Australian Government
Department of Health
National Industrial Chemicals
Notification and Assessment Scheme

Characterisation of tattoo inks used in Australia

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This report can be found on the NICNAS website:
https://www.nicnas.gov.au/chemical-information/Topics-of-interest2/subjects/tattoo-inks-used-in-Australia/Characterisation-of-tattoo-inks-used-in-Australia

1. Overview

In Australia, NICNAS is responsible for the regulation of chemicals present in tattoo inks. This report describes activities undertaken in 2014–2015 to identify tattoo inks used in Australia and to characterise the chemicals in these inks.

NICNAS conducted this study by:

- using desktop research to determine the tattoo inks likely to be used in Australia and ingredients of these inks
- surveying tattooists in Sydney to get an indication of tattoo inks used in Australia
- commissioning comprehensive chemical analysis of a representative selection of the tattoo inks identified.

The main findings from these activities were:

- Desktop analysis identified 89 unique chemicals in tattoo inks likely to be used Australia.
- There was good agreement between the outcomes of interviews with tattooists and desktop research regarding tattoo inks used in Australia.
- Inks not intended for tattooing are used for this purpose.
- Ingredients listed on the labels of some tattoo inks were incorrect.
- 19 unique colourants were identified in the sample of tattoo inks analysed and specific patterns of use for certain colourants.
- The presence of certain metals in tattoo inks is associated with the use of specific colourants.
- The amines identified in the tattoo inks are associated with the use of azo pigments as colourants.
- The presence of polycyclic aromatic hydrocarbons in tattoo inks is associated with black tattoo inks and the use of Pigment Black 7 (carbon black) as a colourant.

The regulatory status of the analysed tattoo inks and their chemical components is also discussed.

Based upon the findings, NICNAS makes the following recommendations, to protect human health, for consideration by the relevant authorities:

- Advise state health authorities that specific tattoo inks:
    - are not compliant with regulations for the supply and use of these products in Australia
    - are marketed with incorrect ingredient information or are not intended to be used for this purpose.
- The information in this report can be used in risk assessments and subsequent consideration of public health risk management controls, if warranted.

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2. Background

Tattooing is the process of injecting ink into the dermal layer of the skin in order to permanently or semi-permanently colour the skin. Tattoo inks may include multiple colourants to achieve a certain colour, as well as other chemicals such as water, glycerol, isopropyl alcohol, witch hazel, preservatives, resins and contaminants. The colourants used include both pigments (that are insoluble in water) and dyes (that are soluble in water); however, pigments represent the vast majority of colourants used in tattoo inks.

Tattooing can be performed either as a form of body art or for cosmetic purposes. An important difference between these types of tattoos is that colourants are selected for permanency for body art tattoos, while cosmetic tattoo colourants are meant to eventually fade over a period of time.

Chemical ingredients of tattoo inks and tattoo removal solutions are considered industrial chemicals, and the introduction of these chemicals into Australia is regulated by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS). NICNAS started collecting information on tattoo inks in Australia from 2005. In 2013, information from literature on tattoo ink composition was consolidated, with 120 chemicals identified as being used internationally as ingredients of tattoo inks.

The current report describes activities undertaken by NICNAS in 2014–2015 that build upon these previous findings.

3. Activities undertaken in 2014 and 2015

NICNAS conducted various activities in 2014 and 2015 to:

- identify specific tattoo inks used in Australia and patterns of usage of these tattoo inks
- determine the chemical composition of the identified tattoo inks using various methods

The specific activities undertaken were to:

1. identify brands likely to be used in Australia through review of Australian customs data and tattoo inks available for sale online (eBay)
2. identify chemicals present in tattoo inks for the identified brands using reports of analysis conducted by other regulatory agencies and ingredient information provided by manufacturers
3. survey professional tattoo artists in Australia to identify tattoo ink brands used and relevant patterns of use
4. develop a representative list of tattoo inks used in Australia using information obtained from the previous activities
5. conduct an independent and comprehensive chemical analysis of these tattoo inks
6. ascertain the regulatory status of these chemical ingredients

3.1. Identify tattoo inks in commerce in Australia

NICNAS reviewed Australian customs data and the online sale of tattoo inks through eBay to identify tattoo inks in commerce in Australia as an indication of their use.

3.1.1. Review of Australian Customs data

NICNAS conducted a review of the Customs (Australian Border Force) data to identify importers and suppliers of tattoo inks. Customs data were searched from 2010 onwards using the search term ‘tattoo’ in the Importer and Goods Description fields to generate a preliminary list of importers and suppliers. The preliminary data set was then filtered by removing animal tattoo and cosmetic tattoo entries and non-relevant transactions. Results were limited to overseas suppliers in the past three years. Identified suppliers were then queried against import transactions to identify additional importers. From the final list of 2,314 transactions, 55 overseas suppliers and 68 importers were identified. The websites for some of the suppliers and importers provided information on the brands sold and the individual tattoo inks within that brand.

3.1.2. eBay searches

NICNAS conducted two searches on the eBay website in January 2015, one using the term “tattoo ink” and the second using tattoo ink brand names.

In the first (search 1), the phrase “tattoo ink” was searched in the tattoos and body art category with the preferred location Australia. 186 listings were identified and filtered to remove non-tattoo ink entries, and an attempt was made to identify a brand for the remaining entries. The results from this search are presented in Table 1.

Table 1: Results of eBay search 1

Brands	Number of listings
Intenze	46
Kuro Sumi	36
Dragonhawk	25
Prizm	5
Eternal	3
Colour King	2
Kokkai Sumi	2
Mom’s	2
Starbrite	2
Fusion	1

Not specified	33

The second search used tattoo ink brands identified from the Customs data and from analysis of tattoo ink composition by other regulatory bodies. In search 2, these brand names were used as search terms for searching in the same category as search 1—tattoos and body art category—the difference being that the second search did not restrict location to Australia. The results from search 2 are presented in Table 2.

Table 2: Results of eBay search 2

Brand	Number of listings
Intenze	533
Starbrite	777
Kuro Sumi	302
Mom's	309
Alla Prima	0
Skincandy	74
Silverback	0
Eternal	4
Fusion	1
Waverly	0
National HLC	0
Colour King	9
Tang Dragon	0
Classic Color	0
Gold 13	0
Dragon	0

The eBay searches offered two interesting observations:

- Manufacturers often have distinctive names for individual tattoo inks. For example, the Intenze brand has tattoo inks named Snow White Opaque, Lemon Yellow, Mario's Blue and True Black rather than simply white, yellow, blue and black. The majority of tattoo inks for which a brand could not be identified in search 1 also used the same names as the Intenze brand. While this is not strictly counterfeiting, it may represent attempts to benefit from an established brand.

- Kuro Sumi was identified as a popular brand on eBay by the number of listings. Many of the listings for Kuro Sumi contained images of the tattoo ink in packaging that differs from the standard packaging for this brand. It is therefore possible that some of the listings are counterfeit tattoo inks.

Tattoo ink brands likely to be commonly used in Australia were identified by:

- comparing the brands identified in the Customs data and eBay searches—if a brand appeared in both Customs and eBay data sets, it was considered likely to be in use in Australia
- reviewing Customs data to look for brands sold by more than one overseas supplier, and
- using Customs data to identify two brands of tattoo inks for permanent make-up applications, which were also considered likely to be used in Australia.

3.2. Follow-up identification of chemical ingredients in tattoo inks likely to be used in Australia

3.2.1. Identifying relevant information on the chemical composition of tattoo inks

Upon completing the review of Customs data and eBay searches, the following strategy was used to identify chemicals present within tattoo inks likely to be in use in Australia.

Sources of information on tattoo ink composition were identified. These include:

- Safety Data Sheets (SDSs)—a number of manufacturers provide SDSs for the tattoo inks they produce, with some containing comprehensive information on tattoo ink composition
- New Zealand Survey of Selected Samples of Tattoo Inks for the Presence of Heavy Metals, 2013, which examined the presence of heavy metals in 118 individual tattoo inks
- a detailed Swedish compositional analysis of 31 tattoo inks titled *En rapport från Kemikalieinspektionen—Rapport Nr 3/10*
- information on the composition of 16 tattoo inks provided to NICNAS by Dr Urs Hauri, State Laboratory of the Canton Basel City, Switzerland, and
- a list of 13 tattoo inks recalled via the European Union (EU) Rapid Exchange of Information System (RAPEX) for unsafe consumer products, which included the concentration and chemical identity of the substance resulting in recall.

Chemicals listed in the SDSs of tattoo inks for the brands identified as likely to be used in Australia were collated into a spreadsheet, although some brands of interest did not provide useful information in their SDSs (Table 3). The spreadsheet also included additional information on tattoo ink composition from chemical analysis conducted by regulatory agencies.

The majority of information on chemical composition (>80%) was derived from SDSs provided by manufacturers. Except for water, glycerol and isopropyl alcohol, all chemicals identified as present in a tattoo ink—in some case from multiple sources—were included in the spreadsheet.

Table 3 lists the tattoo ink brands identified as likely to be used in Australia, whether or not the tattoo inks from these brands were included in the spreadsheet, and the source of data if included.

Table 3: Status of tattoo ink brands likely to be used in Australia

Brand	Included in spreadsheet	Source of data
Intenze	Yes	SDS, chemical analysis
Starbrite	Yes	SDS, chemical analysis
Kuro Sumi	Yes	SDS, chemical analysis
Mom’s	Yes	SDS, chemical analysis
Alla Prima	Yes	SDS, chemical analysis
Skincandy	Yes	SDS
Biotouch	Yes	SDS
Pure Colors	Yes	SDS
Classic	Yes	Chemical analysis
Silverback	No	No ingredient information available
Eternal	No	No ingredient information available
Fusion	No	No ingredient information available
Colour King	No	No ingredient information available
Waverly	No	No ingredient information available
National	No	No ingredient information available

3.2.2. Findings from collected chemical ingredient information about tattoo inks likely to be used in Australia

3.2.2.1. Overview

The spreadsheet consists of 1,710 entries of chemicals present in tattoo inks. This encompasses 471 individual tattoo inks containing multiple chemicals. A total of 89 unique chemicals (Table A1 in the Appendix) were identified, with the vast majority of chemicals present in more than one tattoo ink. Two proprietary chemical names were identified from SDSs, for which it was not possible to determine the chemical identity. Manufacturer information was obtained from the SDSs of 448 of the 471 tattoo inks, while composition analysis was available for 114 of 471 listed tattoo inks. There was some overlap between SDS and composition analysis information. Both information sources for chemical ingredients were available for some of the tattoo inks examined.

Of the tattoo inks listed, 85% were for body art, while 15% of tattoo inks were for cosmetic tattoo usage. The body art ink brands were Starbrite, Intenze, Kuro Sumi, Mom's, Alla Prima, Skincandy and Classic. For cosmetic tattooing, the brands were Biotouch and Pure Colours.

55 of the 89 tattoo ink ingredients were previously identified by NICNAS in 2013 as being present in tattoo inks. The chemicals in tattoo inks consist of colourants, contaminants and other ingredients such as preservatives.

3.2.2.2. Colourants

A total of 53 colourants were identified as ingredients of tattoo inks and are listed in Table A2 in the Appendix. Fifteen of the colourants were identified as ingredients in the SDSs of at least three different manufacturers, and these are also listed in Table A2 in the Appendix.

