** Flammable liquid and vapour. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. Runoff to sewer may create fire or explosion hazard.

**Hazardous thermal decomposition products** Combustion products may include the following:
carbon dioxide
carbon monoxide
metal oxide/oxides

**Special protective actions for fire-fighters** Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

**Special protective equipment for fire-fighters** Fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear. Fire-fighters' protective clothing will only provide limited protection.



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## Section 6. Accidental release measures

**Personal precautions, protective equipment and emergency procedures**

| | |
|---|---|
| **For non-emergency personnel** | Immediately contact emergency personnel. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. No flares, smoking or flames in hazard area. Avoid breathing vapour or mist. Provide adequate ventilation. Put on appropriate personal protective equipment. Floors may be slippery; use care to avoid falling. Eliminate all ignition sources. |
| **For emergency responders** | Entry into a confined space or poorly ventilated area contaminated with vapour, mist or fume is extremely hazardous without the correct respiratory protective equipment and a safe system of work. Wear self-contained breathing apparatus. Wear a suitable chemical protective suit. Chemical resistant boots. See also the information in "For non-emergency personnel". |
| **Environmental precautions** | Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). |

**Methods and materials for containment and cleaning up**

| | |
|---|---|
| **Small spill** | Stop leak if without risk. Move containers from spill area. Absorb with an inert material and place in an appropriate waste disposal container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor. The method and equipment used must be in conformance with appropriate regulations and industry practice on explosive atmospheres. |
| **Large spill** | Stop leak if without risk. Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations. Use spark-proof tools and explosion-proof equipment. Contaminated absorbent material may pose the same hazard as the spilt product. The method and equipment used must be in conformance with appropriate regulations and industry practice on explosive atmospheres. Dispose of via a licensed waste disposal contractor. |

## Section 7. Handling and storage

**Precautions for safe handling**

| | |
|---|---|
| **Protective measures** | Put on appropriate personal protective equipment (see Section 8). Avoid breathing vapour or mist. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity during transfer by earthing and bonding containers and equipment before transferring material. Avoid contact with eyes, skin and clothing. Empty containers retain product residue and can be hazardous. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Do not reuse container. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Do not swallow. Aspiration hazard if swallowed. Can enter lungs and cause damage. Never siphon by mouth. Avoid prolonged or repeated contact with skin. During metal working, solid particles from workpieces or tools will contaminate the fluid and may cause abrasions of the skin. Where such abrasions result in a penetration of the skin, first aid treatment should be applied as soon as reasonably possible. The presence of certain metals in the workpiece or tool, such as chromium, cobalt and nickel, can contaminate the metalworking fluid and as a result may induce allergic skin reactions. Keep away from ignition sources such as heat/sparks/open flame. - No smoking. Concentrations of mist, fumes and vapours in enclosed spaces may result in the formation of explosive atmospheres. Excessive splashing, agitation or heating must be avoided. |
| **Advice on general occupational hygiene** | Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Wash thoroughly after handling. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures. |

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## Section 7. Handling and storage

**Conditions for safe storage, including any incompatibilities**

Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Eliminate all ignition sources. Separate from oxidising materials. Keep container tightly closed and sealed until ready for use. Store and use only in equipment/containers designed for use with this product. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination.

## Section 8. Exposure controls/personal protection

**Control parameters**

**Occupational exposure limits**

| Ingredient name | Exposure limits |
|---|---|
| Low boiling point hydrogen treated naphtha | **ACGIH TLV (United States).** TWA: 300 ppm |
| Base oil - unspecified | **ACGIH TLV (United States).** TWA: 5 mg/m³ 8 hours. Issued/Revised: 11/2009 Form: Inhalable fraction |
| 2-Butoxyethanol | **ACGIH TLV (United States).** TWA: 20 ppm 8 hours. Issued/Revised: 1/2003 |

**Appropriate engineering controls**

All activities involving chemicals should be assessed for their risks to health, to ensure exposures are adequately controlled. Personal protective equipment should only be considered after other forms of control measures (e.g. engineering controls) have been suitably evaluated. Personal protective equipment should conform to appropriate standards, be suitable for use, be kept in good condition and properly maintained.
Your supplier of personal protective equipment should be consulted for advice on selection and appropriate standards. For further information contact your national organisation for standards.
Provide exhaust ventilation or other engineering controls to keep the relevant airborne concentrations below their respective occupational exposure limits.
The final choice of protective equipment will depend upon a risk assessment. It is important to ensure that all items of personal protective equipment are compatible.

**Environmental exposure controls**

Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

**Eye protection**

Safety glasses with side shields.

**Skin protection**

**Hand protection**

Wear chemical resistant gloves. Recommended: Nitrile gloves. The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Gloves should therefore be chosen in consultation with the supplier/manufacturer and with a full assessment of the working conditions.

