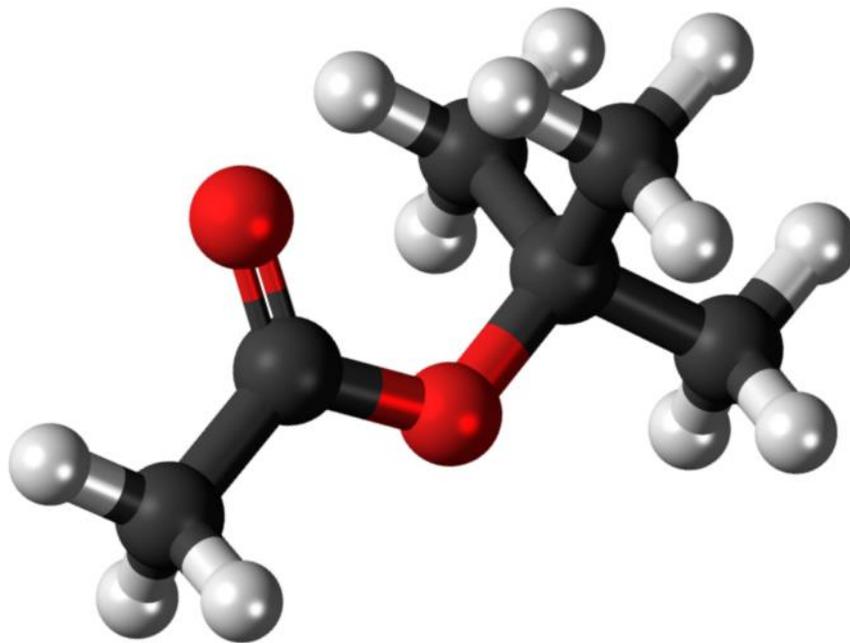




SOUTH COAST  
AIR QUALITY  
MANAGEMENT DISTRICT

# tBAc Assessment White Paper



**PRELIMINARY DRAFT**

OCTOBER 2016

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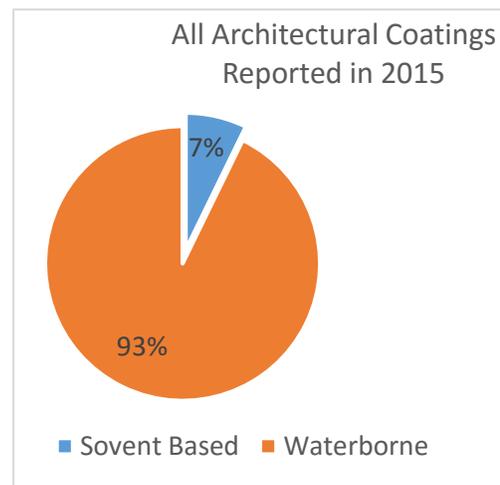
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## EXECUTIVE SUMMARY

The control of volatile organic compound (VOC) emissions plays a critical role in reducing the formation of ground level ozone, as well as particulate matter (PM) caused by the formation of secondary organic aerosols (SOA). One successful method of control is to replace atmospherically reactive VOC solvents with solvents that the United States Environmental Protection Agency (U.S. EPA) has defined as exempt because of low reactivity, and thus with low ozone and fine particulate matter (PM<sub>2.5</sub>) formation potential. When considering how these lower reactivity solvents should be regulated, South Coast Air Quality Management District (SCAQMD) staff evaluates potential downsides (e.g. toxicity, flammability, odor, cost, etc.) to its use. The focus of this paper is to re-examine the partial exemption of tertiary-Butyl Acetate (tBAC) as a VOC in current and proposed SCAQMD rules based on the recently revised health risk assessment (HRA) guidelines by the Office of Environmental Health Hazard Assessment (OEHHA).

## BACKGROUND

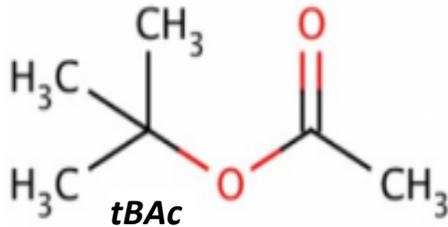
The SCAQMD is the air pollution control agency responsible for all of Orange County and the major portions of Los Angeles, Riverside, and San Bernardino Counties. The agency's mission is to provide an environment of clean air and protect public health from the adverse effects of air pollution with sensitivity to businesses and the community. The South Coast Air Basin (Basin) currently has some of the worst air quality in the nation. To protect public health, improve air quality, and attain federal and state ozone and PM standards, the SCAQMD passes regulations that limit emissions of VOCs and oxides of nitrogen (NO<sub>x</sub>). Ground-level ozone and PM is formed in the atmosphere by the photochemical reactions of VOCs and NO<sub>x</sub>. The SCAQMD has a long regulatory history of reducing VOCs in paint coatings, solvents, and adhesives. The shift to lower emitting VOC products has been accomplished by replacing solvents in high-VOC products with low or near-zero VOC waterborne products, using high solids or reactive chemistries, and/or switching to low-reactivity solvents. Certain VOCs are less reactive in the atmosphere and, therefore, do not contribute significantly to the formation of ozone and/or PM<sub>2.5</sub>.



Controlling VOCs by exempting solvents with negligible atmospheric reactivity helps the SCAQMD meet air quality goals while allowing manufacturers the flexibility in product formulations to meet strict VOC limits. Industries affected by VOC regulations petitioned the SCAQMD to exempt compounds from the VOC definition that have been deemed negligibly reactive by the U.S. EPA. For instance, the U.S. EPA's exemption of acetone (1) and perchlorobenzotrifluoride (pCBtF) (2) in 1994, led to successful product reformulations and VOC emission reductions. Although exempt VOCs may not increase ground-level ozone formation within the Basin, there is growing concern that some of these VOCs may present additional risks due to their toxicity, odor, flammability, and/or other environmental consequences such as water pollution. The SCAQMD staff evaluates potential adverse environmental or health impacts of exempt solvents through the preparation of staff reports and Environmental Assessments (EA) in

compliance with the California Environmental Quality Act (CEQA) and strives to minimize or mitigate other environmental and/or health impacts.