There is a significant difference in tattoo ink colourants used, depending on whether a tattoo is for body art or cosmetic purposes. Body art tattoo inks favour organic colourants, while inorganic colourants—and in particular iron oxides—predominate in permanent make up/cosmetic tattoo inks. Only five colourants were used in both types of tattoo ink: Pigment Black 7 (carbon black), Pigment Red 4, Pigment Red 101, Pigment White 6 (titanium dioxide) and Pigment Yellow 42. For the remaining colourants, 34 were exclusive to body art tattoo inks and 14 were restricted to cosmetic tattoo inks.

Of the commonly used colourants, some are almost exclusively used to achieve certain colour effects. Pigment White 6 (titanium dioxide) is used by all brands to lighten a hue—for example to turn red into pink. Pigment Black 7 (carbon black) is used by all brands (except for the brand Pure Colours) to achieve a black colour. For almost all body art tattoo inks, Pigment Blue 15:3 and Pigment Green 7 are used to give a blue and green colour, respectively.

The brand Skincandy included several blacklight tattoo inks, which incorporate two chemicals that fluoresce when illuminated with ultraviolet (UV) light. These chemicals are coumarin (CAS RN 91-44-1) and melamine formaldehyde toluenesulfonamide polymer (CAS RN 39277-28-6), which produce a visual effect and have not been included in the list of colourants.

3.2.2.3. Contaminants

Compositional analysis by overseas bodies indicates that heavy metals are often present in tattoo inks even though they are not listed on SDSs provided by manufacturers. Heavy metals may be included as contaminants when certain metal-based colourants are used in tattoo inks. There may be other means by which heavy metals occur as contaminants but this was not investigated further.

In addition to heavy metals, other contaminants of concern identified in tattoo inks were aromatic amines and polycyclic aromatic hydrocarbons (PAHs).

3.2.2.4. Other chemicals

Tattoo inks from the brands Kuro Sumi and Mom’s included proprietary resins that could not be identified from the manufacturer’s SDS. The majority of tattoo ink SDSs do not list preservatives, although the SDSs did list two preservatives: diazolidinyl urea (CAS RN 78491-02-8) and benzisothiazolon (CAS RN 2634-33-5). Formaldehyde (CAS RN 50-00-0) was also present in a tattoo ink, although it was not clear whether it was a preservative or contaminant.

3.2.2.5. Compliance of chemical ingredients with the Council of Europe Resolution ResAP(2008)1

A number of countries regulate tattoo inks based upon the Council of Europe Resolution ResAP(2008)1 on requirements and criteria for the safety of tattoos and permanent make-up. Of the 471 tattoo inks identified as likely to be used in Australia, 193 or 41% were not compliant with ResAP(2008)1. There were 37 chemicals or concentrations of chemicals that were not compliant with ResAP(2008)1. This indicates a poor understanding of (or indifference to) ResAP(2008)1 by manufacturers.

No restricted substances were identified in tattoo inks meant for cosmetic use. However, it should be noted that the only source of chemical ingredients for these tattoo inks was the SDS provided by the manufacturers, and unlike body art tattoo inks, independent analyses of chemical composition were not available.

3.2.2.6. Limitations in the identification of chemical ingredients in tattoo inks

NICNAS identified some limitations with the approach described above:

- The Customs data set only provides information at the distributor/brand level and the identification of individual tattoo inks within a brand was not possible.
- Identification of popular brands during the initial searches was by confirmation with a complementary data source (i.e. comparison of Customs and eBay data, and brands available from multiple suppliers in the Customs data). Imports with a value of less than $1,000 are not captured. Therefore, there is a reasonable possibility that some tattoo ink brands commonly used in Australia may not have been identified.
- Obvious errors in chemical identity were frequently observed in SDSs provided by manufacturers and these were corrected during the review. However, some substance identification errors may not have been detected.

Some manufacturers are reported to provide incorrect information on product labels or SDSs, possibly intentionally in some cases, to disguise the actual chemical ingredients (Hauri, 2011). Any such errors would have been incorporated in the compiled spreadsheet.

- It is not possible to account for changes in formulation or manufacture of tattoo inks after the date of SDS publication.

3.3. Survey of professional tattoo artists in Australia

Tattooists were surveyed to identify the commonly used tattoo inks brands in Australia.

3.3.1. Description and findings of tattoo artist survey

Professional tattoo artists were surveyed to:

- confirm that tattoo ink brands identified from Customs data and eBay searches were actually used in Australia
- further identify commonly used brands not captured in the previously described activities, and
- identify any relevant patterns of tattoo ink use.

NICNAS attended The Australian Tattoo and Body Art Expo held in Sydney in March 2015 and met with a number of tattooists. In addition, NICNAS attended inspections of tattooing businesses by the City of Sydney Council in March and April 2015. At these inspections, NICNAS interviewed tattoo artists. A total of 22 professional body art tattooists were interviewed at the inspections and expo.

Information obtained from the survey indicates that:

- Most tattooists use between one and three different brands in their work.
- The following brands were being used, followed in brackets by the number of tattooists using the brands: Intenze (10), Fusion (7), Eternal (7), Waverly (6), Starbrite (5), Dermaglo (3), Stable (2), National Tattoo Supply (2), Mom’s Millennium (1), Skincandy (1), Alla Prima (1), Bloodline (1), and Old Gold (1).
- Some brands specialise in black tattoo inks, and the black ink brands Dynamic, Kuro Sumi and Talens were used by 7, 4 and 3 tattooists surveyed, respectively.
- Black is the most commonly used colour in tattoos.
- Some tattooists use brands of black that are different from the brands they use for colour tattoos—usually one of the specialty black ink brands.
- Tattooists generally apply more black-only tattoos compared with coloured tattoos. Some tattooists specialise in only black tattoos.
- For many tattoos, only black ink is used and black outlining is common in colour tattoos.
- After black, red is the next most popular colour in tattoos. Other frequently used colours are yellow, green and blue.

- The majority of professional artists do not make their own tattoo inks from powdered colourant, although they may have done so in the past. Two of the tattooists interviewed used powdered colourant from the brand National Tattoo Supply.
- None of the tattooists surveyed perform UV-visible tattooing. Many of the tattooists interviewed expressed doubts about the safety of this type of tattoo ink.
- Nearly all tattooists interviewed obtain tattoo inks from the Australian distributor, Protat Tattoo Supplies.
- None of the tattooists interviewed purchased from eBay and many expressed concern regarding the quality and authenticity of tattoo inks from this source.
- The majority of tattoo inks used are manufactured in the USA.
- Most tattooists estimate they use between 20 and 30 individual tattoo inks for their work. The number of individual tattoo inks used by an individual tattooist ranged between 7 and approximately 70.
- Some tattooists mix different coloured tattoo inks together to obtain the desired colour.
- Some tattooists dilute their tattoo inks using substances such as water, witch hazel solution and vodka.
- Some tattooists mentioned they use organic tattoo inks and may be under the impression these tattoo inks are more natural.
- Most tattooists are not aware of what a material safety data sheet (MSDS) or an SDS is, and do not have them for the tattoo inks they use.
- Many of the tattooists are aware of the recent tattoo ink safety warning from NSW Health (June 2014). They may not be aware of the reason for the warning, which was chemical contamination by phenylenediamine and heavy metal. The health warning was sent by mail to many of the tattooing establishments.

3.3.2. Limitations of tattoo artist survey

NICNAS identified some limitations of the survey:

- Except for specialty black inks, which have a limited product range, it was not possible to identify the individual tattoo inks used from the survey conducted.
- The number of tattooists surveyed (22) was relatively small and the majority were from the Sydney Metropolitan area. It is possible that the information obtained is not representative of use Australia-wide.
- Tattoo ink usage by non-professional tattooists was not investigated. It is possible that the type and composition of tattoo inks used by these individuals differs significantly from those used by professional artists.
- Professional tattooists conducting cosmetic tattooing were not represented in the survey.

3.4. Chemical analysis of body art tattoo inks in use in Australia

3.4.1. Purpose of conducting chemical analysis

NICNAS commissioned an analysis of the chemical composition of tattoo inks to:

- Characterise the chemical composition of body art tattoo inks used in Australia.
- Determine compliance with the regulatory requirements for tattoo inks in Australia based on the chemical ingredients identified during analysis. Relevant regulations are defined by the Standard for the Uniform Scheduling of Medicines and Poisons (Poisons Standard) administered by the Therapeutic Goods Administration (TGA) and Model Work Health and Safety (WHS) laws administered by Safe Work Australia.
- Determine the compliance of body art tattoo inks used in Australia with the ResAP(2008)1 requirements and criteria for the safety of tattoos and permanent make-up, which are used by a number of European countries as the basis for the regulation of chemicals in tattoo inks.

3.4.2. Sourcing tattoo inks for analysis

3.4.2.1. Selection of body art tattoo ink brands

The usage of tattoo inks was ascertained through the survey of tattooists in metropolitan Sydney in March and April 2015 described above. Based on the findings, the following brands were selected for analysis:

- Intenze, Fusion, Eternal, Starbrite and Waverly as the five most popular coloured tattoo ink brands among the interviewed tattooists
- Dynamic, Kuro Sumi and Talens, as the three most popular speciality black tattoo ink brands.

Waverly, the third most popular coloured ink brand, was not included in the analysis as the identified importer was not registered with NICNAS. The importer's details were referred to the NICNAS Registration Outreach and Reporting Program for further action.

Most of the above selected brands were also identified as likely to be in use in Australia by NICNAS's analysis of Customs and eBay data, and some of these brands had also been selected for analysis by the New Zealand EPA.

3.4.2.2. Selection of individual body art tattoo inks

The basis for selection of the individual body art tattoo inks from among the popular brands identified is as follows:

- The colours black, red, yellow, green and blue were identified as being commonly used by tattooists. From the selected brands, two tattoo inks were selected at random for each of these colours.

- Where possible, tattoo inks not already examined by regulatory agencies in New Zealand and Sweden were selected to avoid duplication. However, for brands with a limited product range, it was not always possible to select a specific colour tattoo ink that had not been previously analysed.
- One or two tattoo inks were selected from the specialty black tattoo ink brands.
- A review of the SDS for the chemical ingredients for certain tattoo inks from Starbrite indicated potential non-compliance with ResAP(2008)1. Five of these tattoo inks were included in the list to be analysed.

A total of 49 body art tattoo inks were selected for analysis and are listed in Table A3 of the Appendix.

3.4.2.3. Purchase of tattoo inks

Three individual sealed containers of each of the 49 tattoo inks with identical lot/batch numbers were purchased from the Australian supplier Protat Pty Ltd. This supplier is commonly used by the tattooists NICNAS surveyed. It is expected that the tattoo inks purchased are representative of those in use, and that the chemical composition does not differ substantially from the same tattoo inks available from other suppliers.

Two laboratories conducting the analysis each received one container of tattoo ink, and the third container was archived for potential future analysis.

3.4.3. Analytical techniques

3.4.3.1. Analysis of the chemical composition of tattoo inks

The following laboratory analysis was conducted:

- Quantification of elemental metals.
- Quantification of amines present as contaminants or released from azo colourants.
- Quantification of polycyclic aromatic hydrocarbons (PAH).
- Identification of colourants.

Intertek Testing Services Hong Kong Ltd quantified metals, PAH and amines, with the identification of colourants conducted by Microtrace LLC.