**Skin protection**

Use of protective clothing is good industrial practice. Wear clothing and footwear that cannot be penetrated by chemicals or oil. Cotton or polyester/cotton overalls will only provide protection against light superficial contamination that will not soak through to the skin. Overalls should be laundered on a regular basis. When the risk of skin exposure is high (e.g. when cleaning up spillages or if there is a risk of splashing) then chemical resistant aprons and/or impervious chemical suits and boots will be required. Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

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## Section 8. Exposure controls/personal protection

| | |
|---|---|
| **Respiratory protection** | Use with adequate ventilation.<br>In case of insufficient ventilation, wear suitable respiratory equipment.<br>Recommended: half-face mask - organic vapor filter (Type A).<br>The correct choice of respiratory protection depends upon the chemicals being handled, the conditions of work and use, and the condition of the respiratory equipment. Safety procedures should be developed for each intended application. Respiratory protection equipment should therefore be chosen in consultation with the supplier/manufacturer and with a full assessment of the working conditions. |

## Section 9. Physical and chemical properties

**Appearance**

| | |
|---|---|
| **Physical state** | Liquid. |
| **Colour** | Clear Brown. [Light] |
| **Odour** | Solvent. |
| **Odour threshold** | Not available. |
| **pH** | Not available. |
| **Melting point** | Not available. |
| **Boiling point** | Not available. |
| **Drop Point** | Not available. |
| **Flash point** | Closed cup: 60°C (140°F) [Pensky-Martens.] |
| **Evaporation rate** | Not available. |
| **Flammability (solid, gas)** | Not applicable. Based on - Physical state |
| **Lower and upper explosive (flammable) limits** | Not available. |
| **Vapour pressure** | Not available. |
| **Vapour density** | Not available. |
| **Relative density** | Not available. |
| **Density** | <1000 kg/m³ (<1 g/cm³) at 30°C |
| **Solubility** | insoluble in water. |
| **Partition coefficient: n-octanol/water** | Not available. |
| **Auto-ignition temperature** | Not available. |
| **Decomposition temperature** | Not available. |
| **Viscosity** | Kinematic: <2 mm²/s (<2 cSt) at 40°C |

## Section 10. Stability and reactivity

| | |
|---|---|
| **Reactivity** | No specific test data available for this product. Refer to Conditions to avoid and Incompatible materials for additional information. |
| **Chemical stability** | The product is stable. |
| **Possibility of hazardous reactions** | Under normal conditions of storage and use, hazardous reactions will not occur.<br>Under normal conditions of storage and use, hazardous polymerisation will not occur. |
| **Conditions to avoid** | Avoid all possible sources of ignition (spark or flame). Avoid excessive heat. Do not pressurise, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. |
| **Incompatible materials** | Reactive or incompatible with the following materials: oxidising materials. |
| **Hazardous decomposition products** | Under normal conditions of storage and use, hazardous decomposition products should not be produced. |

## Section 11. Toxicological information

**Information on toxicological effects**

**Aspiration hazard**

| Name | Result |
|---|---|
| Low boiling point hydrogen treated naphtha | ASPIRATION HAZARD - Category 1 |

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## Section 11. Toxicological information

**Information on the likely routes of exposure** Routes of entry anticipated: Dermal, Inhalation.

**Potential acute health effects**

**Eye contact** Causes eye irritation.

**Inhalation** Vapour inhalation under ambient conditions is not normally a problem due to low vapour pressure.

**Skin contact** Causes mild skin irritation. Defatting to the skin.

**Ingestion** Irritating to mouth, throat and stomach. Aspiration hazard if swallowed -- harmful or fatal if liquid is aspirated into lungs. Ingestion of large quantities may cause nausea and diarrhoea.

**Symptoms related to the physical, chemical and toxicological characteristics**

**Eye contact** Adverse symptoms may include the following:
pain or irritation
watering
redness

**Inhalation** Exposure to high concentrations can cause dizziness, lightheadedness, headache, nausea and blurred vision. Higher levels may cause unconsciousness.
May be harmful by inhalation if exposure to vapour, mists or fumes resulting from thermal decomposition products occurs.

**Skin contact** Adverse symptoms may include the following:
irritation
redness
dryness
cracking

**Ingestion** Adverse symptoms may include the following:
nausea or vomiting

**Delayed and immediate effects and also chronic effects from short and long term exposure**

**Inhalation** Overexposure to the inhalation of airborne droplets or aerosols may cause irritation of the respiratory tract.

**Potential chronic health effects**

**General** No known significant effects or critical hazards.

**Carcinogenicity** No known significant effects or critical hazards.

**Mutagenicity** No known significant effects or critical hazards.

**Teratogenicity** No known significant effects or critical hazards.

**Developmental effects** No known significant effects or critical hazards.

**Fertility effects** No known significant effects or critical hazards.

**Numerical measures of toxicity**

**Acute toxicity estimates**

| Route | ATE value |
|---|---|
| Oral | 16666.7 mg/kg |
| Dermal | 36666.7 mg/kg |
| Inhalation (vapours) | 366.7 mg/l |

## Section 12. Ecological information

**Environmental effects** No known significant effects or critical hazards.

**Persistence and degradability**

Expected to be biodegradable.

**Bioaccumulative potential**

Not available.

