# Annex XV dossier

## PROPOSAL FOR IDENTIFICATION OF A SUBSTANCE AS A CMR 1B OR 1A, PBT, vPvB OR A SUBSTANCE OF AN EQUIVALENT LEVEL OF CONCERN

**Substance Name(s):** 4,4'-bis(dimethylamino)benzophenone (Michler's ketone)

**EC Number(s):** 202-027-5

**CAS Number(s):** 90-94-8

**Submitted by:** European Chemicals Agency at the request of the European Commission

**PUBLIC VERSION**: *This version does not include the confidential annexes to Parts I and II.*

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# PROPOSAL FOR IDENTIFICATION OF A SUBSTANCE AS A CMR 1A OR 1B, PBT, VPVB OR A SUBSTANCE OF AN EQUIVALENT LEVEL OF CONCERN

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- The substance is proposed to be identified as substance meeting the criteria of Article 57 (a) of Regulation (EC) 1907/2006 (REACH) owing to its classification as carcinogen category 1B[1] which corresponds to classification as carcinogen category 2[2].

## Summary of how the substance meets the Carcinogen 1B criteria

4,4'-bis(dimethylamino)benzophenone (Michler's ketone) is listed as Index number 606-073-00-0 in Regulation (EC) No 1272/2008 and classified in Annex VI, part 3, Table 3.1 (list of harmonised classification and labelling of hazardous substances) as carcinogen, Carc. 1B (H350: "May cause cancer.") The corresponding classification in Annex VI, part 3, Table 3.2 (the list of harmonised classification and labelling of hazardous substances from Annex I to Directive 67/548/EEC) of Regulation (EC) No 1272/2008 is carcinogen, Carc. Cat. 2, R45 ("May cause cancer.")

Therefore, this classification of Michler's ketone in Regulation (EC) No 1272/2008 shows that the substance meets the criteria for classification as carcinogen in accordance with Article 57 (a) of REACH.

**Registration dossiers submitted for the substance:** No (Registration dossiers were submitted for a substance that includes Michler's base as impurity)

[1] Classification in accordance with Regulation (EC) No 1272/2008 Annex VI, part 3, Table 3.1 List of harmonised classification and labelling of hazardous substances.

[2] Classification in accordance with Regulation (EC) No 1272/2008, Annex VI, part 3, Table 3.2 List of harmonised classification and labelling of hazardous substances (from Annex I to Council Directive 67/548/EEC).

# PART I

# JUSTIFICATION

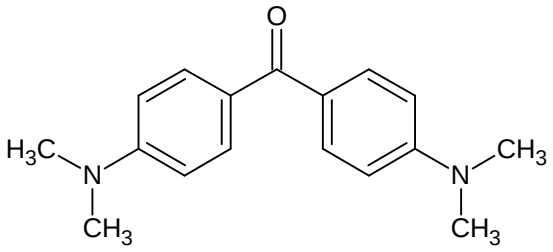
## 1 IDENTITY OF THE SUBSTANCE AND PHYSICAL AND CHEMICAL PROPERTIES

### 1.1 Name and other identifiers of the substance

Table 1: Substance identity

| | |
|---|---|
| **EC number:** | 202-027-5 |
| **EC name:** | 4,4'-bis(dimethylamino)benzophenone |
| **CAS number (in the EC inventory):** | 90-94-8 |
| **CAS name:** | Methanone, bis[4-(dimethylamino)phenyl]- |
| **IUPAC name:** | bis[4-(dimethylamino)phenyl]methanone |
| **Index number in Annex VI of the CLP Regulation** | 606-073-00-0 |
| **Molecular formula:** | $C_{17}H_{20}N_2O$ |
| **Molecular weight range:** | 268.4 g/mol |
| **Synonyms:** | Benzophenone, 4,4'-bis(dimethylamino)- (6CI,8CI);<br>4,4'-Bis(N,N-dimethylamino)benzophenone;<br>4,4'-Bis(dimethylamino)benzophenone;<br>4,4'-Tetramethyldiaminobenzophenone;<br>Bis(4-dimethylaminophenyl) ketone;<br>Bis[(4-dimethylamino)phenyl]methanone;<br>Bis[p-(N,N-dimethylamino)phenyl] ketone;<br>DABP; Di(p-dimethylamino)benzophenone;<br>Michler's ketone;<br>N,N,N',N'-Tetramethyl-4,4'-diaminobenzophenone;<br>NSC 9602;<br>Nisso Cure MABP;<br>S 112; S 112 (ketone);<br>p,p'-Bis(dimethylamino)benzophenone;<br>p,p'-Tetramethyldiaminobenzophenone |