The focus of the chemical analysis was to determine the chemical composition of the tattoo inks used in Australia and to identify any chemicals of concern in the inks. Therefore, the chemicals selected for analysis were primarily based on the potential risk to human health posed by the selected metals, amines, PAH, and certain colourants. Recommended methods for the analysis of tattoo inks and the concentration limits specified in ResAP(2008)1 were also considered when determining what kind of analysis should be undertaken. In addition, previous chemical analysis of tattoo inks conducted by overseas regulatory agencies guided the work.

3.4.3.2. Quantification of metals

The metals selected for analysis were based on those specified in ResAP(2008)1, as well as the analysis of tattoo inks conducted by the Swedish Chemicals Agency and the New Zealand EPA. There are no specific Australian regulations for the metal content of tattoo inks; however, some of the metals quantified are listed in the Poisons Standard or classified as hazardous by Safe Work Australia. Table A4 in the Appendix lists the metals quantified, the listings in the Poisons Standard, hazard classifications according to Safe Work Australia and maximum concentrations permitted in tattoo inks by ResAP(2008)1.

The test method was microwave digestion of samples with nitric acid, followed by Inductively Coupled Plasma (ICP) analysis.

3.4.3.3. Quantification of amines released from azo colourants

Certain azo colourants can break down to form amines that pose a risk to human health. ResAP(2008)1 provides a list of amines of concern that are potentially released from azo colourants in tattoo inks. The selection of amines for the current analysis was guided by the listings in the Poisons Standard and ResAP(2008)1. Not all amines listed in the Poisons Standard were analysed, and the selection of chemicals from the Standard was dependent on the methodology used to quantify the amines. Table A5 in the Appendix lists the amine species quantified in the current analysis, listings in the Poisons Standard, and hazard classification according to Safe Work Australia.

Amines were quantified as described in the specification EN 14362-1: 2012, Textiles—Methods for determination of certain aromatic amines derived from azo colorants: Detection of the use of certain azo colorants accessible with and without extracting the fibres. This specification is recommended in ResAP(2008)1 for the analysis of amines in tattoo inks and was used for this purpose by the Swedish Chemicals Agency.

The method for the quantification of amines uses dithionite to reduce azo bonds and other reactive groups to identify potential breakdown products of azo colourants. It does not distinguish between amines already present in tattoo inks and those formed from dithionite reduction.

3.4.3.4. Quantification of PAH

The selection of PAH species for quantification was based on analysis conducted by the Swedish Chemicals Agency in 2010, which quantified PAH species according to the Geprüfte Sicherheit (GS) Mark. Table A6 of the Appendix lists the PAH species quantified, listings in the Poisons Standard, and hazard classification according to Safe Work Australia.

The test method used is as described in the specification, *AfPS GS 2014:01 PAK, Testing and assessment of polycyclic aromatic hydrocarbons (PAHs) in the course of awarding the GS mark*. A previous version of this specification had been used by the Swedish Chemicals Agency to quantify PAHs in tattoo inks.

3.4.3.5. Identification of colourants

Colourants were identified to:

- define the colourant composition of individual tattoo inks
- determine the distribution of colourants in the tattoo inks
- identify patterns of usage.

Confocal Raman spectroscopy was used to analyse the colourants present in the tattoo inks. Polarised light microscopy was also used to corroborate the spectroscopy findings. It should be noted that Raman spectroscopy analysis may not have been able to identify colourants present in very small amounts.

3.4.4. Results and discussion

3.4.4.1. Visual examination

The containers of the tattoo ink brands Intenze, Starbrite and Kuro Sumi list the ingredients, including a complete list of colourants. Fusion brand lists the colourant ingredients generically as non-toxic pigments. The brands Royal Talens, Eternal and Dynamic provide no information on the label about the composition of the tattoo inks.

The container of the Royal Talens ink selected for analysis states that it is “Not for tattoo”. Despite this, it was identified as used for tattooing by a number of tattoo artists surveyed in March and April 2015.

3.4.4.2. Chemical analysis and results

The analysis commenced in July 2015 and was completed in August 2015 with the delivery of the tattoo ink analysis reports. The findings of the analysis are described in detail in the following sections.

3.4.4.3. Metal content of analysed tattoo inks

Barium was detected in 14 of the 49 tattoo inks analysed (29%), and in 12 tattoo inks the amount of barium present was significantly greater than trace amounts (>100 ppm), ranging from 3,000 to 7,800 ppm (0.3 to 0.8%). While it is possible that the barium in these tattoo inks was a contaminant, the significant amounts may also indicate that barium compounds were deliberately added. Barium in tattoo inks is associated with yellow azo colourant ingredients.

The analysis quantified soluble copper rather than total copper. This is an important distinction as the phthalocyanine colourants commonly used in green and blue tattoo inks contain bound copper as part of their molecular structure. Of the 49 tattoo inks analysed, 17 (35%) contained soluble copper, with the concentration above trace levels (>100 ppm, with some inks containing up to 35,000 ppm) in 12 of the tattoo inks. All tattoo inks containing a phthalocyanine colourant were found to contain detectable levels of soluble copper. The likely source of the soluble copper is contamination during manufacture of the colourant.

The majority of tattoo inks (40 of 49, or 82%) contained chromium at a concentration of up to 23 ppm. Chromium VI, a known sensitiser, was not detected in any of the tattoo inks.

It has been suggested that the concentration of nickel in consumer products should be below 5 ppm and if possible below 1 ppm (Basketter et al, 2003). Nickel was present in 46 of the 49 tattoo inks (94%). Except for the tattoo ink Fusion Ink Melon Red (11 ppm), nickel was below 5 ppm in the other tattoo inks.

Other metals were also detected in the tattoo inks analysed as outlined in Table 4 below.

Table 4: Proportion and maximum concentration of selected metals in the 49 tattoo inks analysed.

Metal	Number of tattoo inks (% of total)	Maximum concentration (ppm)
Antimony	1 (2%)	1.2
Arsenic	1 (2%)	1.6
Lead	1 (2%)	1.9
Mercury	2 (4%)	0.7
Selenium	2 (4%)	2.0
Strontium	12 (24%)	310
Zinc	2 (4%)	28

3.4.4.4. Amines as contaminants or breakdown products of azo colourants

Amines were detected in 17 of the 49 tattoo inks analysed (35%). The presence of amines is associated with the use of azo pigments as colourants in tattoo inks. All the tattoo inks in which amines were present contain azo colourants. Twenty-four of the tattoo inks analysed contain at least one azo colourant and, of these, amines were detected in 17 (71%).

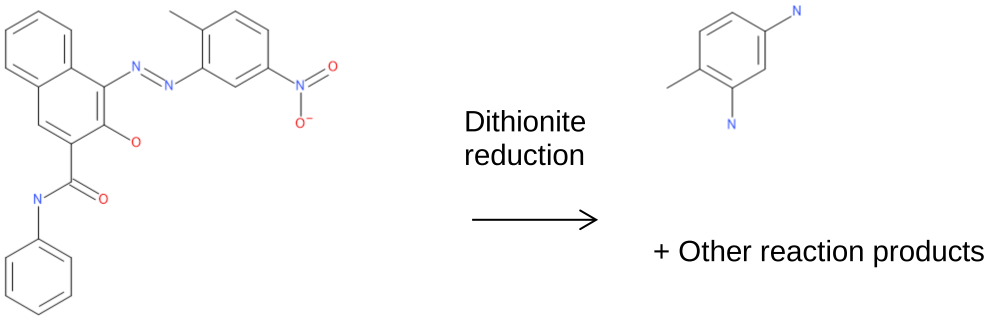
The three amines identified in tattoo inks are:

- 1,3-benzenediamine, 4-methyl- (4-methyl-m-phenylenediamine, CAS RN 95-80-7)
- benzenamine, 2-methyl- (o-toluidine, CAS RN 95-53-4), and
- benzenamine, 2-methoxy- (o-anisidine, CAS RN 90-04-0).

The concentration of the individual amines generally ranged between 15 and 89 ppm, with the exception of Fusion Ink Melon Red discussed below. Some of the tattoo inks in which amines were detected contained two or three amines.

The structures of the azo colourants in the tattoo inks containing amines were examined to identify the possible sources of the amines. Except for one tattoo ink, reduction of the azo colourants during analysis would not have resulted in the amines identified. This suggests that, for the majority of amine-containing tattoo inks, amines were introduced at some point during manufacture, most likely during the manufacture of the azo colourants. The exception is Fusion Ink Melon Red, where reduction of Pigment Red 22 with dithionite can produce 1,3-benzenediamine, 4-methyl- (CAS RN 95-80-7) (Figure 1). The concentration of this chemical (CAS RN 95-80-7) in this tattoo ink (21,000 ppm or 2.1%) is three orders of magnitude higher than the amines detected in the other tattoo inks, which is consistent with the source being the breakdown of the major colourant, Pigment Red 22. However, as noted in section 3.4.3.3, it is not possible to conclusively determine the source of the chemical (CAS RN 95-80-7) in this tattoo ink.

Figure 1: Dithionite reduction of Pigment Red 22 to form 1,3-benzenediamine, 4-methyl-



A number of the tattoo inks examined contained the benzidine congener-based pigments—Pigment Orange 13, Pigment Orange 16, Pigment Yellow 14 and Pigment Yellow 83. Azo bond reduction of these colourants results in the amines 3,3′-DMOB (CAS RN 119-90-4) for Pigment Orange 16, and 3,3′-DCB (CAS RN 91-94-1) for the others. While these amines should have been detected in tattoo inks containing benzidine congener-based pigments, they were below the limit of detection in all tattoo inks examined.

The method for the quantification of amines was developed for use with textiles and leather and subsequently adapted for tattoo inks. This method has been used by regulatory agencies to measure amines in tattoo inks and is recommended for this purpose by ResAP(2008)1. However, it is unclear if the assay method has been adequately validated for use with tattoo ink samples. It is therefore possible that, for technical reasons, the assay method may have limitations in determining breakdown products of azo colourants in tattoo inks. This also highlights the need for validated methods for the analysis of tattoo inks. Another possibility is that under the reducing conditions of the assay, these four pigments do not react significantly with dithionite to form the expected breakdown products.

3.4.4.5. Polycyclic aromatic hydrocarbons (PAHs)

PAHs were detected in 11 of the 49 tattoo inks analysed (22%) at an average total concentration of 9.0 ppm and a maximum total concentration of 16.7 ppm. With the exception of a single blue tattoo ink (Fusion Ink Power Blue), all the tattoo inks containing PAHs were black tattoo inks, in which the colourant is Pigment Black 7 (carbon black). PAHs in tattoo inks are associated with the use of Pigment Black 7 as colourant, and of the 12 black tattoo inks analysed, 10 (83%) contain PAHs. Pigment Black 7 is produced by the incomplete combustion of hydrocarbons and contamination during manufacture of this colourant is the most likely source of the PAHs identified.

Of the PAHs detected, naphthalene (CAS RN 91-20-3), acenaphthylene (CAS RN 208-96-8), fluoranthene (CAS RN 206-44-0), pyrene (CAS RN 129-00-0), and benzo(ghi)perylene (CAS RN 191-24-2) are frequently found in the tattoo inks, with pyrene the most abundant PAH. Phenanthrene (CAS RN 85-01-8) is also present in some black tattoo inks.