**Mobility** Volatile. Liquid. insoluble in water.

**Other adverse effects** No known significant effects or critical hazards.

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## Section 13. Disposal considerations

**Disposal methods**

The generation of waste should be avoided or minimised wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

## Section 14. Transport information

| | IMDG | IATA |
|---|---|---|
| **UN number** | UN1993 | UN1993 |
| **UN proper shipping name** | FLAMMABLE LIQUID, N.O.S. (Low boiling point hydrogen treated naphtha) | FLAMMABLE LIQUID, N.O.S. (Low boiling point hydrogen treated naphtha) |
| **Transport hazard class(es)** | 3 | 3 |
| **Packing group** | III | III |
| **Environmental hazards** | No. | No. |
| **Additional information** | Emergency schedules (EmS)<br>F-E, S-E | - |

**Special precautions for user** Not available.

**Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code** Not available.

## Section 15. Regulatory information

**Regulation according to other foreign laws**

**Australia inventory (AICS)** At least one component is not listed.

**Canada inventory status** At least one component is not listed.

**China inventory (IECSC)** At least one component is not listed.

**REACH Status** For the REACH status of this product please consult your company contact, as identified in Section 1.

**Japan inventory (ENCS)** At least one component is not listed.

**Korea inventory (KECI)** At least one component is not listed.

**Philippines inventory (PICCS)** Not determined.

**United States inventory (TSCA 8b)** At least one component is not listed.

**Thailand - Harmful Chemicals List I** Listed

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## Section 16. Other information

**History**

| | |
|---|---|
| **Date of issue/Date of revision** | 05/02/2014. |
| **Date of previous issue** | 17/07/2013. |
| **Prepared by** | Product Stewardship |
| **References** | Not available. |

**Indicates information that has changed from previously issued version.**

**Notice to reader**

All reasonably practicable steps have been taken to ensure this data sheet and the health, safety and environmental information contained in it is accurate as of the date specified below. No warranty or representation, express or implied is made as to the accuracy or completeness of the data and information in this data sheet.

The data and advice given apply when the product is sold for the stated application or applications. You should not use the product other than for the stated application or applications without seeking advice from BP Group.

It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. The BP Group shall not be responsible for any damage or injury resulting from use, other than the stated product use of the material, from any failure to adhere to recommendations, or from any hazards inherent in the nature of the material. Purchasers of the product for supply to a third party for use at work, have a duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet. Employers have a duty to tell employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken. You can contact the BP Group to ensure that this document is the most current available. Alteration of this document is strictly prohibited.

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# Material Safety Data Sheet

Prepared according to 29 CFR 1910.1200

## 1. Chemical Product and Company Identification

American Refining Group, Inc.
77 North Kendall Avenue
Bradford, PA 16701 USA
Tel: (814) 368.1200
www.amref.com

| | |
|---|---|
| **Product Name** | Brad Penn® R&O ISO VG 22 Turbine/Hydraulic Oil |
| **Product Code** | BP7362 |
| **CAS Number** | Not applicable for mixtures |
| **Synonyms** | Turbine/Hydraulic Oil |
| **Generic Chemical Name** | Petroleum hydrocarbon |
| **Product Type** | Mixture |
| **Transportation Emergency Phone No.** | Chemtrec: 1-800-424-9300 (24 HRS) |
| **ARG Emergency Phone No.** | 814-368-1297 (24 HRS) |
| **MSDS E-Mail** | msds@amref.com |

## 2. Hazards Identification

| | |
|---|---|
| **Appearance** | Liquid |
| **Odor** | Petroleum Oil |
| **Signal Word** | CAUTION!<br>May cause skin irritation<br>Prolonged skin contact may cause irritation<br>May cause eye irritation<br>May cause respiratory tract irritation |
| **OSHA Regulatory Status** | This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200) |
| **Precautions** | |
| **Inhalation** | Avoid breathing dust/fume/gas/mist/vapors/spray. Keep container tightly closed. Use only with adequate ventilation. |
| **Eyes** | Avoid contact with eyes. Wash thoroughly after handling. |
| **Skin** | Avoid contact with skin and clothing. Wash thoroughly after handling. |
| **Medical Conditions Aggravated by Exposure** | Pre-existing disorders involving any target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product |
| **Chronic Effects** | See Section 11 for complete health hazard information |
| **Environmental Effects** | See Section 12 for complete ecological information |

## 3. Composition / Information on Ingredients

This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200)

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| | |
|---|---|
| Component Regulatory Information | This product may be regulated, have exposure limits or other information identified as the following: Mineral Oil (See Section 8) |

## 4. First Aid Measures

| | |
|---|---|
| **Eyes** | Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately. |
| **Skin** | In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately. |
| **Inhalation** | Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately. |
| **Ingestion** | DO NOT INDUCE VOMITING. If conscious, rinse out mouth with water. Get medical attention immediately. |
| **Note to Physicians** | No specific treatment. Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled. |

## 5. Fire Fighting Measures

**Flammable Properties**
Not available
**Extinguishing Media**
Use dry chemical, $CO_2$, water spray (FOG) or foam
**Specific Hazards Arising from Chemical**
Elevated temperatures can lead to the formation of irritating fumes and vapors. Decomposition products may include the following materials: Carbon dioxide and Carbon monoxide.
**Protective Equipment and Precautions for Firefighters**
Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

## 6. Accidental Release Measures

**Personal Precautions**
No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
**Environmental Precautions**
Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution.

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## 6. Accidental Release Measures

**Methods for Containment**

Stop leak if without risk.

**Methods for Cleanup**

Move containers from spill area. Approach release from upwind. Absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

## 7. Handling and Storage

**Handling Procedures**

Eating, drinking, and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing vapor or mist. Use only with adequate ventilation. Use non-sparking tools.

**Shipping and Storing Procedures**

Store in accordance with local regulations. Store in a segregated and approved area. Keep in the original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials. Do not store in unlabeled containers. Store and use away from heat, sparks, open flame or any other ignition source. Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material. Empty containers that retain product residue may be hazardous. Do not reuse container.