## Structural formula:




## 1.2 Composition of the substance

**Name:** 4,4'-bis(dimethylamino)benzophenone

**Description: ---**

**Degree of purity:** see confidential Annex

Table 2: Constituents

| **Constituents** | **Typical concentration** | **Concentration range** | **Remarks** |
|---|---|---|---|
| *4,4'-bis(dimethylamino)benzophenone*<br>202-027-5 | | See confidential Annex | Information from C&L notifications |

Table 3: Impurities

| **Impurities** | **Typical concentration** | **Concentration range** | **Remarks** |
|---|---|---|---|
| *No information available* | | | No impurities indicated in the C&L notifications |

Table 4: Additives

| **Additives** | **Typical concentration** | **Concentration range** | **Remarks** |
|---|---|---|---|
| *No information available* | | | No additives indicated in the C&L notifications |

## 1.3 Physico-chemical properties

Table 5: Overview of physicochemical properties

| Property | Value | Remarks |
|---|---|---|
| Physical state at 20°C and 101.3 kPa | solid | |
| Melting/freezing point | 179ºC | Lide, David. R.; Handbook of Chemistry and Physics 2009, 88th, P3-50 |
| Boiling point | 427.7±30.0ºC (1013.25 hPa) | Extracted from CAS; (1) |
| Vapour pressure | 2.15e-7 hPa (T=25ºC) | Extracted from CAS; (1) |
| Water solubility | 7.5e-3 g/L (pH7 T=25ºC) | Extracted from CAS; (1) |
| pKa | 2.55 (T=25ºC) | Extracted from CAS; (1) |
| Partition coefficient n-octanol/water (log value) | 3.870 (T=25ºC) | Extracted from CAS; (1) |
| Density | 1.101 g/cm$^3$ (T=20ºC) | Extracted from CAS; (1) |

(1) calculated using Advanced Chemistry Development (ACD/Labs) software v11.02 (© 1994-2012 ACD/Labs)

# 2 HARMONISED CLASSIFICATION AND LABELLING

4,4'-bis(dimethylamino)benzophenone (Michler's ketone) is listed as index number 606-073-00-0 in Annex VI, part 3 of Regulation (EC) No 1272/2008 as follows:

Table 6: Classification according to part 3 of Annex VI, Table 3.1 (list of harmonised classification and labelling of hazardous substances) of Regulation (EC) No 1272/2008

| **International Chemical Identification** | **EC No** | **CAS No** | **Classification** | | **Labelling** | | | **Spec. Conc. Limits, M-factors** | **Notes** |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Hazard Class and Category Code(s)** | **Hazard statement code(s)** | **Pictogram, Signal Word Code(s)** | **Hazard state-ment code(s)** | **Suppl. Hazard statement code(s)** | | |
| 4,4'-bis(dimethylamino) benzophenone; Michler's ketone | 202-027-5 | 90-94-8 | Carc. 1B<br>Muta. 2<br>Eye Dam. 1 | H350<br>H341<br>H318 | GHS08<br>GHS05<br>Dgr | H350<br>H341<br>H318 | - | - | - |

Table 7: Classification according to part 3 of Annex VI, Table 3.2 (list of harmonized classification and labelling of hazardous substances from Annex I of Council Directive 67/548/EEC) of Regulation (EC) No 1272/2008

| **International Chemical Identification** | **EC No** | **CAS No** | **Classification** | **Labelling** | **Concentration Limits** | **Notes** |
|---|---|---|---|---|---|---|
| 4,4'-bis(dimethylamino)benzophenone; Michler's ketone | 202-027-5 | 90-94-8 | Carc. Cat. 2; R45<br>Muta. Cat. 3; R68<br>Xi; R41 | T<br>R: 45-41-68<br>S: 53-45 | - | - |

# 3 ENVIRONMENTAL FATE PROPERTIES

Not relevant for the identification of the substance as SVHC in accordance with Article 57(a).

# 4 HUMAN HEALTH HAZARD ASSESSMENT

See section 2 on harmonised classification and labelling.

# 5 ENVIRONMENTAL HAZARD ASSESSMENT

Not relevant for the identification of the substance as SVHC in accordance with Article 57(a).