3.4.4.6. Identification of colourants in tattoo inks

A total of 19 unique colourants (Table 5) were identified as ingredients of the 49 tattoo inks analysed. Except for Pigment Red 209 (CI 73905, CAS RN 3573-01-1), the remaining colourants were also identified earlier as likely colourants in tattoo inks through the desktop research on tattoo ink ingredients. Colourants identified in the current analysis can be grouped into classes as inorganic, azo, phthalocyanine, indigoid and oxazine.

There are a number of trends evident in the use of colourants in the tattoo inks analysed. The colourant Pigment Black 7 is used exclusively in black and greywash tattoo inks. All the blue and most of the green tattoo inks use phthalocyanine colourants, with Pigment Blue 15 present in all blue tattoo inks and Pigment Green 7 used in the majority of green tattoo inks. Red and yellow tattoo inks all contain azo colourants. The analysis showed that there is diversity in azo compared to phthalocyanine colourants, with 6 red, 5 yellow and 2 orange colourants identified in red and yellow tattoo inks. Further, tattoo inks with a red base colour frequently use yellow and orange colourants, and likewise yellow base colour tattoo inks also use red and orange colourants. Most of the green tattoo inks contain a significant amount of yellow colourants. Of the 10 green tattoo inks analysed, 8 inks contain yellow colourant; in 5 inks, yellow is one of the major colourants; and 2 inks contain no recognised green colourant and only yellow colourants.

Table 5: Colourants Identified as ingredients of the 49 tattoo inks analysed

Common name	CI no.	CAS no.	CAS name
Pigment Black 7	77266	1333-86-4	Carbon black
Pigment Blue 15, α isoform	74160	147-14-8	Copper, [29*H*,31*H*-phthalocyaninato(2-)-κN^{29},κN^{30}, κN^{31},κN^{32}]-, (*SP*-4-1)-
Pigment Blue 15, β isoform	74160	147-14-8	Copper, [29*H*,31*H*-phthalocyaninato(2-)-κN^{29},κN^{30}, κN^{31},κN^{32}]-, (*SP*-4-1)-
Pigment Green 7	74260	1328-53-6	C.I. Pigment Green 7
Pigment Orange 13	21110	3520-72-7	3*H*-Pyrazol-3-one, 4,4'-[(3,3'-dichloro[1,1'-biphenyl]-4,4'-diyl) bis(2,1-diazenediyl)]bis[2,4-dihydro-5-methyl-2-phenyl-
Pigment Orange 16	21160	6505-28-8	Butanamide, 2,2'-[(3,3'-dimethoxy[1,1'-biphenyl]-4,4'-diyl) bis(2,1-diazenediyl)]bis[3-oxo-*N*-phenyl-
Pigment Red 22	12315	6448-95-9	2-Naphthalenecarboxamide, 3-hydroxy-4-[2-(2-methyl-5-nitrophenyl)diazenyl]-*N*-phenyl-
Pigment Red 101	77491	1309-37-1	Iron oxide (Fe_2O_3)
Pigment Red 122	73915	980-26-7	Quino[2,3-*b*]acridine-7,14-dione, 5, 12-dihydro-2,9-dimethyl-
Pigment Red 170	12475	2786-76-7	2-Naphthalenecarboxamide, 4-[2-[4-(aminocarbonyl)phenyl]diazenyl]-*N*-(2-ethoxyphenyl)-3-hydroxy-
Pigment Red 209	73905	3573-01-1	Quino[2,3-*b*]acridine-7,14-dione, 3, 10-dichloro-5,12-dihydro-
Pigment Red 210	12477	61932-63-6	C.I. Pigment Red 210
Pigment Violet 23, β isoform	51319	6358-30-1	Diindolo[2,3-*c*:2',3'-*n*] triphenodioxazine, 9,19-dichloro-5, 15-diethyl-5,15-dihydro-
Pigment White 6, rutile	77891	13463-67-7	Titanium oxide (TiO_2)

Common name	CI no.	CAS no.	CAS name
Pigment Yellow 14	21095	5468-75-7	Butanamide, 2,2'-[(3,3'-dichloro[1, 1'-biphenyl]-4,4'-diyl)bis(2,1-diazenediyl)]bis[*N*-(2-methylphenyl) -3-oxo-
Pigment Yellow 42, α isoform	77492	51274-00-1	C.I. Pigment Yellow 42
Pigment Yellow 65	11740	6528-34-3	Butanamide, 2-[2-(4-methoxy-2-nitrophenyl)diazenyl]-*N*-(2-methoxyphenyl)-3-oxo-
Pigment Yellow 74	11741	6358-31-2	Butanamide, 2-[2-(2-methoxy-4-nitrophenyl)diazenyl]-*N*-(2-methoxyphenyl)-3-oxo-
Pigment Yellow 83	21108	5567-15-7	Butanamide, 2,2'-[(3,3'-dichloro[1, 1'-biphenyl]-4,4'-diyl)bis(2,1-diazenediyl)]bis[*N*-(4-chloro-2,5-dimethoxyphenyl)-3-oxo-

3.4.5. Regulatory compliance

The following describes the status of the identified chemicals in relation to:

- their listing on AICS
- the schedules of the Poisons Standard
- the Hazardous Substances Information System (HSIS) and consequent labelling requirements
- assessments conducted under NICNAS's Inventory Multi-tiered Assessment and Prioritisation (IMAP) program
- ingredient information provided by the manufacturer.

These findings are current as of April 2016.

3.4.5.1. Comparison of analysis results with ingredients listed on labels

Colourants identified as being present in tattoo inks by Raman spectroscopy were compared with colourant ingredients printed on the packaging. Metals and PAHs are likely to be contaminants, while amines could be breakdown products or contaminants; therefore, these are non-intentional ingredients and not required to be listed on the packaging. In general, the tattoo ink packaging lists the colourants and the medium in which they are suspended.

Three of the seven brands examined—Intenze, Starbrite and Kuro Sumi—provide detailed ingredient information on the labels/containers, including the colourants used. The colourants identified in Starbrite and Kuro Sumi tattoo inks through analysis are consistent with those listed on the label. The colourants described on the Intenze containers are generally consistent with those identified by Raman spectroscopy. However, three Intenze tattoo inks labels list incorrect colourants as outlined in Table 6.

Table 6: Incorrectly identified colourants in Intenze tattoo inks

Tattoo ink	Colourants listed on label	Actual colourants
Intenze Cherry Bomb	Pigment Violet 1 Pigment Red 210 Pigment Orange 13 Pigment White 6	**Pigment Red 122** Pigment Orange 13 Pigment White 6
Intenze Grasshopper Green	Pigment Blue 15 Pigment Yellow 65 Pigment White 6	**Pigment Green 7** Pigment Yellow 65 Pigment White 6
Intenze Light Green	Pigment Blue 15 Pigment Yellow 65 Pigment White 6	**Pigment Green 7** Pigment Yellow 65 Pigment White 6

Colourants highlighted in bold are not permitted in tattoo inks under ResAP(2008)1. The analysis showed that the colourants listed on the label are inaccurate; therefore, the ink is non-compliant with ResAP(2008)1.

3.4.5.2. Australian Inventory of Chemical Substances (AICS) status of analysed chemicals in tattoo inks

Most of the chemicals in the analysed tattoo inks are listed on the Australian Inventory of Chemical Substances (AICS).

Pigment Red 210 (CI 12477, CAS RN 61932-63-6) is not listed on the AICS and is an ingredient in three of the tattoo inks analysed. This colourant is a mixed coupling product of Pigment Red 170 (CI 12475, CAS RN 2786-76-7) and Pigment Red 266 (CI 12474, CAS RN 36968-27-1), both of which are present on the AICS. Therefore, for AICS purposes, Pigment Red 210 is considered to be an existing chemical and listed on the AICS by virtue of being a mixture of Pigment Red 170 and Pigment Red 266.

The PAHs acenaphthylene (CAS RN 208-96-8) and benzo(ghi)perylene (CAS RN 191-24-2) are not listed on AICS. According to the *Industrial Chemicals (Notification and Assessment) Act 1989* (ICNA Act), incidentally produced chemicals are not considered to be new industrial chemicals for regulatory purposes. Therefore, tattoo inks containing CAS RN 208-96-8 and CAS RN 191-24-2 as contaminants can be imported without notification to NICNAS.

3.4.5.3. Poisons Standard status of analysed chemicals in tattoo inks

The Poisons Standard consists of decisions regarding the classification of medicines and poisons into schedules for inclusion in relevant state and territory legislation. The Poisons Standard also includes model provisions for containers and labels, a list of products recommended to be exempt from these provisions, and recommendations for other controls on drugs and poisons. If a preparation contains two or more poisons, the provisions relating to each of the schedules in which those poisons are included apply.

Listings in Schedules 2, 3, 4, 8 and 9 are not considered in this report as they are relevant for medicines and research/teaching chemicals. Schedules 5, 6, 7 and 10 are relevant to chemicals in products that are available for use by the general public. Schedules 7 and 10 of the Poisons Standard control the use and availability of chemicals in the workplace. The tattoo inks analysed are intended for use by professional tattooists and are therefore regarded as workplace chemicals. Compliance with the Poisons Standard was reviewed as it is noted that these products are also available to the general public and that non-professional tattooing is a relatively common practice.

The chemicals present in some of the tattoo inks analysed means requirements for Schedules 5, 6 or 7 apply to them. None of these tattoo inks met the labelling requirements specified in these schedules. However, as noted above, the tattoo inks are primarily intended for use by professionals.

3.4.5.3.1 Metals quantified

Schedule 6 entries for the metals barium, chromium, lead and antimony are applicable to 40 of the 49 tattoo inks analysed. A requirement for Schedule 6 entries is use of the signal word ‘Poison’ on the labels.

The Schedule 6 entry for iron compounds applies to tattoo inks containing the iron oxide colourants Pigment Red 101 and Pigment Yellow 42. Publicly available scientific literature indicates that these colourants and most inorganic tattoo colourants currently in use are of low concern.

Three of the tattoo inks analysed contain metals above the cut-offs listed in Schedule 7 (Table A4 in the Appendix): Starbrite Yellow Glow contains 1.6 ppm (mg/kg) of arsenic, Intenze Bright Red 1 ppm of selenium and Kuro Sumi Greywash 2 ppm selenium. Schedule 7 chemicals should only be available to specialised or authorised users and not to the general public.

3.4.5.3.2 Amines

The Poisons Standard prohibits 1,2-benzenediamine (CAS registry number (RN) 95-54-5), 1,3-benzenediamine (CAS RN 108-45-2) and 2,4-toluenediamine (CAS RN 95-80-7) in tattoo ink preparations through their listing in Schedule 10 of the Poisons Standard. Of these Poisons Standard entries, only CAS RN 95-80-7 was quantified. The other two amines were not quantified as part of the current analysis as they required a new test method to be developed. The Poisons Standard also has a group entry prohibiting phenylenediamines including alkylated, arylated and nitro derivatives in tattoo inks, incorporating the amines CAS RN 615-05-4 and CAS RN 106-50-3, which were included in the analysis but not detected in any of the tattoo inks. Many of the remaining amines analysed are listed in the Poisons Standard under entries not specific to tattoo inks (Table A6 in the Appendix).