## 8. Exposure Controls / Personal Protection

**Component Exposure Limits**

**Oil Mist (mineral)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ACGIH TLV:** | TWA: | N/A ppm | TWA: | 5 $mg/m^3$ | STEL: | N/A ppm | STEL: | 10 $mg/m^3$ |
| **OSHA PEL:** | TWA: | N/A ppm | TWA | 5 $mg/m^3$ | STEL: | N/A ppm | STEL: | N/A $mg/m^3$ |
| **NIOSH REL:** | TWA: | N/A ppm | TWA | 5 $mg/m^3$ | STEL: | N/A ppm | STEL: | 10 $mg/m^3$ |

N/A signifies not available

**Engineering Controls**

Material should be handled in enclosed vessels and equipment. Use only in adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

**Eye/Face Protection**

Chemical goggles or face shield.

**Skin Protection**

Chemical resistant, impervious gloves complying with an approved standard should be worn at all times. Coveralls, apron, and boots as necessary to minimize contact.

**Respiratory Protection**

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicated this is necessary. Respirator selection must be based on known or anticipated exposure levels.

**General Hygiene**

Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing.

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## 9. Physical and Chemical Properties

| | | | |
|---|---|---|---|
| **Appearance** | Amber | **Vapor Pressure** (mm Hg at 20℃) | 0 |
| **Odor** | Petroleum oil | **Water Soluble** | No |
| **Physical State** | Liquid | **Specific Gravity** (g/cc) | .87 |
| **Flash Point** (℉) | 385 | **Density** (lbs/gal) | 7.15 |
| **Boiling Point** (℉) | >625 | **pH** | Not available |

## 10. Chemical Stability & Reactivity Information

**Stability** Stable under normal conditions
**Polymerization** No polymerization
**Incompatibility** Strong acids and oxidizing materials
**Conditions to Avoid** High temperatures
**Hazardous Decomposition Products** Smoke, carbon monoxide, carbon dioxide, aldehydes and other products of incomplete combustion.

## 11. Toxicological Information

**Acute Exposure**

**Respiratory Irritation** If material is misted or if vapors are generated from heating, exposure may cause irritation of mucous membranes and the upper respiratory tract. Based on data from components or similar materials.

**Eye Irritation** May cause eye irritation. Vapors formed from heating may cause eye irritation.

**Skin Irritation** May cause skin irritation. Prolonged or repeated direct exposure to the skin may result in symptoms of irritation and redness, dermatitis or oil acne.

**Sensitization** Not expected to cause skin or respiratory sensitization.

**Component Analysis – LD50 / LC50**

**Acute Toxicity Estimate (ATE) Values for Product:**

| | | |
|---|---|---|
| **Inhalation LC50 Rat** | >100 | mg/L 1 HR |
| **Oral LD50 Rat** | >5000 | mg/kg |
| **Dermal LD50 Rabbit** | >2000 | mg/kg |

**Chronic Exposure**

**Target Organ Effects** No data available to indicate product or components present at greater than 1% are chronic health hazards.

**Carcinogenicity** This product contains mineral oils which are considered to be severely refined and not considered to be carcinogenic under IARC. All of the oils in this product have been demonstrated to contain less than 3% extractables by the IP 346 test.

**Mutagenicity** No data available to indicate product or any components present at greater than .1% are mutagenic or genotoxic.

**Reproductive Toxicity** No data available to indicate product or any components present at greater than .1% are a reproductive toxin.

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**Teratogenicity** No data available to indicate product or any components contained at greater than .1% may cause birth defects.

## 12. Ecological Information

**Component Analysis- Ecotoxicity – Aquatic Life**

| Duration/Test/Species | Concentration/Conditions |
|---|---|
| 96 Hr LC50 Pimephales promelas | N/A mg/L |

**Degradability** Not determined
**Bioaccumulation** Not determined
**Soil Mobility** Not determined

## 13. Disposal Considerations

**Disposal Instructions**
The generation of waste should be avoided or minimized wherever possible. Treatment, storage, transportation and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations.

## 14. Transportation Information

**Emergency Response Guide No.** 128 *North American Emergency Response Guide Book*

| | UN Number | Shipping Name (technical name) | Hazard Class | Packing Group |
|---|---|---|---|---|
| **U.S. DOT Bulk** | | Not Regulated | | |
| **U.S. DOT Non-Bulk** | | Not Regulated | | |

## 15. Regulatory Information

**SARA Extremely Hazardous Substances (Sections 302 & 304)** This product does not contain greater than 1% of any "extremely hazardous substances" listed pursuant to Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) Section 302 or Section 304 as identified in 40 CFR Part 355, Appendix A and B.

**SARA Section 313** This product does not contain greater than 1.0% of the substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

**SARA Section 311 & 312 Classifications**

| | |
|---|---|
| **Acute Hazard** | No |
| **Chronic Hazard** | No |
| **Fire Hazard** | No |

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## 15. Regulatory Information

**Reactivity Hazard** No

**CERCLA** This product does not contain any "hazardous substances" listed under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) in 40 CFR Part 302, Table 302.4.

**Clean Water Act / Oil Pollution Act** This product contains petroleum distillates and may be subject to regulation by Section 311 of the Clean Water Act and the Oil Pollution Act. Releases of the product into or leading to surface waters must be reported to the National Response Center at 1-800-424-8802.