# 6 CONCLUSIONS ON THE SVHC PROPERTIES

## 6.1 CMR Assessment

4,4'-bis(dimethylamino)benzophenone (Michler's ketone) is listed as Index number 606-073-00-0 in Regulation (EC) No 1272/2008 and classified in Annex VI, part 3, Table 3.1 (list of harmonised classification and labelling of hazardous substances) as carcinogen, Carc. 1B (H350: "May cause cancer.") The corresponding classification in Annex VI, part 3, Table 3.2 (the list of harmonised classification and labelling of hazardous substances from Annex I to Directive 67/548/EEC) of Regulation (EC) No 1272/2008 is carcinogen, Carc. Cat. 2, R45 ("May cause cancer.")

Therefore, this classification of Michler's ketone in Regulation (EC) No 1272/2008 shows that the substance meets the criteria for classification as carcinogen in accordance with Article 57 (a) of REACH.

# PART II

# INFORMATION ON USE, EXPOSURE, ALTERNATIVES AND RISKS

## 1. MANUFACTURE, IMPORT, EXPORT

### 1.1 Manufacture process

Michler's ketone is an anthropogenic substance and does not occur naturally in the environment (EC&HC, 2010).

Several manufacture methods are reported in the literature:

- It is obtained by reaction of dimethylaniline with phosgene (Gessner, 2000).
- A second synthetic route involves the catalytic oxidation of Michler's base (Gessner, 2000)
- It can be made by condensing dimethylaniline with phosgene in the presence of zinc chloride (Gessner, 2000; Röper et al. 2000; in EC&HC, 2010)
- Another method of production uses dimethylaniline, aluminum chloride and carbon tetrachloride (Merck 2006; Lewis 2007; HSDB 2009; in EC&HC, 2010).

### 1.2 Volumes

#### 1.2.1 EU data

***REACH Registration and C&L notification data***

No registration had been submitted for Michler's ketone by the time of submission of this report for identification of the substance as SVHC.

Overall 12 classification & labelling notifications on behalf of ~200 legal entities had been submitted for Michler's ketone by that time.

***Data from EU Member States***

Of the Member States contacted, six provided responses, with only Sweden and Finland indicating the presence of Michler's ketone on their market.

Mixtures were imported in 2009 to Sweden from other Member States, containing in total less than 0.1 tonnes of the substance (Swedish Products Register, 2009). In Finland, for Michler's ketone there are less than 4 manufacturers / importers, and therefore the information on quantities is confidential. It cannot be excluded that Michler's ketone is present as impurity in

substance(s) included in the respective national registries, as the use indicated in the registries was as colourant (see section 2.2 below).

As for the other 4 Member States which responded:

- Not registered by Dutch companies;
- No information on use of Michler's ketone on the Nordic SPIN database or on Denmark's database on substances in consumer products (i.e. database on substances identified in consumer products in various Danish projects conducted during the last 10-15 years);
- No import to /export from Estonia of Michler's ketone has been registered to customs authorities;
- No info held on the substance by the United Kingdom;

According to NTP (SRI 2009 in NTP, 2011), in 2009 Michler's ketone was manufactured by one manufacturer in Europe.

***Consultation with industry stakeholders***

Questionnaires were sent to companies identified in ECHA's classification & labelling notifications database[3] or from other sources on the internet. Furthermore, questionnaires were sent to industry associations, including four trade associations (ETAD, VdMi, CEPE, EuPIA) and six pulp and paper associations (CEPI, INTERGRAF, CEPIPRINT, EADP, FAEP, ENPA).

CEPE (European Council of producers and importers of paints, printing inks and artists' colours) performed a survey with a negative result as results uses in coatings or inks. No information was directly available to INTERGRAF (International confederation for printing & allied industries). It was noted that EuPIA (the European Printing Ink Association) has published an "Exclusion List for Printing inks and Related Products" (EuPIA, 2011), which is a commitment of ink manufacturers not to use dangerous substances. It is a list that describes "substances previously used or relevant in the formulation of printing inks that must be avoided and which under normal established and foreseeable conditions of use in the manufacture and application of printing inks would cause a risk to health". This list includes, among others, substances / mixtures with CMR 1A/1B classification as well as explicitly Michler's ketone. In that publication it is mentioned that the majority of raw materials used in printing inks are produced under commercial industrial conditions and may contain unavoidable impurities, mostly in small quantities. As some of these impurities may be on the exclusion list, every effort is made to ensure that they are at a minimum level. The EuPIA Exclusion List is by its nature a recommendation and does not constitute legal obligations. It is though reported by the Association to have the full support of all of its printing ink manufacturer members.