The chemical 1,3-benzenediamine, 4-methyl- (4-methyl-m-phenylenediamine, CAS RN 95-80-7) was identified in two tattoo inks, Eternal Ink True Gold and Fusion Ink Melon Red. This amine is listed in Schedule 10 under the entry 2,4-toluenediamine as not permitted at any concentration in tattoo ink preparations. However, as discussed previously, in the case of Fusion Ink Melon Red it is possible that some or all of the CAS RN 95-80-7 detected may be the result of dithionite reduction of Pigment Red 22. Therefore, the amine CAS RN 95-80-7 potentially occurs as a contaminant during the manufacture of azo colourants or as a breakdown product of azo colourants. Depending on the rate and conditions of reduction during normal tattoo ink use, the potential breakdown products may not be present at the concentrations identified or even at biologically relevant levels during use. However, the potential of Pigment Red 22 to form CAS RN 95-80-7 warrants further investigation of the risk posed by this colourant.

3.4.5.3.3 PAHs

Naphthalene (CAS RN 91-20-3) at or above 1 mg per L is listed in Schedule 6, which applies to 6 of the 49 tattoo inks analysed. The other PAH species (CAS RN 208-96-8, 206-44-0, 129-00-0, 191-24-2 and 85-01-8) are listed in Schedule 5 under the group entry for hydrocarbons, liquid. Listing in schedule 5 requires products available for consumer use to be labelled with the word ‘Caution’.

3.4.5.4. Hazard classification of analysed tattoo ink chemicals as listed on the Hazardous Substances Information System

Safe Work Australia administers the Model Work Health and Safety (WHS) Regulations, which contain detailed requirements to support the duties in the Model WHS Act. They are model provisions only. To be legally binding, they need to be enacted or passed by Parliament in each state and territory jurisdiction. Hazardous chemicals in the workplace must be correctly labelled and a SDS provided during supply. Safe Work Australia also administers the Hazardous Substances Information System (HSIS), a database containing hazard classifications and exposure standards for many chemicals used in Australian workplaces.

Chemicals identified as ingredients of tattoo inks were queried against this database to determine their hazard classification. Many of the metals, amines and PAHs quantified are classified as hazardous in the HSIS (Table A4, A5 and A6 in the Appendix); however, the concentration of each chemical in the tattoo inks was low and below the hazard classification threshold. Therefore, the tattoo inks are not classified as hazardous.

3.4.5.5. NICNAS assessments of chemicals identified in tattoo inks

3.4.5.5.1 Amines

Three amines identified in a number of the tattoo inks analysed (CAS RN 95-80-7, 95-53-4 and 90-04-0) have undergone Tier II risk assessments under the IMAP Framework.

An IMAP assessment found that CAS RN 95-80-7 is both genotoxic and carcinogenic (NICNAS, 2016a). Following the recommendation in the IMAP report on the chemical CAS RN 95-80-7, the chemical has been included in Schedule 10 of the Poisons Standard for its use in hair dyes and tattoo inks. However, further assessment for risk management purposes of other chemicals in tattoo inks that breakdown to CAS RN 95-80-7 may be warranted..

An IMAP assessment found that CAS RN 90-04-0 could be carcinogenic following long-term repeated exposure and a genotoxic mode of action cannot be excluded (NICNAS, 2016b). In the IMAP report, potential exposure through tattoo inks is noted, and the risk was considered in the assessment for Pigment Yellow 74 (CAS RN 6358-31-2) (NICNAS, 2016c). The IMAP report for CAS RN 90-04-0 recommends that formulators and importers of tattoo inks should consider substituting products containing this chemical.

The IMAP report for CAS RN 95-53-4 found that it could be carcinogenic following long-term repeated exposure and a genotoxic mode of action cannot be excluded (NICNAS, 2016d), and also notes potential exposure via tattoo inks and that the risk posed by this exposure would be considered in subsequent IMAP assessments. However, no azo colourants that could degrade to this amine were identified on the Stage 1 IMAP list, and therefore the risk of CAS RN 95-53-4 as a breakdown product of tattoo ink colourants was not considered.

3.4.5.5.2 PAHs

The six PAH species identified in tattoo inks are all impurities, most likely introduced during manufacture of Pigment Black 7. Apart from acenaphthylene (CAS RN 208-96-8) and benzo(ghi)perylene (CAS RN 191-24-2), which are not listed on the AICS, the remaining PAHs analysed have undergone IMAP assessments. Tier I IMAP assessment is a high throughput approach using tabulated electronic data. Tier I assessments were conducted for fluoranthene (CAS RN 206-44-0), pyrene (CAS RN 129-00-0), and phenanthrene (CAS RN 85-01-8) (NICNAS, 2016e), as these chemicals were not identified as having any industrial uses, and so these chemicals were not considered to pose an unreasonable risk to the health of workers and the public. The Tier II risk assessment for naphthalene (CAS RN 91-20-3) did not consider exposure, risk management or further assessment for this chemical as a component of tattoo inks (NICNAS, 2016f). The assessments did not cover the possible presence of these chemicals as incidentally produced substances in products such as tattoo inks.

3.4.5.5.3 Colourants

IMAP assessments of eight of the colourants identified during analysis have been completed.

Pigment Black 7 (CI 77266, CAS RN 1333-86-4) (NICNAS, 2016g) and Pigment White 6 (CI 77891, CAS RN 13463-67-7) (NICNAS, 2016h) were assessed for their use in tattoo inks and current controls are considered sufficient to manage the risk posed by these chemicals. Pigment Green 7 (CI 74260, CAS RN 1328-53-6) was also assessed as an IMAP Tier I assessment and found to not pose an unreasonable risk to the health of workers and the public (NICNAS, 2016e).

The colourants Pigment Orange 13 (CI 2110, CAS RN 3520-72-7), Pigment Orange 16 (CI 21160, CAS RN 6505-28-8), Pigment Yellow 14 (CI 21095, CAS RN 5468-75-7) and Pigment Yellow 83 (CI 21108, CAS RN 5567-15-7) were assessed as a category assessment for selected benzidine-congener-based pigments (NICNAS, 2016i). Overall, the assessment found that available data indicate that these chemicals have limited bioavailability. Limited uptake of the chemicals in particle form cannot be ruled out. Generally, the systemic acute and long-term toxicity of the chemicals through dermal, inhalation and oral exposure is considered low. However, emerging evidence indicate that these chemicals can undergo photodegradation upon exposure to various sources of light, in particular solar radiation and lasers. The potential breakdown products 3,3'-DCB (CAS RN 91-94-1) and 3,3'-DMOB (CAS RN 119-90-4) are reasonably anticipated to be human carcinogens. The assessment included the following recommendations:

- Given the limited information on the photodegradation of pigments in tattoo inks and permanent makeup into carcinogenic substances, the chemicals are recommended for Tier III IMAP assessment.
- Formulators and importers of tattoo inks should consider substituting products which contain the pigments in this group.

The above benzidine congener colourants were commonly present in the tattoo inks analysed, and members of this group were identified in 11 of 25 tattoo inks (44%) containing an azo colourant. The chemical analysis also examined the presence of the amines 3,3'-DCB or 3,3'-DMOB, the potential breakdown products of the benzidine congeners and these were not detected in any of the inks analysed. This indicates that, there was no breakdown of the above benzidine congener colourants into 3,3'-DCB or 3,3'-DMOB in the samples analysed. Due to the issues previously noted with the procedure for amine analysis (section 3.4.5.5.3), it is unclear whether these chemicals may have been present as colourant breakdown products or contaminants introduced during manufacture.

A Tier II assessment has been conducted for Pigment Yellow 74 (CI 11741, CAS RN 6358-31-2) (NICNAS, 2016c). No critical health effects were identified except under conditions where the azo bond is reduced. Due to the potential to form the carcinogenic breakdown product anisidine, recommendations similar to those for selected benzidine-congener-based pigments were made regarding Tier III assessment and products containing this pigment. The need for further regulatory control for public health protection will be determined as part of the Tier III assessment. Pigment Yellow 74 is a common azo colourant in the tattoo inks analysed, and was present in 6 of 25 (24%) of the tattoo inks containing an azo colourant.

Nickel salts have been assessed as Tier II IMAP assessments and these assessments recommended that the entry for nickel sulfate in Schedule 6 be amended to specify nickel soluble salts (NICNAS, 2016j; NICNAS 2016k; NICNAS 2016l). However, the scheduling delegate decided not to implement this recommendation. A key consideration was that the NICNAS assessment and advice from the Advisory Committee on Chemicals Scheduling did not identify a potential use for soluble nickel salts other than nickel sulfate in domestic products. If this recommendation had been adopted, then it would have applied to 46 of the 49 tattoo inks analysed.

3.4.6. Compliance of tattoo inks with ResAP(2008)1

ResAP(2008)1 specifies requirements for the composition, labelling, use and risk evaluation of tattoo inks in some European countries. Therefore, comparison of the chemical analysis with ResAP(2008)1 provides an indication of the compliance of these inks in regulatory jurisdictions outside Australia. Of the 49 tattoo inks tested, only 4 (8%) were compliant with ResAP(2008)1. The tattoo inks were non-compliant either because they contained ingredients prohibited under ResAP(2008)1 or by exceeding the concentrations allowed under it. Many of the tattoo inks tested are non-compliant for more than one reason—for example one of the inks tested contained two metals above the permitted limit, a prohibited amine, and a prohibited colourant.

Compliance is poor across the brands analysed as shown in Table 7. It should be noted that five of the Starbrite inks were selected for analysis because they were potentially non-compliant (ie selection bias was present in the sample). Therefore, none of the brands stands out as particularly better or worse than others regarding compliance with ResAP(2008)1.

Table 7: Compliance of tattoo inks analysed with ResAP(2008)1 sorted by brand

Brands	Number of inks tested	Number of inks compliant with ResAP(2008)1
Intenze	10	0
Fusion Inks	10	0
Eternal inks	10	1
Starbrite inks	15	2
Dynamic ink	1	0
Kuro Sumi	2	0
Royal Talens	1	1

Specific causes for non-compliance with ResAP(2008)1 are outlined in Table 8. There are a number of trends evident when the type of ink is considered; specifically, the base colour and colourants used. Notably, PAH is associated with Pigment Black 7, barium with yellow azo colourants, copper with phthalocyanine colourants, and amines with azo colourants. Potential reasons for these associations have been discussed previously in this report.

Table 8: Proportion, base colour and colourants of tattoo inks non-compliant with ResAP(2008)1 and non-compliant ingredients

Non-compliant ingredients	Proportion non-compliant inks	Predominant base colour	Predominant colourants
Barium	12 of 49 (24%)	Yellow	Yellow azo
Copper	15 of 49 (31%)	Blue and Green	Phthalocyanine
Mercury	1 of 49 (2%)	None	None
Amines	17 of 49 (35%)	Red and Yellow	Azo
PAHs	11 of 49 (27%)	Black	Pigment Black 7
colourants	16 of 49 (33%)	Green, Red, Yellow, Blue, Purple	Pigment green 7, Pigment red 122, Pigment violet 23, Pigment yellow 83

Tattoo inks were selected from one of six base colours for analysis (black, red, yellow, green, blue and purple).

4. Recommendations

4.1. Public health protection

Schedules 5, 6, 7 and 10 of the Poisons Standard are relevant to chemicals in products that are available for use by the general public, while Schedules 7 and 10 control the use and availability of chemicals in the workplace. As noted earlier, tattoo inks available in Australia are intended for use by professionals; however, use of these tattoo inks by the general public is not uncommon.

It is recommended that the information in this report be used in risk assessments and subsequent consideration of public health risk management controls, if warranted.