## REGULATORY HISTORY OF TBAC



tBAC is a solvent used to formulate coatings, lubricants, cleaners, degreasers, and adhesives. tBAC is a replacement for conventional solvents, due to its favorable chemical characteristics (e.g. boiling point, evaporation rate, flashpoint and explosive limit, auto-ignition temperatures, and vapor pressure) being similar in range to conventional solvents such as toluene, xylene, and methyl ethyl ketone (MEK) (3). In 1997, a petition was submitted by ARCO Chemical Company to the U.S. EPA to remove tBAC from the regulatory definition of

a VOC. In 1998, Lyondell Chemical purchased ARCO Chemical Company and is currently the manufacturer of tBAC. In 2004, the U.S. EPA removed tBAC as a VOC after finding it negligibly reactive in the atmosphere and not significantly contributing to ozone formation.

A compound is determined to be negligibly reactive by the U.S. EPA by comparing it to the reactivity of ethane. The atmospheric reactivity comparisons are based on three different metrics: reaction rate constant ( $K_{OH}$ ) with the hydroxyl radical (OH), maximum incremental reactivity (MIR) on a reactivity per unit mass basis and MIR on a reactivity per-mole basis (4). Historically, the U.S. EPA exempted compounds by comparing the  $K_{OH}$  value of the compound of interest to the  $K_{OH}$  value of ethane. A higher  $K_{OH}$  value indicates a compound will initially react more quickly with the OH molecule than ethane. MIR by mass and by mole are more recently developed metrics derived from computer-based photochemical modeling and takes into account more complete ozone forming activity of the compound of interest. The molar-based MIR is more consistent with earlier smog chamber experiments and can be more environmentally protective, but the mass-based MIR is consistent with mass-based VOC regulations. U.S. EPA's 2005 Interim Guidance on the Control of Volatile Organic Compounds in Ozone State Implementation Plans states that a "comparison to ethane on a mass basis strikes the right balance between a threshold that is low enough to capture compounds that significantly affect ozone concentrations and a threshold that is high enough to exempt some compounds that may usefully substitute for more highly reactive compounds" (5). tBAC was exempted because it is less reactive than ethane on a per-mass basis, but it is more reactive on a per-mole basis (6).

The U.S. EPA initially retained requirements for recordkeeping, emissions reporting, photochemical dispersing modeling, and inventory requirements, because of the concern that compounds such as tBAC, in sufficient quantities or locations may form ozone. The recordkeeping and reporting requirements were removed in early 2016 because it was determined the data collected provided no relevant data for the U.S. EPA in regard to tBAC emissions contributing directly to ozone formation (7).

OEHHA has not identified any studies on the carcinogenicity of tBAC, however, some studies have been conducted on the primary metabolite tertiary-Butyl Alcohol (tBA). Neither tBAC nor tBA have been classified as a human carcinogen. Based in part on a study conducted by the National Toxicology Program (NTP) in 1995 with rats and mice exposed to tBA in drinking water (8), OEHHA determined that tBA poses

a potential cancer risk to humans. Since tBA metabolizes from tBAC, OEHHA is now proposing a new inhalation slope factor (ISF) for tBAC. ISF is a term used by OEHHA in the draft risk assessment, which is also known as the cancer potency factor (CPF). For the purpose of this paper, the term CPF will be used.

In 2006, the California Air Resources Board (CARB) released an Environmental Impact Analysis (EIA) on tBAC (6). The analysis determined the VOC exemption of tBAC would not be expected to increase the formation of SOAs, which contribute to PM<sub>2.5</sub> formation and global warming, cause stratospheric ozone depletion, have adverse water or soil impacts, or have significant economic impacts. However, CARB's evaluation determined tBAC could pose a potential cancer risk to humans. A substitution analysis was conducted by CARB for compounds that tBAC would potentially replace in different product categories. The product categories studied included consumer products, architectural coatings, degreasing, automotive refinishing, metal furniture and parts/products, and wood furniture. It was estimated the exemption could have increased tBAC emissions an additional 33 to 54 tons per day (tpd) statewide and, possibly reduce approximately one percent of the estimated average statewide total ozone formation (6). Three tBAC exposure scenarios (population-weighted health risk, near-source impact, and indoor workplace exposure) and the health benefits from reduction of ozone were evaluated. In the January 2006 EIA, CARB recommended exempting tBAC from the definition of VOC in the California Consumer Products Regulation (CPR) and that individual regulatory agencies perform a more in depth analysis before incorporating the exemption. CARB included an exemption in their automotive refinishing coatings Suggested Control Measure (SCM) which was adopted in October 2005. However, when the SCM for architectural coatings was amended on October 25, 2007, CARB did not include an exemption for tBAC due to the potential toxicity. CARB also did not ultimately include a tBAC exemption in the CPR.

### *Rule 102*

Compounds exempted as a VOC by the U.S. EPA are considered by the SCAQMD for possible inclusion for a full VOC exemption. The SCAQMD uses Rule 102 – Definitions to list VOC exempt compounds. Rule 102 divides exempt compounds into two categories: Group I and Group II. Both groups are exempt as VOCs by the U.S. EPA; however, Group II compounds are considered toxic, potentially toxic, upper-atmosphere ozone depleters and/or cause other environmental impacts (9). Many SCAQMD rules include prohibitions to limit the usage of Group II exempt compounds in excess of 0.1 percent by weight to discourage usage. However, because of limited information on tBAC's toxicity, SCAQMD staff determined that assessments and potential limited exemptions in individual rules would be more a health protective approach and did not list tBAC as an exempt VOC in Rule 102 (10).