**Global Chemical Inventories**

| Inventory | Component |
|---|---|
| | All components |
| US TSCA | Present |
| EU | Present |
| Japan | Not available |
| Australia | Present |
| New Zealand | Present |
| Canada | Present |
| Switzerland | Not available |
| Korea | Present |
| Philippines | Present |
| China | Present |
| Taiwan | Not available |

## 16. Other Information

**US NFPA Ratings**

| Health | Fire | Instability |
|---|---|---|
| 0 | 1 | 0 |

**HMIS Ratings**

| Health | Fire | Physical Hazards |
|---|---|---|
| 0 | 1 | 0 |

**Precautionary Labels**

**Signal Word** Caution!
May cause skin irritation
Prolonged skin contact may cause irritation
May cause eye irritation
May cause respiratory tract irritation

**Preparation/Revision Date** 3/23/2012

**Revision Reason** MSDS out of date

**Prepared By:** Jenna Prechtl, Product Compliance Coordinator

*The information provided on this MSDS is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation,*

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## 16. Other Information

*disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.*

**End of MSDS**

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# Product Overview
## Cleaners



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rge title and interior pages © Dürr Ecoclean GmbH, small title © Henkel KGaA

GmbH

| Short Description | Consistency | Application | Substrate to be Cleaned / Material Resistance | | | | | | | | W |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steel/ Iron | Cast Iron | Zinc | Al-Knead Alloys | Al-Cast Alloys | Magne- sium | Copper | Brass | |
| Basic ingredients: carbonates, borates and phosphates. For aluminium parts without etching. | P | dip/us | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: carbonates, borates and phosphates. High performance cleaning of aluminium parts. | P | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: carbonates and phosphates. For various metals with low soil level. Slight etching of aluminium and its alloys. | P | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: carbonates and silicates. For steel and zincated steel prior to phosphating. | P | ed | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates. For steel prior to phosphating, silicate-free. | P | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: borates, phosphates and silicates. For all materials prior to phosphating, surfactant-free. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: carbonates and phosphates. For steel, zinc and aluminium alloys prior to phosphating. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates. High performance cleaner for steel and cast iron with heavy soils incl. pigments. | P | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: silicates, phosphates and alkalines. Specially suitable for multi-metal, two-component system best cleaning results with surfactant additive. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates. High performance cleaner for steel, cast iron with heavy soils incl. pigments and after cutting, stamping pressing or cold forming. | P | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates and surfactants. Cleaner for the removal of heavy soils and greasy contamination as well as pigmented, fatty acid containing drawing compounds from steel in immersion process. | L | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: alkalines and phosphonates. Two-component cleaner for ferrous metals for cleaning after cutting, stamping, pressing or cold forming. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: silicates, phosphates and carbonates. Specially suitable for multi-metal in spray process after cutting, stamping and pressing in manufactoring industries. | P | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: silicates, alkalines, carbonates and surfactants. Degreasing of heavily soiled and greasy steel and copper surfaces and it alloys in immersion processes. | P | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates. Low alkalinity cleaner suitable for all metals prior to phosphating, BonderiteNT, small appliance cleaning. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |

P3-Cleaners: All cleaners fulfil the EU Detergency Regulation (EC) No. 648 / 2004 dated 31st. M

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| Short Description | Consistency | Application | Substrate to be Cleaned / Material Resistance | | | | | | | | W |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steel/ Iron | Cast Iron | Zinc | Al-Knead Alloys | Al-Cast Alloys | Magne-sium | Copper | Brass | |
| Basic ingredients: phosphates. Free of silicate and non ionic surfactant. Medium alkaline cleaner prior to phosphating, BonderiteNT, small appliance cleaning and before enammeling. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: alkalines and complexing agents. Multipurpose surfactant-free base for Al etching, dephosphating, paint stripping, cleaning and electrocleaning. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: silicates, phopsphates and surfactants. Multimetal cleaner for various applications. | P | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates. Demulsifying mild alkaline cleaner with high performance for steel and cast iron with heavy soils incl. pigments. | L | spray/dip/us | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Alkaline cleaner, silicate-free, with low etch for aluminium. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: silicates, phosphates, carbonates and surfactants. Good cleaning of all metals especially for aluminium alloys in immersion processes. | P | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates, alkaline hydroxides, and complexing agents. Free of silicate and surfactant. For steel and partly zinc plated steel, surfactant-free. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: carbonates, phosphates, surfactants, alkaline hydroxides, silicates and complexing agents. Cleaner for dip applications on steel substrates. | P | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphonates, salts, organic components and surfactants. Suitable for nearly all materials (metals and plastics) and processes. Degrasing of machinery parts in manual, dip and spray applications. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates, alkali hydroxides, silicates and complexing agents. Strongly recommended for bicomponent for all metals. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: alkali hydroxides and complexing agents. High alkaline cleaner with surfactant for heavy duty immersion cleaning of steel parts, incl. electrolytic cleaning. For spray applications prior to phosphating. Suitable for hard water. | L | spray/dip/us | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: gluconates. Mould cleaner for steel to remove release agent and rubber without attack on the base material. | L | dip/us | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates, alkali hydroxides and complexing agents. Recommended for electrolytical degreasing, descaler / deruster, paint stripper, aluminium etching. | L | dip/spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |

P3-Cleaners: All cleaners fulfil the EU Detergency Regulation (EC) No. 648 / 2004 dated 31st. M