In summary:

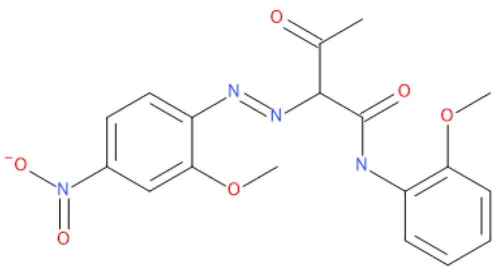
- Benzenamine, 2-methyl- (CAS RN 95-53-4) and benzenamine, 2-methoxy- (CAS RN 90-04-0) have been identified as being present in certain tattoo inks used in Australia. ResAP(2008)1 does not permit the presence of these amines in tattoo ink preparations.

  The other amines that were analysed are listed in Table A5 in the Appendix. These amines were not present in any of the tattoo inks examined; however, they may be present in other tattoo inks used in Australia. In addition, ResAP(2008)1 does not permit the presence of these amines in tattoo ink preparations.

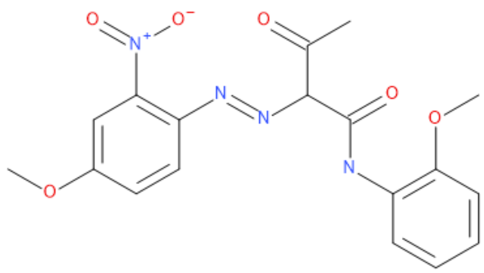
- Pigment Yellow 74 and Pigment Yellow 65 have been identified as ingredients of tattoo inks in the chemical analysis. This report has identified that Pigment Yellow 74 is a common ingredient in tattoo inks. Pigment Yellow 65 is structurally similar to Pigment Yellow 74 as shown in Figure 2, and is also a common colourant in tattoo inks. Its chemical similarity to Pigment Yellow 74 warrants consideration of the need for similar regulatory controls for Pigment Yellow 65.

  Certain reduction products of Pigment Yellow 74 and 65 are not permitted in tattoo inks under the Schedule 10 Poisons Standard entry for phenylenediamines; 1,4-benzenediamine, 2-methoxy- (CAS RN 5307-02-8) for Pigment Yellow 74 and 1,2-benzenediamine, 4-methoxy- (CAS RN 102-51-2) for Pigment Yellow 65. Additionally, in vitro studies have shown that Pigment Yellow 74 can be metabolised in the body, and that the pigment breaks down in sunlight to produce aromatic amines (Cui et al, 2004; Cui et al, 2005).

Figure 2: Structural comparison of Pigment Yellow 74 (CAS RN 6358-31-2) and Pigment Yellow 65 (CAS RN 6528-34-3)



Pigment Yellow 74



Pigment Yellow 65

- Pigment Red 22 has been identified as an ingredient of tattoo inks in Australia by the chemical analysis undertaken. The quantification of amines has further identified that dithionite reduction of Pigment Red 22 produces 2,4-toluenediamine (1,3-benzenediamine, 4-methyl-, CAS RN 95-80-7). In vivo studies have shown that Pigment Red 22 breaks down under laser irradiation to produce aromatic amines, while in vitro studies have demonstrated that UVB and sunlight degrades this pigment to also produce aromatic amines (Engel et al, 2007; Engel et al 2010).

  ResAP(2008)1 does not permit the use of Pigment Red 22 in tattoo ink preparations.

- The chemical analysis undertaken has confirmed that the benzidine-congener-based pigments, Pigment Orange 13 (CI 2110, CAS RN 3520-72-7), Pigment Orange 16 (CI 21160, CAS RN 6505-28-8), Pigment Yellow 14 (CI 21095, CAS RN 5468-75-7) and Pigment Yellow 83 (CI 21108, CAS RN 5567-15-7) are present as ingredients of tattoo inks used in Australia. Desktop analysis of ingredient information provided by manufacturers identified an additional benzidine congener-based pigment, Pigment Orange 34 (CI 21115, CAS RN 15793-73-4), as an ingredient of tattoo inks available in Australia. The group IMAP assessment that includes these five benzidine-congener-based pigments recommends that the risk posed by these chemicals in tattoo inks is further investigated.

As summarised in Table 9, the activities undertaken by NICNAS have identified eight colourants that may warrant further risk assessment.

Table 9: List of tattoo ink colourants used in Australia and their concerns

Colourant	CAS no.	Concerns
Pigment Yellow 74	6358-31-2	Carcinogenic breakdown products (IMAP). Reduction product 1,4-benzenediamine, 2-methoxy- (CAS RN 5307-02-8). Studies showing potential metabolism and breakdown in sunlight to aromatic amines.
Pigment Yellow 65	6528-34-3	Structural similarity to Pigment Yellow 74. Reduction product 1,2-benzenediamine, 4-methoxy- (CAS RN 102-51-2).
Pigment Red 22	6448-95-9	Reduction product 1,3-benzenediamine, 4-methyl- (CAS RN 95-80-7). In vivo and in vitro studies demonstrating breakdown to produce aromatic amines. Not permitted in tattoo inks by regulations in other countries.
Pigment Orange 13	3520-72-7	Carcinogenic breakdown products (IMAP).
Pigment Orange 16	6505-28-8	Carcinogenic breakdown products (IMAP).
Pigment Orange 34	15793-73-4	Carcinogenic breakdown products (IMAP).
Pigment Yellow 14	5468-75-7	Carcinogenic breakdown products (IMAP).
Pigment Yellow 83	5567-15-7	Carcinogenic breakdown products (IMAP).

- Chemical analysis of tattoo inks has identified nickel as present in products used on consumers. This information was not available when these compounds were recommended for scheduling following an earlier IMAP assessment.
- The six PAH species identified in tattoo inks are all impurities, most likely introduced during manufacture of Pigment Black 7. The information could be used to control the use of crude grades of Pigment Black in tattoo inks.

4.2. Recommendations to state and territory health authorities

To note that:

- Royal Talens ink brand is being sold and used for tattooing purposes in Australia when the container labelling indicates that it is not intended for this purpose.
- The tattoo inks Intenze Cherry Bomb, Intenze Grasshopper Green and Intenze Light Green contain inaccurate listing of ingredients on the labels. There are no specific health concerns regarding these tattoo inks; however, users should be aware of the discrepancy between the stated and actual ingredients.
- A number of the tattoo inks analysed are non-compliant with the Poisons Standard. Starbrite Yellow Glow, Intenze Bright Red, and Kuro Sumi Grey Wash contain metals listed in Schedule 7 of the Poisons Standard. Eternal Ink True Gold contains 2,4-toluenediamine, which is not permitted in tattoo inks through its listing on Schedule 10 of the Poisons Standard. In addition, Fusion Ink Melon Red contains a colourant ingredient that breaks down to form 2,4-toluenediamine, and 2,4-toluenediamine may also be present in this tattoo ink.

The concentration of the ingredients quantified may vary according to lot/batch. Lot and batch numbers for the tattoo inks analysed are provided in Table A3 in the Appendix.

5. Acknowledgements

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7. Appendix

Table A1: Chemicals identified as present in tattoo inks likely to be used in Australia through desktop research

Chemical	CAS preferred name	CAS RN	CICN*
4-Methyl-m-phenylendiamine	1,3-Benzenediamine, 4-methyl-	95-80-7	
Acenaphthen	Acenaphthylene, 1,2-dihydro-	83-32-9	
Acenaphthylene	Acenaphthylene	208-96-8	
Aniline	Benzenamine	62-53-3	
Anthracene	Anthracene	120-12-7	
As (Arsenic)			
Ba (Barium)			
Basic red 1	Xanthylium, 9-[2-(ethoxycarbonyl)phenyl]-3,6-bis(ethylamino)-2,7-dimethyl-, chloride (1:1)	989-38-8	45160
Basic violet 10	Xanthylium, 9-(2-carboxyphenyl)-3,6-bis(diethylamino)-, chloride (1:1)	81-88-9	45170
Benzisothiazolon	1,2-Benzisothiazol-3(2H)-one	2634-33-5	
Benzo(a)pyrene	Benzo[a]pyrene	50-32-8	
Benzo(b)fluoranthene	Benz[e]acephenanthrylene	205-99-2	
Benzo(ghi)perylene	Benzo[ghi]perylene	191-24-2	
Cd (Cadmium)			
Co (Cobalt)			
Coumarin	2H-1-Benzopyran-2-one, 7-(diethylamino)-4-methyl-	91-44-1	
Cr (Chromium)			
Cu (Copper)			

Chemical	CAS preferred name	CAS RN	CICN*
D&C orange 5	Spiro[isobenzofuran-1(3H),9'-[9H]xanthen]-3-one, 4',5'-dibromo-3',6'-dihydroxy-	596-03-2	45370:1
D&C red 7	2-Naphthalenecarboxylic acid, 3-hydroxy-4-[2-(4-methyl-2-sulfophenyl)diazenyl]-, calcium salt (1:1)	5281-04-9	15850:1
Diazolidinyl urea	Urea, N-[1,3-bis(hydroxymethyl)-2,5-dioxo-4-imidazolidinyl]-N,N'-bis(hydroxymethyl)-	78491-02-8	
FD&C blue 1	Benzenemethanaminium, N-ethyl-N-[4-[[4-[ethyl[(3-sulfophenyl)methyl]amino]phenyl](2-sulfophenyl)methylene]-2,5-cyclohexadien-1-ylidene]-3-sulfo-, inner salt, aluminum salt (3:2)	15792-67-3	42090:2
Fluoranthene	Fluoranthene	206-44-0	
Fluorene	9H-Fluorene	86-73-7	
Formaldehyde	Formaldehyde	50-00-0	
Hg (Mercury)			
Hydroxymethyl amino ethanol	Ethanol, 2-(hydroxymethylamino)-	34375-28-5	
Indeno(1,2,3-cd)pyrene	Indeno[1,2,3-cd]pyrene	193-39-5	
Manganese violet	Diphosphoric acid, ammonium manganese(3+) salt	10101-66-3	77742
Melamine formaldehyde toluenesulfonamide polymer	Benzenesulfonamide, ar-methyl-, polymer with formaldehyde and 1,3,5-triazine-2,4,6-triamine	39277-28-6	
Naphthalene	Naphthalene	91-20-3	
Ni (Nickel)			
o-Anisidine	Benzenamine, 2-methoxy-	90-04-0	
Pb (Lead)			