Only 2 companies filled in the questionnaire. One company reported a very small volume of << 1 t of the substance imported as such from China in 2011. Only a small fraction of this volume was used in the EU after repackaging. The second company did not refer to a use of

[3] During the consultation, in principle only companies which had submitted single-substance notifications (i.e. not bulk notifications) were contacted. When the submission had been made by a group of Manufacturers / Importers, only the submitting legal entity was contacted.

Michler's ketone, but rather of a dye containing Michler's ketone below 0.1%, in very small amounts.

### 1.2.2 Non-EU data

The following information (and accordingly the references) is available from the Canadian Screening assessment report (EH&HC, 2010) and the Report on Carcinogens released in the frame of the National Toxicology Program of U.S. (NTP, 2011):

Approximately 800 kg of Michler's ketone were imported into Canada in 2006, whereas no manufacture was reported in Canada for that year. Between 1 t and 10 t of Michler's ketone were used in Canada in 2006 (according to submissions made under section 71 of CEPA 1999 and the Challenge questionnaire submissions, Environment Canada 2008).

Previously received information from the Domestic Substances List (DSL) nomination (1984–1986) showed that the total quantity of Michler's ketone reported as imported, manufactured or in commerce in Canada during the calendar year 1986 was 1,000t (Environment Canada 1988). Therefore, Michler's ketone production, import and use in Canada have decreased significantly since the 1980s.

In 1975, the production of Michler's ketone in the United States was estimated at over 900 kg (HSDB 2009). No current production data were available.

Imports of Michler's ketone in the United States totalled approx. 550 kg in 1972, 20t in 1975 (HSDB 2009), and about 10 t in 1983 (USITC 1984). No more recent data on imports or exports for the United States were available.

# 2. USES

## 2.1 Uses according to the literature

Information on potential uses/applications was retrieved from public on-line sources.

Michler's ketone is an important **intermediate in the manufacture of triphenylmethane dyes**. Many triaminotriarylmethane dyes can be produced by condensation of Michler's ketone with aromatic amines. The ketone must generally be activated with phosgene or phosphorus oxychloride, whereby a reactive blue chloro compound is formed from the intermediate geminal dichloride (Gessner, 2000).

The following is an indicative list of substances that are reported to be manufactured from Michler's ketone:

C.I. Acid Blue 34; C.I. Acid Blue 86;C.I. Acid Blue 88; C.I. Acid Violet 15; C.I. Acid Violet 38; Acid Violet 2B; C.I. Basic Orange 23; C.I. Basic Violet 3; C.I. Basic Yellow 2; Ceres Blue I; Fanal Blue 3B supra; C.I. Solvent Violet 9; C.I. Solvent Yellow 34 (Society of Dyers and Colourists, 1956 in NCI, 1979, cited in HSDB 2009); Basazol Violet, Basic Brown C2, C.I. Basic Purple 48; Methyl Violet DAW (EC&HC, 2010); C.I. Basic Blue 26 (Gessner and Mayer, 2000).

It appears that at least six of those substances (Acid Violet 15, Basic Yellow 2, Solvent Violet 9, Solvent Yellow 34, C.I. Basic Violet 3, C.I. Basic Blue 26) are on the EU market, as

classification and labelling notifications and/or registrations have been received for them[4]. Moreover, there are some further to the above listed substances, for which submitted classification and labelling notifications indicate the presence of Michler's ketone as impurity (none of those substances with classification as CMR, by the time of submission of this report), and therefore presumably manufacture via Michler's ketone.

The substances listed by Society of Dyers and Colourists are reported to be used to make ultraviolet-cured printing ink for carton board and paper and as dyes for pen inks, carbon paper, alcoholic solvents, biological stains, oils, waxes, textiles, and leather; while one pigment is also used as a fungicide. The substances mentioned in the Canadian report are referred to as examples of paper colourants that may contain Michler's ketone residues.

The literature shows that research activity for the manufacture of further dyes from Michler's ketone is ongoing (e.g. Dumur et al., 2008).

References exist also on the use of Michler's ketone as **intermediate in the manufacture of pharmaceuticals** (EC&HC, 2010 with the following citations: Techrainbow 2009; 2009 personal communication from Therapeutic Products Directorate, Health Canada, to Existing Substances Bureau, Health Canada), as well as on applications **in the production of polymers** (EC&HC, 2010 with the following citations: Emmett et al. 1977; Pillai et al. 1982; Shen et al. 1984; Tanaka et al. 1993; Granchak et al. 1995; Huang et al. 1999; Onen 2001; Fan 2004).