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# Core Range – for Total Process Cost Reduction

| Short Description | Consistency | Application | Substrate to be Cleaned / Material Resistance | | | | | | | | W |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steel/ Iron | Cast Iron | Zinc | Al-Knead Alloys | Al-Cast Alloys | Magne-sium | Copper | Brass | |
| **Corrosion Protection** | | | | | | | | | | | |
| Basic ingredients: alcanolamines and surfactants. All-purpose immersion (with or without ultrasonic) cleaner, leaves hydrophobic surface. For the final and intermediate cleaning, excellent for removing of polishing pastes. | L | dip/us | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphates and surfactants. Cleaner for the removal of heavy soils and greasy contamination as well as pigmented, fatty acid containing drawing compounds from steel in spray application. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphonates, salts, organic components, alkalines and surfactants. Removing of heavily soiled and greasy contaminations as well as pigmented, fatty acid containing drawing compounds from steel and plastic by spray application. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| | | | | | | | | | | | |
| Basic ingredients: phosphoric acids. Immersion cleaning and degreasing of iron, steel, copper, brass and aluminium surfaces with no major metal attack. | L | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphoric acids. Spray cleaning and degreasing of iron, steel, copper, brass and aluminium surfaces with no major metal attack. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: phosphoric- / sulphuric acids. For iron, steel and aluminium. Suitable for heavy duty operations. | L | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: complexing agents and organic acids. Neutral derusting, particularly after deburring operations replacing conventional acidic multi-stage operations. | L | dip/spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: surfactants and mineral acids. Strong deoxidizer. High performance pickling prior to heavy phosphating (Zn, Mn). Used instead of sandblasting. | L | dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |

P3-Cleaners: All cleaners fulfil the EU Detergency Regulation (EC) No. 648 / 2004 dated 31st. M

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| Short Description | Consistency | Application | Substrate to be Cleaned / Material Resistance | | | | | | | | Wo |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steel/ Iron | Cast Iron | Zinc | Al-Knead Alloys | Al-Cast Alloys | Magne-sium | Copper | Brass | |
| Corrosion Protection oil (6–12 months). | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 2 in 1 product, cutting fluid and corrosion protection emulsion (5–6 months). Water miscible cutting fluid for general machining. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Corrosion protection emulsion (2–3 months), suitable only for soft water. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Corrosion protection emulsion (3–4 months), suitable from 15°dH upward. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Aqueous corrosion protective (2–3 days). Ideal prior to painting. Passivation of steel and cast iron for subsequent storage in closed warehouses. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Amine-free aqueous corrosion protective (4–8 weeks), passivating of steel and cast iron for subsequent storage in closed warehouses. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Aqueous corrosion protective for short term indoor storage (2–3 weeks). | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Corrosion protection emulsion suitable for soft and hard water. Replenished by drag in of Multan 97–10 cutting-fluid. Non foaming in cold water. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: isoparaffinic hydrocarbons. Dewatering fluid, temporary corrosion protection, no VOC. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: isoparaffinic hydrocarbons, corrosion inhibitors. Dewatering fluid, temporary corrosion protection, film not visible, performance > 25 cycles condensed water test. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |

P3-Cleaners: All cleaners fulfil the EU Detergency Regulation (EC) No. 648 / 2004 dated 31st. M

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# Core Range – for Total Process Cost Reduction

| Short Description | Consistency | Application | Substrate to be Cleaned / Material Resistance | | | | | | | | W |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steel/ Iron | Cast Iron | Zinc | Al-Knead Alloys | Al-Cast Alloys | Magne-sium | Copper | Brass | |
| **rosion Inhibitors – Salt-free** | | | | | | | | | | | |
| Basic ingredients: amines, carboxylic acids. All-purpose cleaner with high biostability. 100% permeability on UF. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. All-purpose cleaner especially suitable for aluminium and magnesium alloys. 100% permeability on UF. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Standard cleaner with very good surface finish. 100% permeability on UF. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Cold sprayable cleaner with good cleaning performance and corrosion protection. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Cleaner with excellent corrosion protection. 100% permeability on UF. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Self-demulsifying neutral cleaner. Excellent cleaning performance. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Self-demulsifying neutral cleaner. Contains fungicide. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Standard neutral cleaner, biostable formulation. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Highly concentrated. Suitable for highly burdened systems. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Best-in-Class salt-free neutral cleaner. Excellent cleaning performance, also suitable for non-ferrous metals, cleaning prior to hardening processes. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| **rosion Inhibitors – Salt-containing** | | | | | | | | | | | |
| Basic ingredients: amines, carboxylic acids. Neutral cleaner for heavy duty cleaning operations. Improved biostability. 100% permeability on UF. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Self-demulsifying neutral cleaner with high cleaning performance. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids, phosphates. Neutral cleaner with excellent cleaning performance for light pigment soiling and lapping paste. | L | spray/dip | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids. Neutral cleaner with excellent cleaning performance for light pigment soiling and lapping pastes. Foam-free even when contaminated with coolant emulsion. | L | spray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Basic ingredients: amines, carboxylic acids, phosphates. Cold sprayable neutral cleaner. | L | spray/ high pressure | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |