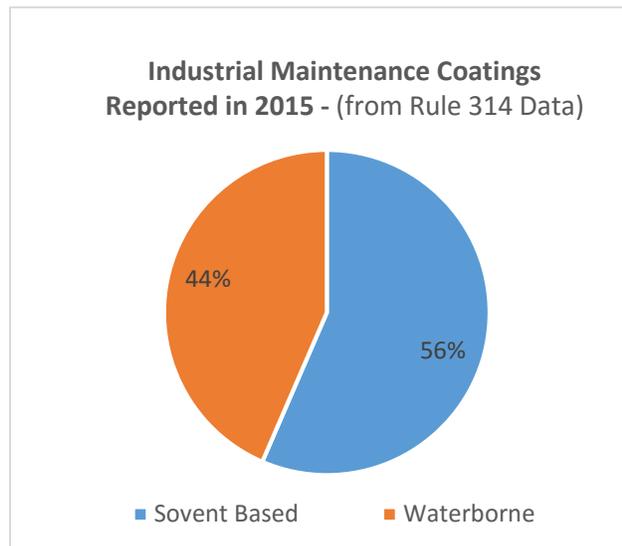
### *Rule 1151*

In 2005, Rule 1151 – Motor Vehicle and Mobile Equipment Non-Assembly Line Coating Operations was amended to include a limited exemption for tBAC in automotive refinishing coatings, other than color coatings and clear coatings (topcoats). The tBAC exemption was adopted to be consistent with CARB's SCM and to provide flexibility in developing low VOC compliant coatings. The Rule 1151 amendment EA determined that VOC reductions would be 0.3 tpd with the assumption that tBAC was the only viable exempt solvent (10). In Rule 1151, a requirement was included for staff to conduct a technical assessment on the use of tBAC as an exempt VOC by July 1, 2007. However, as was noted during the 2014 Rule 1151 amendment, the assessment could not be conducted earlier because no tBAC containing automotive

refinishing coatings were commercially available at that time, despite the anticipated need for tBAC to formulate compliant products (11). The technical assessment was postponed to December 31, 2016 to incorporate the revised OEHHA HRA guidelines, which had previously been then expected to be completed in Spring 2015. This paper serves as the technical assessment for the need and the associated risk of the partial tBAC exemption in Rule 1151.

### Rule 1113

In 2006, Rule 1113 – Architectural Coatings was amended to include a limited exemption for tBAC in IM coatings. The exemption was adopted based on the results of a technological assessment conducted by a committee known as the Essential Public Service Agency (EPSA). EPSA included representatives from



the Los Angeles Department of Water and Power, Department of Water Resources, California Department of Transportation, and the Metropolitan Water District of Southern California (MWD). The assessment consisted of three phases and tested approximately 100 IM coatings over a three-year period using a number of ASTM International standard test methods, taking into consideration immersion, atmospheric weathering, mechanical strength, and physical properties (12). The results of the testing showed the availability of high performing, compliant IM immersion coatings, but limited availability of atmospheric exposure coatings able to meet the more stringent VOC limits. Industry expectations

for the lifespan of IM coatings are at least seven years once applied and MWD has further stringent performance standards of a 15-year lifespan for coatings exposed to extreme environmental conditions (13). The IM coatings tested with tBAC showed promise in meeting the 100 grams per liter VOC limit (if considered as an exempt solvent) and for meeting the necessary performance standards required for public infrastructure. IM coatings with tBAC were therefore given a limited exemption in Rule 1113 because of the limited availability on the number of compliant atmospheric exposure IM coatings that could provide long-term durability in protecting infrastructure.

The CEQA analysis for the 2006 limited tBAC exemption used a conservative analysis by evaluating the potential toxic impacts using a CPF from scientific literature, as no CPF was available from OEHHA at the time. This analysis did not find a significant increase in toxic impacts on any off-site residential or off-site worker receptors. Some architectural coating manufacturers requested a broader exemption of tBAC for other coating categories; however, the exemption was only included for IM coatings because of the more stringent performance requirements and limited number of coatings available, as well as the expectation that professional workers would use personal protective equipment (PPE) (14).

## Emission Inventory

In 2014, CARB conducted a survey of architectural coatings sold statewide in 2013. The survey required coating manufacturers to provide information on architectural coatings sold in California, including raw materials for products currently using tBAC (15). The preliminary data revealed around 100 IM coatings reported with a range of 0.7 to 33.5 percent tBAC, and a sales weighted average of 10.4 percent tBAC. The CARB SCM for architectural coatings has a higher VOC limit than Rule 1113, and does not exempt tBAC as a VOC. Based on the preliminary data of the IM coatings reported to CARB and the assumption that the coatings are all sold in the Basin, it is estimated that 0.06 tpd of tBAC is emitted from IM coatings in the Basin. CARB has not conducted a recent survey on automotive refinishing coatings. The last survey was conducted in 2002, before tBAC was exempted, and there was no tBAC reported in that survey (16). Based on the 2014 rule amendment of Rule 1151, staff estimates tBAC usage in the Basin for automotive refinishing coatings to be less than for architectural coatings. Past research found no tBAC containing automotive refinishing coatings commercially available or being applied in the Basin (11), even after nine years of the limited exemption. Recent staff inspections and research also found minimal amounts of tBAC usage for non-topcoats in the Basin.