Michler's ketone is also used as **additive in dyes and pigments, acting as photosensitizer[5]**.

Michler's ketone analogs are used in photoinitiation systems. Photoinitiator systems are useful in imaging systems such as photopolymerisable lithographic plate constructions, in proofing materials, and in radiation (UV) cured coatings and inks (US Patent 4,576,975; 1986).

Michler's ketone has been reported to be used as curing agent in ultraviolet (UV)-cured printing inks for cartonboard, acting as a catalyst to harden ink when it is exposed to UV light during the printing process (Castle et al. 1997; Salafranca and Franz 2000; in EC&HC, 2010). Printing ink is typically applied to the outside of food packaging materials, and therefore there would be no direct contact with food (EC&HC, 2010).

In fact Michler's ketone absorbs intensely at 366 nm and it is an effective photosensitizer provided energy transfer is exothermic and the concentration of the acceptor is sufficiently high to quench the photoreaction of Michler's ketone with itself (Charles D. DeBoer et al., 1973 cited in Wikipedia). According to Gessner (2000), a large number of investigations have been carried out on the use of Michler's ketone as a photosensitizer.

In the literature there are further reports on the use of Michler's ketone **as light absorbent** (Yasuda et al. 2008 cited in EC&HC, 2010), as well as **in photoresist formulations** (Fan

[4] This information is based on the CAS numbers provided for those dyes in Colour Index International. For further information on C.I. Basic Violet 3 and C.I. Basic Blue 26 see respective A.XV reports.

[5] A photosensitizer facilitates (as mediator) the transfer of energy from light to substances, which then by coming to an excited state can effectively give further reactions / be transformed.

2004 in EC&HC, 2010). While it is also mentioned to be used as a component **in dry film products** (EC&HC, 2010) and **as a process chemical for electronic circuit board manufacture** (Chiang and Kuo 2002; Environment Canada 2008; in EC&HC, 2010).

Finally, the Canadian report lists **analytical applications** of Michler's ketone, such as in the investigation of polarities of liquid and solid environments (Spange et al. 2002; Zimmermann et al. 2002; Zimmermann and Spange 2002; in EC&HC, 2010); and in colour tests for nitrites, nitrates and glyceryl trinitration I solutions in distilled water (Munch et al. 1964; Gessner, 2000; Dikusar, 2003; in EC&HC, 2010).

## 2.2 Identified uses in the EU

The company which responded to the questionnaire reported that it is used in **repackaging** and **in Research & Development**.

The information available at the Swedish Register and the Finnish Registry indicates use of Michler's ketone as colouring agent in the manufacture / production of paper and paper products. As mentioned above, it cannot be excluded that Michler's ketone is rather present as impurity in other substance(s) used as colouring agents.

## 2.3 Releases from uses

Most of the information below is summarized from the Canadian Screening Assessment report (EC&HC, 2010).

*Routes of exposure*

According to the Canadian Screening Assessment report, based on the physical and chemical properties of Michler's ketone, the primary routes of exposure are likely to be **oral** and **dermal**. A low vapour pressure and low Henry's Law constant indicate that Michler's ketone is non-volatile. The inhalation route of exposure is therefore not likely to be as relevant as the oral and dermal exposure pathways (EC&HC, 2010).

*Occupational exposure*

The potential for occupational exposure is greatest for workers in facilities that **manufacture Michler's ketone or any of the dyestuffs** for which it is an intermediate (NCI 1979 in NTP, 2011). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 2,026 workers, including 405 women, potentially were exposed to Michler's ketone in the United States (NIOSH 1990 in NTP, 2011).

*Environmental releases*

According to information from the Canadian Screening Assessment report, based on information collected through a survey conducted pursuant to section 71 of CEPA 1999, one facility involved in **colourant production** reported releases to air of minimal amounts of Michler's ketone from the blending of custom dye colours. No measurements or emission estimates were compiled by the facility for this substance, as emissions were not considered to be significant. The quantity of dyes blended at the facility has been reduced since 2006. Some other facilities use a sewage treatment system to minimize releases and limit environmental exposure (Environment Canada 2008 in EC&HC, 2010).