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# Core Range – for Total Process Cost Reduction

| Short Description | Consistency | Application | Working Temperature °C | | pH-value (1 % in DI-wat |
|---|---|---|---|---|---|
| | | | min | max | |
| Basic ingredients: citric acids. Suitable for all types of plastics, recommended for conversion coating processes prior to painting. Phosphates-free. | L | spray | 55 | 65 | 2.8 |
| Basic ingredients: phosphoric citric acids. Suitable for all types of plastics, recommended for conversion coating processes prior to painting. Surfactant-free. Non foaming product. | L | spray | 40 | 65 | 2.5 |
| Basic ingredients: alkali hydroxides. Suitable for all types of plastics, recommended for conversion coating processes prior to painting. Surfactant-free. Non foaming product. | L | spray | 45 | 65 | 11.4 |
| Rinse aid, prior to painting especially for plastics. | L | spray | 25 | 40 | 6.5 |
| Basic ingredients: phosphates and surfactants. Cleaner for the removal of heavy soils and greasy contamination as well as pigmented, fatty acid containing drawing compounds from steel in spray application. | L | spray | 40 | 80 | 12.0 |

P3-Cleaners: All cleaners fulfil the EU Detergency Regulation (EC) No. 648 / 2004 dated 31st. March 2004 valid since 8th. October 2005

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# Core Range – for Total Process Cost Reduction

| Short Description | Consistency | Application | Working Temperature °C | | pH-value (1 % in DI-wat |
|---|---|---|---|---|---|
| | | | min | max | |
| To improve economically degreasing properties for spray systems. Less surfactant needed / lower COD, wide range application. | L | spray | 40 | 60 | 7.0 |
| Basic ingredients: Nonionic surfactants. Defoamer, silicon-free. | L | spray/dip | 40 | 80 | 7.0 |
| Oil based defoamer, high efficiency, no influence on a follow-up painting process. | L | | – | – | |
| Based on nonionic and anionic surfactants. Degreasing booster for alkaline and neutral immersion systems. | L | dip | – | – | 7.2 |
| Cleaning booster / surfactant additiv. Improves the cleaning performance of neutral cleaners, replenishing after centrifuging, ultrafiltration or similar processes. | L | spray | 50 | 80 | – |
| Degreasing booster for neutral and alkaline dip / flood systems, good permeability on UF / MF membranes. | L | dip | – | – | 9.7 |
| Demulsifier / antifoam, splitting of emulsions. | L | spray | – | – | 6.5 |
| Boosting the degreasing properties of spray systems. Contains solvent. | L | spray | 30 | 60 | – |
| High efficient cleaning booster. Contains solvent. | L | dip | 40 | 70 | – |
| Basic nonionic surfactants. Suitable for all materials. | L | spray/dip | 50 | 60 | 5.0–7.0 |
| Basic anionic and nonionic surfactants. Suitable for all materials. | L | dip | 50 | 80 | 5.0–7.0 |
| Degreasing booster for alkaline solutions, contains solvents. Low foaming. | L | spray | – | – | 4.2 |

P3-Cleaners: All cleaners fulfil the EU Detergency Regulation (EC) No. 648 / 2004 dated 31st. March 2004 valid since 8th. October 2005

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# APPENDIX 6

# CALIBRATION GRAPH ICPMS FOR CHROMIUM AND NICKEL

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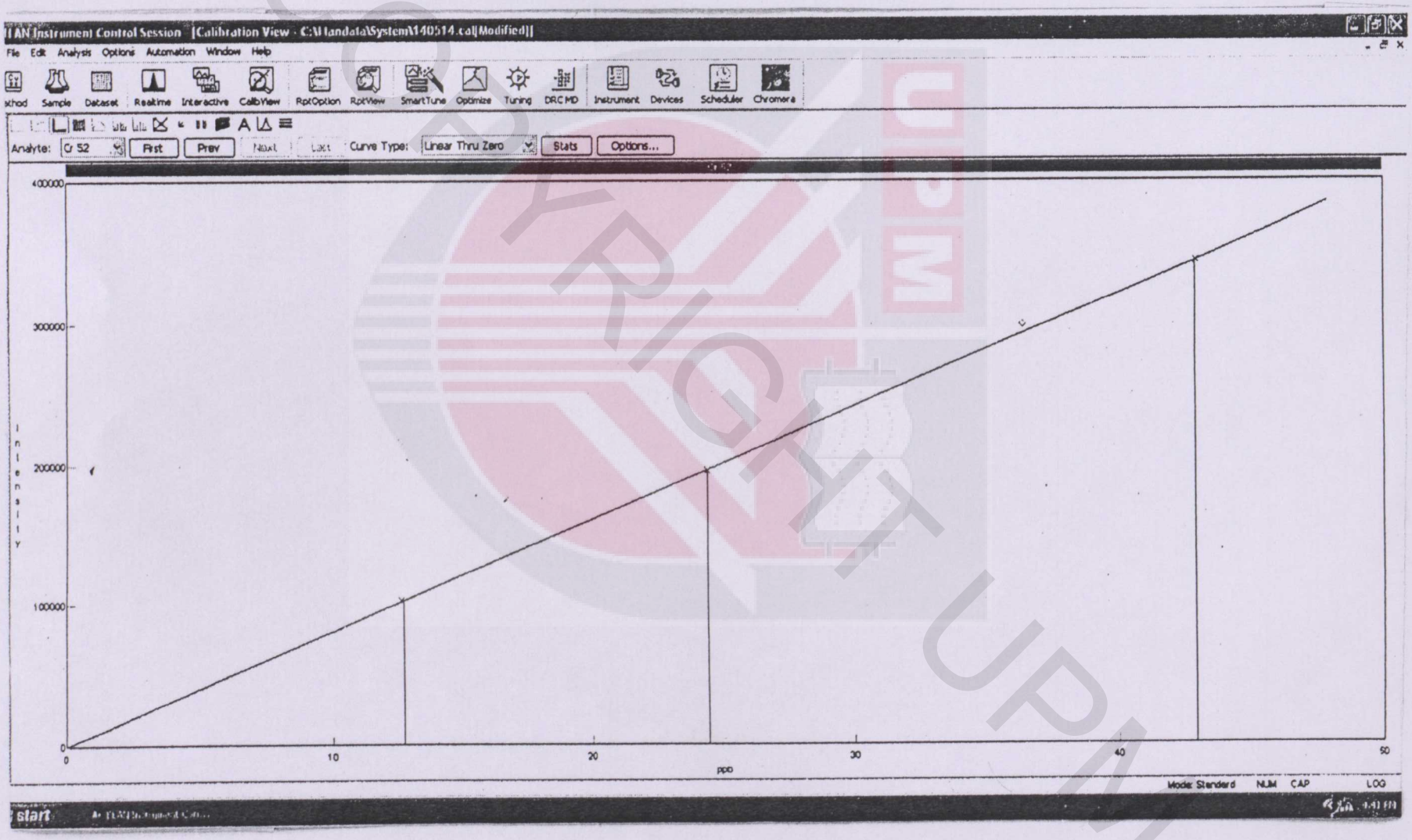
# ICP-MS GRAPH CALIBRATION FOR CHROMIUM