## Recent Assessments for tBAC

In August 2015, OEHHA released a new draft CPF for tBAC for public review that is higher (more carcinogenic) than previously estimated in scientific literature, which prompted this analysis. In May 2016, the U.S. EPA published its draft assessment of the toxicological review of tertiary-butanol (tBA), a primary metabolite of tBAC, for public comment. The U.S. EPA Integrated Risk Information System (IRIS) Program is a human health assessment program that evaluates quantitative and qualitative risk information, including health effects information and toxicity values for health effects that may result from exposure to chemicals found in the environment (17). The draft assessment concluded there is *suggestive evidence of carcinogenic potential* for tBA. *Suggestive evidence of carcinogenic potential* is a descriptor indicating the evidence raises “a concern for potential carcinogenic effects in humans” but is not sufficient for a stronger conclusion (17).

## TOXICS SYMPOSIUM

A Toxics Symposium was held on October 29, 2014 by the SCAQMD to allow experts from the regulatory, industrial, academic, and environmental communities to explore the issues of exempting potentially toxic compounds. The objective was to provide SCAQMD staff with expert advice and recommendations on the potential future direction regarding the analysis and mitigation of potential toxic risks associated with alternative VOC compounds. Representatives from industry stated that they were more concerned with immediate hazards such as the risk posed by the use of flammable solvents, such as acetone, than the potential toxic exposure from tBAC. They pointed to the chemical industry’s long history of mitigating toxic exposure and expressed confidence in their ability to continue to safely utilize potentially toxic substances. The consensus of the speakers from academia, the regulatory and environmental communities was to use a precautionary approach so that regulatory VOC reductions do not increase the use of chemicals that are known or suspected to be toxic. The following was cited as the best practice to mitigate risk:

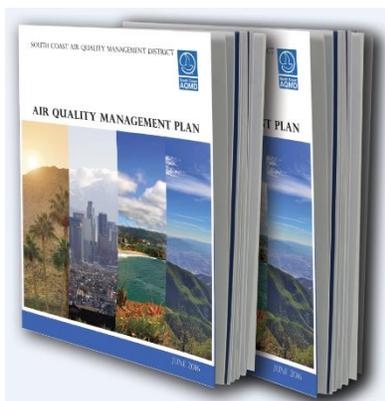
1. Eliminate a chemical that is toxic, or substitute one with a less toxic chemical.
2. Use engineering controls where the chemical is removed from the work area (e.g. fume hood), although, this can create an exposure issue for a nearby receptor.
3. Administrative controls such as training, labels and rotating jobs.
4. Use of PPE.

While PPE can be effective when there is a rigorous safety program established, not all organizations have such a program. In the case of respirators, there can be issues of training, fit, and using the proper respiratory equipment. Although PPE and engineering controls can protect the worker while the coatings are applied, there is still the issue of exposure for nearby off-site receptors.

One overarching sentiment expressed by most participants in the symposium was the frustration with the lengthy chemical assessment process. This has led to the uncertainty that has existed in VOC rulemaking in the last several years in regard to certain chemicals that the U.S. EPA has defined as exempt. The following opinions were expressed at the symposium by various participants:

- Legal obligation to comply with requirements of CEQA
- Defer to OEHHA for guidance and methodology in calculating toxic risk
- Rules 1401 - New Source Review of Toxic Air Contaminants and 1402 – Control of Toxic Air Contaminants from Existing Sources may need to be amended when a final decision on risk limits, exposure limits, or CPFs are determined by OEHHA’s Scientific Review Panel (SRP)
- Interim policy and guidance from OEHHA is acceptable
- Need to work with CARB/OEHHA for a quicker turnaround of final approval (120 days)
- Use a precautionary approach so that regulatory VOC reductions do not increase the use of chemicals that are known or suspected to be toxic

## 2016 AIR QUALITY MANAGEMENT PLAN (AQMP) AND VOC WHITE PAPER



As part of the development of the 2016 AQMP, a series of ten White Papers on key topics were developed. The papers provide better integration of major planning issues regarding air quality, climate, energy, transportation, and business needs. The 2016 AQMP Advisory Group members and recommended technical experts voluntarily participated in monthly White Paper Working Group meetings. The development of the papers began in the early summer of 2014 and the last paper was completed in 2015.

The VOC White Paper evaluated the need for additional VOC controls to achieve more stringent PM<sub>2.5</sub> and ozone standards in the Basin. It assessed the role of VOCs in forming ozone and PM<sub>2.5</sub> to inform policymakers of the most efficient and effective strategies to attain the federal standards that are the subject of the upcoming 2016 AQMP. The current SCAQMD regulatory strategy to reach the PM<sub>2.5</sub> and ozone standards focuses on NO<sub>x</sub> controls with strategic and limited VOC reductions. Recent AQMP modeling shows that achieving the 2022 one-hour

ozone standard is more sensitive to VOC controls than the eight-hour ozone standards (18). The future regulatory direction of VOC rulemaking will be to (19):

- Maximize co-benefits from NO<sub>x</sub>, greenhouse gas reductions, or air toxic controls;
- Promote pollution prevention;
- Incentivize zero and near-zero VOC materials and coatings;
- Maximize reductions from existing regulations through enforcement;
- Prioritize reductions of VOC species that are most reactive;
- Avoid toxic tradeoffs;
- Further evaluate time and place controls; and
- Conduct further studies relative to VOCs.

The 2016 AQMP includes modest VOC reductions in Control Measure CTS-01, with a commitment to reduce two tpd of VOC from coatings, solvents, adhesives, and sealants by 2031 (20). The two-tpd VOC reductions are projected to be achieved without expanding the current exemptions for tBAC or exempting other solvents. In addition, other VOC reductions will be achieved through co-benefits from other control measures.