Chemical	CAS preferred name	CAS RN	CICN*
PEG isoctylphenyl ether	Poly(oxy-1,2-ethanediyl), α-(isooctylphenyl)-ω-hydroxy-	9004-87-9	
Phenanthrene	Phenanthrene	85-01-8	
Pigment black 11	C.I. Pigment Black 11	12227-89-3	77499
Pigment black 7	Carbon black	1333-86-4	77266
Pigment blue 15:3	Copper, [29H,31H-phthalocyaninato(2-)-κN29,κN30,κN31,κN32]-, (SP-4-1)-	147-14-8	74160
Pigment blue 29	C.I. Pigment Blue 29	57455-37-5	77007
Pigment green 13	C.I. Pigment Green 13	148092-61-9	74200
Pigment green 17	Chromium oxide (Cr2O3)	1308-38-9	77288
Pigment green 18	C.I. Pigment Green 18	12001-99-9	77289
Pigment green 36	C.I. Pigment Green 36	14302-13-7	74265
Pigment green 7	C.I. Pigment Green 7	1328-53-6	74260
Pigment orange 13	3H-Pyrazol-3-one, 4,4'-[(3,3'-dichloro[1,1'-biphenyl]-4,4'-diyl)bis(2,1-diazenediyl)]bis[2,4-dihydro-5-methyl-2-phenyl-	3520-72-7	21110
Pigment orange 16	Butanamide, 2,2'-[(3,3'-dimethoxy[1,1'-biphenyl]-4,4'-diyl)bis(2,1-diazenediyl)]bis[3-oxo-N-phenyl-	6505-28-8	21160
Pigment orange 34	3H-Pyrazol-3-one, 4,4'-[(3,3'-dichloro[1,1'-biphenyl]-4,4'-diyl)bis(2,1-diazenediyl)]bis[2,4-dihydro-5-methyl-2-(4-methylphenyl)-	15793-73-4	21115
Pigment orange 5	2-Naphthalenol, 1-[2-(2,4-dinitrophenyl)diazenyl]-	3468-63-1	12075
Pigment red 101	Iron oxide (Fe2O3)	1309-37-1	77491
Pigment red 122	Quino[2,3-b]acridine-7,14-dione, 5,12-dihydro-2,9-dimethyl-	980-26-7	73915

Chemical	CAS preferred name	CAS RN	CICN*
Pigment red 146	2-Naphthalenecarboxamide, N-(4-chloro-2,5-dimethoxyphenyl)-3-hydroxy-4-[2-[2-methoxy-5-[(phenylamino)carbonyl]phenyl]diazenyl]-	5280-68-2	12485
Pigment red 17	2-Naphthalenecarboxamide, 3-hydroxy-4-[2-(2-methyl-5-nitrophenyl)diazenyl]-N-(2-methylphenyl)-	6655-84-1	12390
Pigment red 170	2-Naphthalenecarboxamide, 4-[2-[4-(aminocarbonyl)phenyl]diazenyl]-N-(2-ethoxyphenyl)-3-hydroxy-	2786-76-7	12475
Pigment red 174	Spiro[isobenzofuran-1(3H),9'-[9H]xanthen]-3-one, 2',4',5',7'-tetrabromo-4,5,6,7-tetrachloro-3',6'-dihydroxy-, aluminum salt (3:2)	15876-58-1	45410:2
Pigment red 187	2-Naphthalenecarboxamide, 4-[2-[5-[[[4-(aminocarbonyl)phenyl]amino]carbonyl]-2-methoxyphenyl]diazenyl]-N-(5-chloro-2,4-dimethoxyphenyl)-3-hydroxy-	59487-23-9	12486
Pigment red 2	2-Naphthalenecarboxamide, 4-[2-(2,5-dichlorophenyl)diazenyl]-3-hydroxy-N-phenyl-	6041-94-7	12310
Pigment red 210	C.I. Pigment Red 210	61932-63-6	12477
Pigment red 22	2-Naphthalenecarboxamide, 3-hydroxy-4-[2-(2-methyl-5-nitrophenyl)diazenyl]-N-phenyl-	6448-95-9	12315
Pigment red 23	2-Naphthalenecarboxamide, 3-hydroxy-4-[2-(2-methoxy-5-nitrophenyl)diazenyl]-N-(3-nitrophenyl)-	6471-49-4	12355
Pigment red 254	Pyrrolo[3,4-c]pyrrole-1,4-dione, 3,6-bis(4-chlorophenyl)-2,5-dihydro-	84632-65-5	56110
Pigment red 269	2-Naphthalenecarboxamide, N-(5-chloro-2-methoxyphenyl)-3-hydroxy-4-[2-[2-methoxy-5-[(phenylamino)carbonyl]phenyl]diazenyl]-	67990-05-0	12466

Chemical	CAS preferred name	CAS RN	CICN*
Pigment red 273	C.I. Food Red 17:1	68583-95-9	16035:1
Pigment red 4	2-Naphthalenol, 1-[2-(2-chloro-4-nitrophenyl)diazenyl]-	2814-77-9	12085
Pigment red 5	2-Naphthalenecarboxamide, N-(5-chloro-2,4-dimethoxyphenyl)-4-[2-[5-[(diethylamino)sulfonyl]-2-methoxyphenyl]diazenyl]-3-hydroxy-	6410-41-9	12490
Pigment red 57:2	2-Naphthalenecarboxylic acid, 3-hydroxy-4-[2-(4-methyl-2-sulfophenyl)diazenyl]-, barium salt (1:1)	17852-98-1	15850:2
Pigment red 63:1	2-Naphthalenecarboxylic acid, 3-hydroxy-4-[2-(1-sulfo-2-naphthalenyl)diazenyl]-, calcium salt (1:1)	6417-83-0	15880:1
Pigment violet 1	Xanthylium, 9-(2-carboxyphenyl)-3,6-bis(diethylamino)-, molybdatetungstatephosphate	1326-03-0	45170:2
Pigment violet 19	Quino[2,3-b]acridine-7,14-dione, 5,12-dihydro-	1047-16-1	73900
Pigment violet 23	Diindolo[2,3-c:2',3'-n]triphenodioxazine, 9,19-dichloro-5,15-diethyl-5,15-dihydro-	6358-30-1	51319
Pigment violet 27	Ferrate(4-), hexakis(cyano-κC)-, ammonium iron(3+) (1:1:1), (OC-6-11)-	25869-00-5	77510
Pigment white 6	Titanium oxide (TiO2)	13463-67-7	77891
Pigment yellow 100	C.I. Pigment Yellow 100	12225-21-7	19140:1
Pigment yellow 104	C.I. Pigment Yellow 104	15790-07-5	15985:1
Pigment yellow 119	C.I. Pigment Yellow 119	68187-51-9	77496
Pigment yellow 14	Butanamide, 2,2'-[(3,3'-dichloro[1,1'-biphenyl]-4,4'-diyl)bis(2,1-diazenediyl)]bis[N-(2-methylphenyl)-3-oxo-	5468-75-7	21095

Chemical	CAS preferred name	CAS RN	CICN*
Pigment yellow 151	Benzoic acid, 2-[2-[1-[[(2,3-dihydro-2-oxo-1H-benzimidazol-5-yl)amino]carbonyl]-2-oxopropyl]diazenyl]-	31837-42-0	13980
Pigment yellow 3	Butanamide, 2-[2-(4-chloro-2-nitrophenyl)diazenyl]-N-(2-chlorophenyl)-3-oxo-	6486-23-3	11710
Pigment yellow 42	C.I. Pigment Yellow 42	51274-00-1	77492
Pigment yellow 65	Butanamide, 2-[2-(4-methoxy-2-nitrophenyl)diazenyl]-N-(2-methoxyphenyl)-3-oxo-	6528-34-3	11740
Pigment yellow 74	Butanamide, 2-[2-(2-methoxy-4-nitrophenyl)diazenyl]-N-(2-methoxyphenyl)-3-oxo-	6358-31-2	11741
Pigment yellow 83	Butanamide, 2,2'-[(3,3'-dichloro[1,1'-biphenyl]-4,4'-diyl)bis(2,1-diazenediyl)]bis[N-(4-chloro-2,5-dimethoxyphenyl)-3-oxo-	5567-15-7	21108
Pigment yellow 97	Butanamide, N-(4-chloro-2,5-dimethoxyphenyl)-2-[2-[2,5-dimethoxy-4-[(phenylamino)sulfonyl]phenyl]diazenyl]-3-oxo-	12225-18-2	11767
Pyrene	Pyrene	129-00-0	
Antimony (Sb)			
Tin (Sn)			
Strontium (Sr)			
Witch hazel	Hamamelis virginiana, ext.	84696-19-5	
Zinc (Zn)			

***CICN: Colour Index Constitution Number**

Table A2: Colourants in tattoo inks likely to be used in Australia

Name	CAS RN	CICN	No. inks	Colourant type
Pigment black 7	**1333-86-4**	**77266**	**80**	**Inorganic**
Pigment black 11	12227-89-3	77499	33	Inorganic
FD&C blue 1	15792-67-3	42090:2	1	Triarylmethane
Pigment blue 15:3	**147-14-8**	**74160**	**112**	**Phthalocyanine**
Pigment blue 29	57455-37-5	77007	1	Inorganic
Pigment green 7	**1328-53-6**	**74260**	**58**	**Phthalocyanine**
Pigment green 13	148092-61-9	74200	1	Phthalocyanine
Pigment green 17	1308-38-9	77288	6	Inorganic
Pigment green 18	12001-99-9	77289	3	Inorganic
Pigment green 36	14302-13-7	74265	1	Phthalocyanine
D&C orange 5	596-03-2	45370:1	1	Xanthene
Pigment orange 5	3468-63-1	12075	3	Monoazo
Pigment orange 13	**3520-72-7**	**21110**	**45**	**Diazo**
Pigment orange 16	**6505-28-8**	**21160**	**31**	**Diazo**
Pigment orange 34	15793-73-4	21115	3	Diazo
Basic red 1	989-38-8	45160	1	Xanthene
D&C red 7	5281-04-9.	15850:1	8	Monoazo
Pigment red 2	6041-94-7	12310	1	Monoazo
Pigment red 4	2814-77-9	12085	2	Monoazo
Pigment red 5	6410-41-9	12490	1	Monoazo
Pigment red 17	6655-84-1	12390	1	Monoazo
Pigment red 22	6448-95-9	12315	1	Monoazo
Pigment red 23	6471-49-4	12355	1	Monoazo
Pigment red 57:2	17852-98-1	15850:2	5	Monoazo
Pigment red 63:1	6417-83-0	15880:1	1	Monoazo

Name	CAS RN	CICN	No. inks	Colourant type
Pigment red 101	**1309-37-1**	**77491**	**82**	**Inorganic**
Pigment red 122	**980-26-7**	**73915**	**14**	**Indigoid**
Pigment red 146	5280-68-2	12485	26	Monoazo
Pigment red 170	**2786-76-7**	**12475**	**33**	**Monoazo**
Pigment red 174	15876-58-1	45410:2	1	Xanthene
Pigment red 187	59487-23-9	12486	1	Monoazo
Pigment red 210	**61932-63-6**	**12477**	**43**	**Monoazo**
Pigment red 254	84632-65-5	56110	1	Aminoketone
Pigment red 269	67990-05-0	12466	18	Monoazo
Pigment red 273	68583-95-9	16035:1	7	Monoazo
Pigment violet 1	1326-03-0	45170:2	12	Xanthene
Basic violet 10	81-88-9	45170	1	Xanthene
Manganese violet	10101-66-3	77742	3	Inorganic
Pigment violet 19	**1047-16-1**	**73900**	**4**	**Indigoid**
Pigment violet 23	**6358-30-1**	**51319**	**21**	**Oxazine**
Pigment violet 27	25869-00-5	77510	1	Inorganic
Pigment white 6 (TiO2)	**13463-67-7**	**77891**	**288**	**Inorganic**
Pigment yellow 3	6486-23-3	11710	14	Monoazo
Pigment yellow 14	5468-75-7	21095	32	Diazo
Pigment yellow 42	**51274-00-1**	**77492**	**52**	**Inorganic**
Pigment yellow 65	6528-34-3	11740	48	Monoazo
Pigment yellow 74	**6358-31-2**	**11741**	**13**	**Monoazo**
Pigment yellow 83	**5567-15-7**	**21108**	**7**	**Diazo**
Pigment yellow 97	12225-18-2	11767	7	Monoazo
Pigment yellow 100	12225-21-7	19140:1	7	Monoazo
Pigment yellow 104	15790-07-5	15985:1	4	Monoazo

Name	CAS RN	CICN	No. inks	Colourant type
Pigment yellow 119	68187-51-9	77496	3	Inorganic
Pigment yellow 151	31837-42-0	13980	13	Monoazo

Colourants highlighted in bold are listed ingredients in the SDSs of at least three different manufacturers (section 3.2.2.2).