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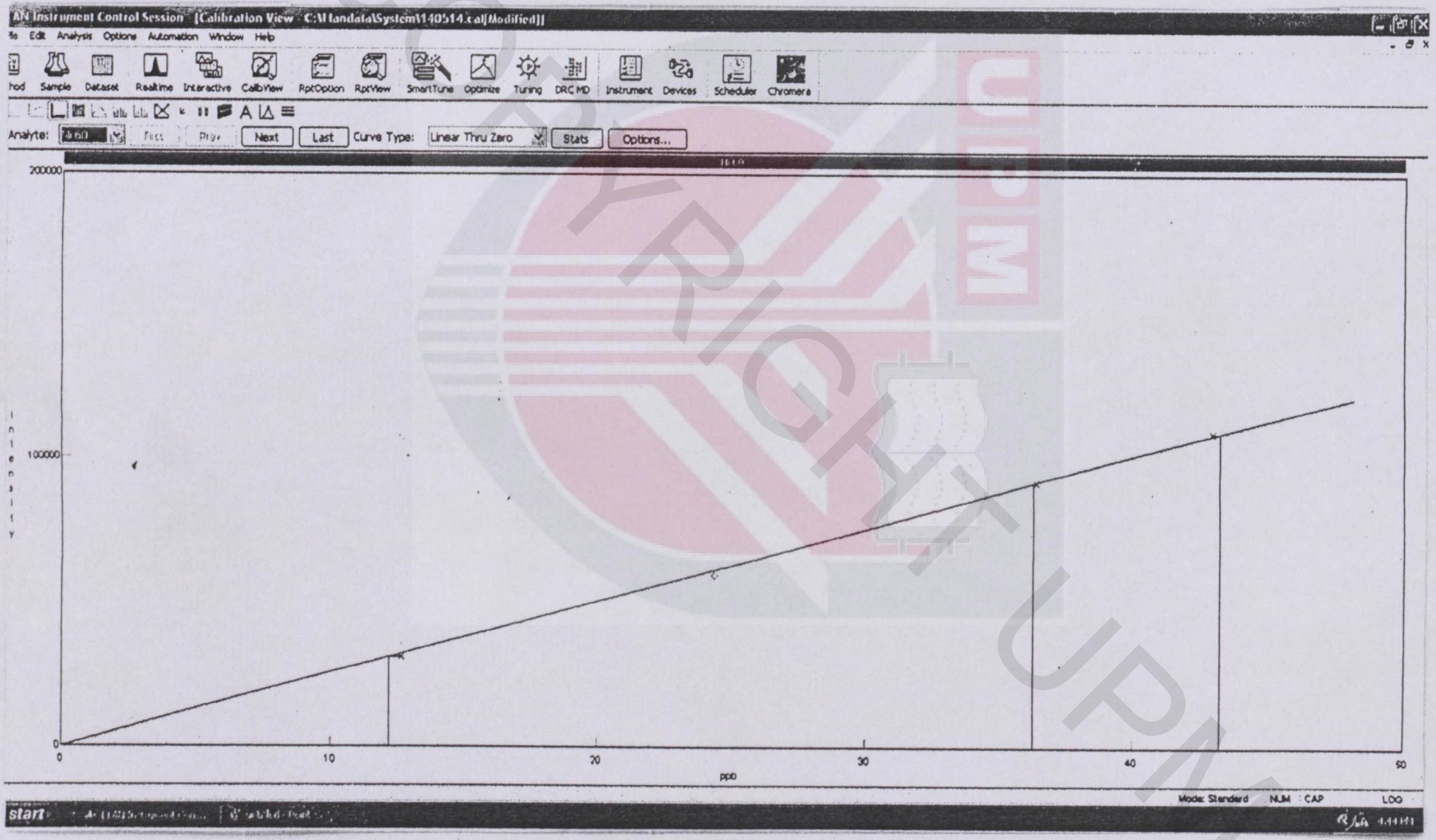
# ICP-MS GRAPH CALIBRATION FOR NICKEL

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