## RISK ASSESSMENTS

### *Off-site Analysis*

The SCAQMD implements an Air Toxics Program to evaluate the risk of new and existing facilities and their health impact on receptors. The analyses conducted for this program are based on information provided by OEHHA, the agency responsible for updating Proposition 65 and developing guidelines for conducting HRAs. Proposition 65 was created to “protect California citizens and [the] State’s drinking water sources from chemicals known to cause cancer, birth defects or other reproductive harm, and to inform citizens about exposures to such chemicals” (21). Under Proposition 65, OEHHA is responsible for annually updating a list of toxic chemicals, including toxic air contaminants (TACs) that are known to cause cancer, birth defects, or other reproductive harm. Currently, tBAC and tBA are not listed. OEHHA is also responsible for establishing guidelines for HRAs under the Air Toxics Hot Spots Act (AB 2588) Health and Safety Code §44360(b) (2). CARB maintains a list of substances (TACs) to be evaluated in HRAs, in accordance with statutory criteria, Health and Safety Code §44321 and available within OEHHA’s Air Toxics Hot Spots Program Guidance Manual. These HRA guidelines and TACs are incorporated into SCAQMD’s Rules 1401 and 1402. HRAs are used to determine the long-term and short-term health risks (both cancer and non-cancer) associated with the exposure to a toxic substance and are used as part of a CEQA analysis.

For the SCAQMD to define a new compound as an exempt VOC for any purpose, it must amend its existing rules. Rule amendments require the preparation of an EA pursuant to CEQA. Such an analysis entails evaluating the reasonably foreseeable direct and indirect impacts from such an action, such as an increase in toxic impacts. For example, the direct air quality impact from lowering VOC content limits is the benefit from a reduction in emissions. Potential indirect environmental impacts from reformulations or replacements could be the potential adverse health risks, odors, hazards, or water demand from the new

formulations. In assessing health risks, potential adverse impacts to off-site residents and off-site workers exposed to the products are evaluated. The health risks are typically evaluated in a HRA, which could involve the use of dispersion modeling to estimate the concentration of the off-site receptor exposure. The HRA would include the potential short-term (acute) non-cancer risks, long-term (chronic) non-cancer risks, and the long-term cancer risk. The HRA uses parameters such as source characterization for dispersion modeling (e.g. whether the source is an area source or point source), exposure level, duration of exposure, and distance to source.

The incremental cancer risk to a maximally exposed individual is referred to as a "maximum individual cancer risk" or MICR. The risk from carcinogens are expressed as the probability of contracting cancer due to exposure from the identified carcinogens. For example, if the emissions from a facility are estimated to produce a risk of one in a million to the most exposed receptor, this means that a hypothetical individual exposed at that receptor's exposure level (e.g., a resident who lives from age 0 to 30 at that location) will have a one in a million chance of contracting cancer over and above his or her chance of contracting cancer from all other factors (for example, diet, smoking, heredity and other factors). For CEQA, the SCAQMD's significance threshold for off-site carcinogenic impacts is a MICR greater than or equal to 10 in a million (23).

The acute and chronic non-cancer risks are characterized using a hazard index (HI), which is the aggregate effect on a target organ or organ system based on exposure to a compound (22). Acute exposures are typically over a period of one hour while chronic exposures last eight years or more. A reference exposure level (REL) is a concentration level below which adverse non-cancer health effects are not expected to occur. The HI is the ratio between the pollutant concentration one is exposed to and the REL. An HI below 1.0 indicates that adverse non-cancer health effects are not expected. An HI above 1.0 does not mean that adverse non-cancer health effects will occur, but the odds increase the higher the HI is above 1.0. OEHHA has not established a non-cancer chronic REL for tBAC or tBA; therefore, no chronic HI can be calculated. The non-cancer acute REL from the CARB EIA was 10,000  $\mu\text{g}/\text{m}^3$ , which was also used by SCAQMD staff (6).

OEHHA reviews the potential health effects of compounds and develops toxicity values including RELs and CPFs. All toxicity assessments are brought before the independent State SRP for its peer review and approval before any REL or CPF is finalized by OEHHA. SCAQMD relies on these RELs and CPFs for all HRA calculations in its regulatory programs (e.g., Rule 1401, 1402, CEQA, etc.)

Cancer risks are calculated using the CPFs and the risk assessment methods in OEHHA's *Air Toxics Hot Spots Guidance Manual for Preparation of Health Risk Assessments* (2015) (24). CPFs are typically expressed in units of inverse dose, or  $(\text{mg}/\text{kg}\text{-day})^{-1}$ . In 1999, OEHHA released a CPF for the tBAC metabolite tBA of  $3 \times 10^{-3} (\text{mg}/\text{kg}\text{-day})^{-1}$  (25). A CPF was derived for tBAC of  $2.0 \times 10^{-3} (\text{mg}/\text{kg}\text{-day})^{-1}$  by assuming 100 percent metabolism of tBAC to tBA, and a 0.64 conversion factor to account for the different molecular weights of the two compounds (14). In August 2015, OEHHA released a new draft CPF for public review for tBAC based on an updated analysis (26). The draft CPF for tBAC is  $6.7 \times 10^{-3} (\text{mg}/\text{kg}\text{-day})^{-1}$ , which yields cancer risks about 3.3 times higher than the risks calculated using the previously derived value of  $2.0 \times 10^{-3} (\text{mg}/\text{kg}\text{-day})^{-1}$ . A higher CPF equates to a higher cancer risk. Table 1 summarizes the history of the CPFs.

Table 1 - History of Cancer Potency Factors for tBAC

	Cancer Potency Factor (mg/kg-day) <sup>-1</sup>
<b>tBA (OEHHA, 1999)</b>	3 x 10 <sup>-3</sup>
<b>tBAC (CARB, 2006)</b>	2 x 10 <sup>-3</sup>
<b>New Draft tBAC (OEHHA, 2015)</b>	6.7 x 10 <sup>-3</sup>

OEHHA's draft analysis is scheduled to be brought before the State SRP for the first time later this year with an anticipated final consideration in 2017.