Table A3: Tattoo inks selected for chemical analysis

Brand	Product	Base colour	Manufacturing information*
Intenze	Zuper Black	Black	Batch BK116IMX40, Exp 01/31/2020
Intenze	Lining Black	Black	Batch BK114IMX40, Lot SS198, Exp 11/30/2019
Intenze	Bright Red	Red	Batch RD63Y71O67IMX40, Lot SS199, Exp 11/30/2019
Intenze	Cherry Bomb	Red	Batch M67O67W118RD63IMX40, Lot SS199, Exp 12/31/2019
Intenze	Banana Cream	Yellow	Batch W119Y72O67IMX40, Lot SS200, Exp 01/31/2020
Intenze	Golden Yellow	Yellow	Batch W118Y72, Lot SS199, Exp 12/31/2019
Intenze	Grasshopper	Green	Batch W115Y71G83IMX40, Lot SS197, Exp 10/31/2019
Intenze	Light Green	Green	Batch Y72W118G83, Lot SS199, Exp 12/31/2019
Intenze	Baby Blue	Blue	Batch W118B75IMX40, Lot SS199, Exp 12/31/2019
Intenze	Mario's Light Blue	Blue	Batch W118B75IMX40, Lot SS199, Exp 12/31/2019
Fusion	Power Black	Black	Lot no. 001, Expires 01/19/2018
Fusion	Basic Black	Black	Lot no. 001, Expires 01/19/2018
Fusion	Really Red	Red	Lot no. 001, Expires 01/19/2018
Fusion	Melon Red	Red	Lot no. 001, Expires 01/19/2018
Fusion	Atomic Yellow	Yellow	Lot no. 001, Expires 01/19/2018

Brand	Product	Base colour	Manufacturing information*
Fusion	Hot Mustard	Yellow	Lot no. 001, Expires 01/19/2018
Fusion	Key Lime	Green	Lot no. 001, Expires 01/19/2018
Fusion	Artichoke	Green	Lot no. 001, Expires 01/19/2018
Fusion	Light Blue	Blue	Lot no. 001, Expires 01/19/2018
Fusion	Power Blue	Blue	Lot no. 001, Expires 01/19/2018
Eternal	Lining Black	Black	Lot # 26, Exp date 01/26/18
Eternal	Grey Wash Dark	Black	Lot # 82, Exp date 03/23/18
Eternal	Crimson Red	Red	Lot #26, Exp date 01/26/18
Eternal	Lipstick Red	Red	Lot # 26, Exp date 01/26/18
Eternal	Lightning Yellow	Yellow	Lot # 281, Exp date 10/08/17
Eternal	True Gold	Yellow	Lot # 82, Exp date 03/23/18
Eternal	Avocado	Green	Lot # 281, Exp date 10/08/17
Eternal	Graffiti Green	Green	Lot # 26, Exp date 01/26/18
Eternal	Dark Cobalt	Blue	Lot # 26, Exp date 01/26/18
Eternal	Sky Blue	Blue	Lot # 280, Exp date 10/07/17
Starbrite	Tribal Black	Black	Lot TB135493, Exp date 03/12/18
Starbrite	Black Outliner	Black	Lot S0403364, Exp 07/28/17
Starbrite	Crimson Red	Red	Lot CR112978, Exp 09/12/17
Starbrite	Scarlet Red	Red	Lot SR1062770, Exp 03/12/18
Starbrite	Yellow Glow	Yellow	Lot YG156451, Exp 03/12/18
Starbrite	Canary Yellow	Yellow	Lot CY103399, Exp 03/12/18
Starbrite	Leaf Green	Green	LF142910, Exp 03/12/18
Starbrite	Green Fields	Green	Lot GF152483, Exp 03/12/18
Starbrite	Country Blue	Blue	Lot CT146010, Exp 03/12/18
Starbrite	Baby Blue	Blue	Lot BB147129, Exp 03/12/18

Brand	**Product**	**Base colour**	**Manufacturing information***
Starbrite	Golden Yellow	Yellow	Lot GY 102491, Exp 03/12/18
Starbrite	Deep Green	Green	Lot DG145681, Exp 03/12/18
Starbrite	Deep Turquoise	Green	Lot DT145628, Exp 03/12/18
Starbrite	Deep Violet	Purple	Lot DV121597, Exp 03/12/18
Starbrite	Lavender	Purple	Lot LV115194, Exp 01/21/18
Dynamic	Black	Black	Lot 81020240
Royal Talens	Black Drawing Ink	Black	
Kuro Sumi	Outlining Ink	Black	Lot # KSOL 140922, MFG date 09/22/14, Best by 09/22/18
Kuro Sumi	Grey Wash	Black	Lot # KSGW 140605, MFG date 05/06/14, Best by 05/06/18

*Chemical analysis undertaken is specific for the lot/batch numbers tested, and may not apply for other lot/batch numbers.

Table A4: List of metals analysed and regulatory status

Metal	Poisons Standard	HSIS	ResAP (ppm)
Arsenic (As)	Schedule 7 at ≥1 mg/kg	Hazardous at ≥0.1%	2
Barium (Ba)	Schedule 6	Hazardous at ≥1%	50
Cadmium (Cd)	Schedule 6	Hazardous at ≥0.1%	0.2
Cobalt (Co)	Not listed	Not listed	25
Chromium (Cr)	Schedule 6	Not listed	Not listed
Chromium (VI)	Schedule 6	Hazardous at ≥0.1%	0.2
Soluble Copper (Cu)	Schedule 6	Not listed	25
Mercury (Hg)	Schedule 7 at ≥1 mg/kg	Hazardous at ≥0.1%	0.2
Nickel (Ni)	Not listed	Not listed	As low as possible
Lead (Pb)	Schedule 6	Hazardous at ≥0.5%	2
Selenium (Se)	Schedule 7 at ≥100 µg/kg	Hazardous at ≥1%	2
Antimony (Sb)	Schedule 6 at ≥1 mg/kg	Hazardous at ≥0.25%	2
Tin (Sn)	Not listed	Not listed	50
Zinc (Zn)	Not listed	Not listed	50
Strontium (Sr)	Not listed	Not listed	Not listed

Poisons Standard: Schedule listings in the Poisons Standard relevant to tattoo ink products.

HSIS: Hazard classification according to Safe Work Australia's Hazardous Substances Information System (HSIS).

ResAP: Maximum allowed concentration (ppm) according to ResAP(2008)1.

Table A5: List of amine species analysed and regulatory status

CAS RN	Chemical name	Poisons Standard	HSIS
293733-21-8	6-Amino-2-ethoxynapthaline	Not listed	Not listed
399-95-1	4-Amino-3-fluorophenol	Not listed	Hazardous at ≥0.1%
60-09-3	4-Aminoazobenzene	Not directly listed*	Hazardous at ≥0.1%
97-56-3	o-Aminoazotoluene	Not directly listed*	Hazardous at ≥0.1%
90-04-0	o-Anisidine	Not directly listed*	Hazardous at ≥0.1%
92-87-5	Benzidine	Not directly listed*	Hazardous at ≥0.01%
92-67-1	Biphenyl-4-ylamine	Not listed	Hazardous at ≥0.1%
106-47-8	4-Chloroaniline	Not directly listed*	Hazardous at ≥0.1%
95-69-2	4-Chloro-o-toluidine	Not directly listed*	Hazardous at ≥0.1%
91-94-1	3,3′-Dichlorobenzidine	Not directly listed	Hazardous at ≥0.1%
119-90-4	3,3′-Dimethoxybenzidine	Not directly listed*	Hazardous at ≥0.1%
119-93-7	3,3′-Dimethylbenzidine	Schedule 7	Hazardous at ≥0.1%
120-71-8	6-Methoxy-m-toluidine	Not directly listed*	Hazardous at ≥0.1%
615-05-4	4-Methoxy-m-phenylenediamine	Schedule 10 tattoo specific	Hazardous at ≥0.1%
101-14-4	4,4′-Methylenebis(2-chloroaniline)	Schedule 7	Hazardous at ≥0.1%
101-77-9	4,4′-Methylenedianiline	Not listed	Hazardous at ≥0.1%
838-88-0	4,4′-Methylenedi-o-toluidine	Not listed	Hazardous at ≥0.1%
95-80-7	4-Methyl-m-phenylenediamine	Schedule 10 tattoo specific	Hazardous at ≥0.1%

CAS RN	Chemical name	Poisons Standard	HSIS
91-59-8	2-Naphtylamine	Not directly listed*	Hazardous at ≥0.01%
99-55-8	5-Nitro-o-toluidine	Not directly listed*	Hazardous at ≥1%
101-80-4	4,4′-Oxydianiline	Not listed	Hazardous at ≥0.1%
106-50-3	Para-phenylenediamine	Schedule 10 tattoo specific	Hazardous at ≥1%
139-65-1	4,4′-Thiodianiline	Not listed	Hazardous at ≥0.1%
95-53-4	o-Toluidine	Not directly listed*	Hazardous at ≥0.1%
137-17-7	2,4,5-Trimethylaniline	Not directly listed*	Hazardous at ≥0.1%
87-62-7	2,6-Xylidine	Not listed	Hazardous at ≥1%
95-68-1	2,4-Xylidine	Not listed	Hazardous at ≥1%

***Listed under the Schedule 7 entry for AZO DYES that are derivatives by diazotisation of any of the following substances.**

Poisons Standard: Schedule listings in the Poisons Standard relevant to tattoo ink products.

HSIS: Hazard classification according to Safe Work Australia's Hazardous Substances Information System (HSIS).

Table A6: List of PAH species analysed and regulatory status

CAS RN	Chemical name	Poisons Standard	HSIS
91-20-3	Naphthalene	Schedule 6	Hazardous at ≥1%
208-96-8	Acenaphthalene	Schedule 5	Not listed
83-32-9	Acenaphthen	Schedule 5	Not listed
86-73-7	Fluorene	Schedule 5	Not listed
85-01-8	Phenanthrene	Schedule 5	Not listed
56-55-3	Benzo(a)anthracene	Schedule 5	Hazardous at ≥0.1%
218-01-9	Chrysene	Schedule 5	Hazardous at ≥0.1%
205-99-2	Benzo(b)fluoranthene	Schedule 5	Hazardous at ≥0.1%
207-08-9	Benzo(k)fluoranthene	Schedule 5	Hazardous at ≥0.1%
50-32-8	Benzo(a)pyrene	Schedule 5	Hazardous at ≥0.01%
193-39-5	Indeno(1,2,3-cd)pyrene	Schedule 5	Not listed
53-70-3	Dibenzo(a,h)anthracene	Schedule 5	Hazardous at ≥0.01%
191-24-2	Benzo(ghi)perylene	Schedule 5	Not listed

Poisons Standard: Schedule listings in the Poisons Standard relevant to tattoo ink products.

HSIS: Hazard classification according to Safe Work Australia's Hazardous Substances Information System (HSIS).