The U.S. Environmental Protection Agency's Toxics Release Inventory reported environmental releases of Michler's ketone of 0.5 t in 1988 and 0.7 t in 1995. In 1999, two industrial facilities released 0.4 t (TRI 2009 in NTP, 2011). No release data have been reported since 1999 (in NTP, 2011).

*Consumer exposure (e.g. due to its presence as impurity in consumer products)*

Michler's ketone is found as a residual in colourants resulting from an intermediary reaction during manufacture; residual levels of Michler's ketone may therefore also be present in some dyes and in final consumer products. The majority of Michler's ketone used in Canada may be found as a residue in paper colourant (i.e., dye, pigment, stain, ink) at a concentration of 0.009–4.5% by weight (primarily ≤ 1%). It could be present in industries involved in manufacturing paper or converting manufactured paper into different forms, such as paper mills or newsprint mills (Environment Canada 2008 in EC&HC, 2010). The presence of Michler's ketone in pen inks was confirmed in Canada by Health Canada's Consumer Product Safety Directorate. To date, Michler's ketone has not been identified in any children's markers; further testing is ongoing (2010 personal communication from Consumer Product Safety Directorate, Health Canada, to Existing Substances Bureau, Health Canada; in EC&HC, 2010). The presence of Michler's ketone in textiles was not confirmed in Canada (info from EC&HC, 2010).

Considerable information, including monitoring studies and modelling, is available in the Canadian assessment (EC&HC, 2010), which can be summarised as follows (in parenthesis references in the Canadian report):

- Residues in mixtures:

- printing inks and adhesives [0.1–1.6% (MSDS 2000, 2003b, 2004a; Aurela 2001; European Commission 2008)]
- printer ribbons [from <0.1% by weight (MSDS 2001a, 2004b, 2006b) to 7.2% (in purple printer ribbon) (MSDS 2007)]
- nylon fabric ribbon cassettes [at <0.30% by weight (MSDS 2004b)]
- pen ink [(at <1% in ball point pens) (Basel-Stadt 2003; MSDS 2003a); 0.0023-0.11% (Art and Creative Materials Institute (ACMI), Duke University (2009 personal communication to Health Canada))]
- permanent marker inks [0.00024-0.13% (Art and Creative Materials Institute (ACMI), Duke University (2009 personal communication to Health Canada)]
- solvent blue 4 dye [4.5% (MSDS 2001b)]

- Residues in articles:

- paperboard / recycled fibres used in food packaging [up to 12 µg/g (Ozaki et al. 2004)]
- recycled paper [up to 12 µg/g (Ozaki et al. 2004)]

The conclusion of the Canadian assessment for the general population was that based upon the information obtained on current uses of Michler's ketone in Canada, exposure of the general population is expected to be very low and limited to the use of paper products containing the

chemical as a manufacturing residual in paper colourants. The general population is unlikely to be exposed to Michler's ketone from other consumer products (EC&HC, 2010).

## 3. ALTERNATIVES

*For uses as intermediate in the manufacture of other substances*

At least for some of the dyes that are manufactured from Michler's ketone there seem to be alternative manufacturing methods available. Nevertheless, some of the alternative chemical intermediates (e.g. Michler's base) have also CMR (carcinogenic, mutagenic or reprotoxic) properties. For instance, C.I. Basic Violet 3 can be manufactured also via Michler's ketone or other intermediates, such as Michler's hydrol. As for Michler's hydrol, it is noted that, although it does not have a harmonised classification, its potential to elicit cancer may deserve further consideration on the basis of its structural similarity with Michler's ketone. Michler's hydrol is not self-classified as CMR according to the C&L notifications submitted to ECHA, while this substance has not been discussed in TC C&L in the past. In another example, C.I. Basic Blue 26 can also be manufactured via Michler's base (CMR substance) by catalytic oxidation of the leuco base (formed by oxidation of Michler's base in the presence of N-phenyl-α-naphthylamine) with air and in the presence of catalytic quantities of (dihydrodibenzotetraaza[14]annulene)iron and chloranil.

*For uses as photosensitizer*

Today, other aromatic amines (e.g. 4,4'-bis-(diethylamino)-benzophenone (DEAB) and 2-amino-4-methylbenzophenone (AMB)) have replaced Michler's ketone, the use of which is no longer recommended by the printing industry in Japan and Europe (Castle et al. 1997; Nagarajan et al. 2000; Salafranca and Franz 2000; in EC&HC, 2010). It is not clear if the above references relate to the use as additive (as photosensitizer) or the use as intermediate (in the production of dyes for printing inks).

## 4. REFERENCES

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