### On-site Analysis

When the tBAC exemption was considered for amendments to Rules 1113 and 1151, the analysis was conducted for off-site exposure. This analysis is similar to a Rule 1401 risk assessment; it considers environmental exposure to individuals who are unaware of the potential risks. SCAQMD staff has a well-established methodology and an adopted CEQA significance threshold to determine what the acceptable risk should be for off-site residents and off-site workers (MICR less than 10 in a million, total chronic and acute HI less than 1) (29). An issue that arose during several recent rule amendments considering the exemption of compounds is how to address occupational exposure (on-site exposure of workers). The evaluation of occupational exposure falls under the purview of federal and state Occupational Safety and Health Administration (OSHA) who sets enforceable permissible exposure limits (PELs), based on eight-hour time-weighted averages, to protect workers from the health effects of exposure to hazardous substances. The PEL set by OSHA for tBAC is 200 parts per million as an eight-hour time weighted average concentration (27). When tBAC was being considered for a VOC exemption in Proposed Amended Rules (PAR) 1107 – Coating of Metal Parts and Products and 1168 – Adhesives and Sealants, the working group suggested an on-site worker exposure analysis was also necessary. However, without an established methodology or CEQA significance threshold for on-site workers, the analysis was not finalized.

Staff recognized that applying the same significance thresholds of 10 in one million established for off-site exposures (considered involuntary risk) to on-site exposures (considered voluntary risk associated with the work environment) might not be appropriate, as there are potentially many chemical exposures that would exceed significance thresholds for off-site receptors. If a TAC is used at a business, a worker can be made aware of the chemical and their inherent risk from exposure, and health risks can be reduced by using the proper PPE and/or engineering controls. This is unlike an off-site exposure where residents may be either unaware or unable to protect themselves from a large coating project occurring next door.

PAR 1107 and 1168 have not yet been brought before the Governing Board in part because a standard methodology and threshold has not been approved for determining if increased risks are significant for on-site worker exposures. In certain instances, this information may also be necessary to complete the CEQA analysis. OEHHA's Hot Spot Guidelines states the following regarding on-site worker exposure:

*Onsite workers are protected by CAL OSHA and typically are not evaluated under the Hot Spots program. Exceptions may include a worker who also lives on the facility property such as at*

*prisons, military bases, and universities that have worker housing within the facility. Another scenario where the District may require assessment of onsite worker exposure and risk is when a facility (e.g., airport) has multiple businesses owned by different entities within the facility/property (e.g., rental car agencies, restaurants, etc.). In these situations the evaluation of onsite cancer risks, and/or acute, 8-hour, and chronic non-cancer hazard indices is appropriate under the Hot Spots program (22)*

The OEHHA guidelines suggests on-site worker risks are not typically evaluated when identifying localized impacts from stationary sources.

## UPDATED ANALYSES

Based on stakeholder input leading up to the February 5, 2016 amendment to Rule 1113, SCAQMD staff included a resolution to review the existing limited exemption for tBAC and analyze the health risks using the draft inhalation CPF released by OEHHA in August 2015. This analysis also serves as the technical assessment required in Rule 1151(c)(32):

*The Executive Officer shall conduct a technical assessment on the use of TBAC as a non-VOC by December 31, 2016. In conducting the technical assessment, the Executive Officer shall consider all information available to the SCAQMD on TBAC including, toxicity, carcinogenic and health risk assessment studies. The Executive Office shall report to the Governing Board as to the appropriateness of maintaining TBAC as a non-VOC.*

In addition to the updated draft CPFs, the analyses conducted for this paper include updated dispersion factors from the most current air dispersion models as well as using updated risk assessment guideline procedures from OEHHA. For the most recently approved risk assessment guidelines, please see SCAQMD's Risk Assessment Procedures for Rules 1401 and 212 (29).

### *Rule 1151*

Following CARB's CPR recommendation and CARB's EIA for tBAC, CARB staff conducted a HRA for automotive refinishing coatings. CARB's HRA resulted in exempting tBAC for the SCM for automotive refinishing coatings. SCAQMD staff conducted a HRA during the 2005 PAR 1151 process, which was similar to CARB's HRA, but with localized SCAQMD-specific parameters, including using annual emission inventory data from facilities in the SCAQMD, default modeling parameters, and conservative meteorological data (10). Consistent with the CARB analysis, staff assumed tBAC would replace 50 percent of the xylene, toluene, and MEK in current compliant coating formulations. Because pCBtF and acetone were already exempt solvents used to lower VOC content, SCAQMD staff also assumed that 100 percent of the pCBtF and acetone usage would be replaced with tBAC. SCAQMD staff used toxicity factors for tBA from scientific literature as a surrogate to tBAC, which was also consistent with the approach used by CARB in its EIA.

A risk greater than 10 in a million was estimated if tBAC was completely delisted as a VOC for all coatings and substituted for xylene, toluene, MEK, acetone and pCBtF (26 in a million). At the time, compliant water-based and/or pCBtF-based color and clear coats were available or expected to be available by the January 1, 2009 VOC limit effective date. Together, color and clear coats comprise the topcoat category,

which staff estimated as comprising 80 percent of the PAR 1151 coating categories. Since topcoats meeting the proposed VOC limits were available, staff proposed to only allow the tBAC exemption for non-topcoat categories (i.e., all categories except clear and color coats) (10).

Based on the limited VOC exemption proposed for inclusion in PAR 1151, the conservatively estimated carcinogenic risk to a residential receptor was five in a million, which is below the significance threshold of 10 in a million. The acute hazard index was estimated to be less than the significance threshold of 1.0. Therefore, PAR 1151 with the limited VOC exemption was considered less than significant for both carcinogenic and non-carcinogenic risk.

For the current analysis, staff calculated the health risks using the new draft CPF, updated dispersion modeling, and with the previously calculated usage. In addition, staff updated the usage assumptions. In the original analysis, the VOC usage was assumed to be 10,528 pounds per year and the exempt usage of 3,402 pounds per year. For this analysis, staff conducted site visits of Rule 1151 facilities, an internet search for tBAC containing automotive refinishing coatings, consulted with coating manufacturers, and reviewed the coatings reported by Rule 1151 facilities in their Annual Emissions Reports. Staff concluded that the quantity of tBAC containing automotive refinishing coatings being used in the Basin by any one facility is lower than previously estimated. Based on information provided by a distributor of tBAC containing automotive refinishing coatings, they supplied approximately 250 gallons of tBAC containing products to all their facilities in 2015. As a conservative estimate, staff assumed all 250 gallons were used at one facility and that these coatings contain 15 percent tBAC, which is based on manufacturers' responses to staff's inquiries. This equated to 270 pounds per year of tBAC used at a facility. Overall, staff found compliant non-tBAC containing coatings in all categories for Rule 1151; tBAC formulations were found to make up only a small fraction of coatings used at Rule 1151 facilities.

A summary of carcinogenic and non-carcinogenic risk related to the limited Rule 1151 tBAC exemption is presented in Table 2. A detailed discussion of the health risk analysis and calculations for the original analysis can be found in Appendix B of the final EA for the 2005 PAR 1151 (3).

*Table 2 - Health Risks from tBAC Substitution for Non-Topcoat Categories in Rule 1151*

Risk Value	Cancer Risk	Non-cancer Acute Risk
<b>Original Analysis</b>	5 in a million	0.02
<b>Using OEHHA's New Draft Cancer Potency Factor</b>	60 in a million	0.02
<b>Using OEHHA's New Draft Cancer Potency Factor and Updated Usage Estimates</b>	3 in a million	0.001
<b>CEQA Significance Threshold</b>	<b>10 in a million</b>	<b>1.0</b>

Based on staff's best estimate of what is being used in the field, the off-site health risk for the partial tBAC exemption is below the CEQA significance threshold of 10 in a million at this time. Previous analyses of the exemption in Rule 1151 found no tBAC containing coatings being sold in the Basin. Staff does not believe that tBAC usage will significantly increase considering the exemption has been in place for over a

decade. However, recent research staff conducted for this assessment found potentially non-compliant use of tBAC in clear and color coatings, which will be addressed through appropriate enforcement actions. Staff recommends conducting outreach and further site visits to Rule 1151 facilities to address potential non-compliant usage and further assess the quantity of tBAC containing coatings currently in use.

### *Rule 1113*

A limited exemption for tBAC was adopted in 2006 in Rule 1113 based on the technology assessment for IM coatings conducted by the EPSA committee. The health risks from the use of tBAC were evaluated using the estimated risk factors for tBA from scientific literature as a surrogate for tBAC to conservatively estimate the potential cancer risk and non-cancer (acute) effects. The EA analyzed potential health risks based on painting a large storage tank using an IM coating with tBAC. Due to the long service life for IM coatings, long-term exposure is not expected in most cases. However, testimony provided at the public workshop for PAR 1113 indicated that certain large facilities employ a full-time painting department to apply IM coatings to various equipment on-site throughout the year, increasing the length of exposure to the surrounding community. A conservative assessment of long-term cancer risks were performed for a sewage treatment plant in Carson, a refinery in El Segundo, and a water/power facility in La Verne using actual information in 2006 regarding IM coating practices at these facilities (14).

All the assumptions and the methodology in calculating the MICR from tBAC exposure at each of the specific facility types using large amounts of IM coatings for the original analysis can be found in Appendix D of the Final EA (28). For this analysis, staff calculated the health risk using the new draft CPF, updated dispersion modeling, with the previously calculated usage assumptions, and a higher tBAC content. This assessment used the original rule amendment usage assumptions (889 gallons per year for the sewage plant, 269 gallons for the refinery and 600 gallons per year for the water and power facility). Staff increased the percent tBAC from 21.2 to 33.5 percent, which is the highest concentration of tBAC reported in the 2014 Draft CARB coatings survey for IM coatings (the sales weighted average was 10.4 percent).

Table 3 provides a summary of all the health risks of the scenarios mentioned above, from both the 2006 amendment to Rule 1113 and SCAQMD staff's updated analysis. Using conservative tBAC emissions for usage limited to IM coatings, the updated analysis concluded that both carcinogenic and non-carcinogenic acute risk are less than significant.

Table 3 - Health Risks from tBAC Usage in IM Coatings in Rule 1113

Risk Value	Non-Cancer Acute Effect	Cancer Risk from Sewage Treatment Facility Scenario	Cancer Risk from Refinery Scenario	Cancer Risk from Water/Power Facility Scenario
<b>Original Analysis</b>	0.4	2 in a million	1 in a million	0.04 in a million
<b>Using OEHHA’s New Draft Cancer Potency Factor</b>	0.2	4.7 in a million	1.9 in a million	0.2 in a million
<b>OEHHA’s New Draft Cancer Potency Factor and Updated Usage Estimates</b>	0.4	7.4 in a million	3.0 in a million	0.3 in a million
<b>CEQA Significance Threshold</b>	<b>1.0</b>	<b>10 in a million</b>	<b>10 in a million</b>	<b>10 in a million</b>

During the 2016 Rule 1113 amendment, public comments indicated tBAC containing IM coatings could be applied on bathroom floors, in schools, or at theme parks and would potentially affect workers applying the coatings. The original risk assessment did not analyze occupational (on-site worker) exposure; however, because it was assumed workers handling and applying IM coatings use PPE; thereby minimizing exposure. According to OSHA, PPE is used to minimize exposure to serious workplace injuries and illnesses and may include gloves, safety glasses and shoes, earplugs, hard hats, respirators, coveralls, vests, and/or full body suits. Typically in IM coatings scenarios, PPE would include all of the above; however, not all coating operations or applications utilize a high level of PPE. PPE can be an effective way to mitigate exposure, but only if there is a rigorous program in place to ensure the appropriate PPE is used and that the proper fit and training is available. Adding PPE requirements in SCAQMD rules has been suggested as one approach; however, this would be difficult for SCAQMD staff to enforce, because the jurisdiction for this kind of requirement typically falls under federal and state OSHAs. The SCAQMD staff is not equipped to properly identify if PPE is being used correctly and does not have the authority to issue violations based on OSHA’s regulations.

*Rule 1107*

During the 2012 PAR 1107 rule development process (the amendment was never adopted or brought before the Board), staff evaluated a potential 100 g/L VOC limit and sought to take advantage of technology transfer from IM coatings in Rule 1113 that already meet this limit. Stakeholders agreed to this approach provided an exemption for tBAC was included; they also sought an exemption for Dimethyl Carbonate (DMC). During the rule development process, SCAQMD staff modeled emissions from two facilities from four volume usage categories (less than 100 gallons per year, less than 1,000 gallons per year, less than 2,000 gallons per year and greater than 2,000 gallons per year) to estimate the potential health risks from a limited exemption (32). Facility-specific parameters were used including building configurations, stack location, receptor distance, and meteorological data. The estimates at the time indicated that some facilities using tBAC could pose an unacceptably high risk to nearby receptors in certain high volume situations. In some high volume scenarios involving DMC, off-site worker exposure risk was high enough to warrant concern about allowing a limited exemption.

To keep off-site health risks below CEQA off-site thresholds, it was determined that up to 560 pounds per year of tBAC and 180,000 pounds of DMC could be used by a facility. With the new draft CPF, the same usage for tBAC would have to be reduced to approximately 80 pounds per year of tBAC. At the time staff was prepared to move forward with a limited exemption, but the issue regarding on-site worker exposure was raised. An analysis of potential on-site risks to workers was conducted using the mass balance (box model) approach used by CARB for their EIA of tBAC, who determined there would be an increased exposure to tBAC. Nevertheless, CARB weighed the increased exposure to tBAC with the decreased exposure to xylene and toluene, and at that time determined the risk from the increased exposure to tBAC to be acceptable. For the Rule 1107 analysis, staff found that the on-site risks far exceeded the 10 in a million CEQA significance threshold for off-site receptors, which is a questionable threshold to use for on-site worker receptors. However, staff was hindered in its on-site worker risk analyses in part because there is no established threshold or methodology to address the on-site worker risk, and as a result, the PAR 1107 was put on hold.

### *Rule 1168*

In 2013, staff began working on an amendment to Rule 1168, with proposed VOC reductions to many sealant and adhesive categories. Industry stakeholders requested a limited exemption for both tBAC and DMC to achieve VOC reductions in the roofing adhesives category (30). Since roofing activities at a particular location occurs infrequently, health risks to off-site receptors would be limited to acute non-carcinogenic impacts. The preliminary analysis found an off-site acute HI to be 17 for tBAC (5.8 for DMC) based on 500 gallons per day usage of an adhesive containing 50 percent tBAC (35 percent DMC) on a 10,000 square foot area source elevated 35 feet and located 25 meters from the receptor (31). The concentrations used for the analysis were based on measured outdoor air sampling from a roofing project.

During the original analysis, staff back calculated the allowable usage and percent formulation such that the exemption would not potentially lead to an exceedance of the acute HI. The allowable usage was inversely related to the percentage of tBAC used in the formulation. For example, that analysis showed a formulation of 60 percent tBAC would have an allowable usage of only 0.05 gallon per day for the applicator or if 500 gallons per day were used by the applicator, only 0.006 percent tBAC would be allowed in the formulation (33). The percent formulations with tBAC or allowable usage amounts are not practical in real roofing applications. Based on its potential to be a human carcinogen, staff removed the proposed tBAC exemption. With the new higher draft OEHHA CPF, the allowable usage and percent formulations would be even less.

The preliminary draft HRA also included an on-site cancer risk analysis for roofing adhesives containing tBAC, which estimated a cancer risk of greater than 1,000 in a million. In part because there is no adopted threshold or methodology to address the on-site worker risk, the rule amendment was put on hold.

## CONCLUSIONS AND RECOMMENDATIONS

Consistent with the VOC white paper, staff proposes to continue a precautionary approach to ensure regulatory VOC reductions do not encourage the usage of chemicals that have a known toxic profile. However, VOC reductions and the resulting ozone and PM<sub>2.5</sub> reductions, may justify exempting a compound with an uncertain toxic profile. In such cases, staff will seek Governing Board direction when considering exempting a compound from the definition of a VOC. When evaluating potential exempt compounds, staff will evaluate:

- Usage in products (interior versus exterior),
- Training of the end user,
- Protective equipment used by the end user,
- Upper range concentration of the chemical in the product,
- Exposure to sensitive receptors, and
- Incremental increase or decrease in toxicity of the chemical it is replacing.

### Rule Recommendations

Staff will continue to monitor the sales and use of tBAC containing coatings in Rules 1113 and 1151 and can re-evaluate the off-site risk once the State's SRP completes its review and the CPF is finalized by OEHHA. Since the rules currently allow a limited exemption for tBAC, the CEQA analysis would consider the tBAC containing coatings as the baseline and evaluate the potential change in toxicity by substituting other solvents for tBAC (e.g. xylene, toluene, MEK, pCBtF, acetone). In the future, if staff determines that it is necessary to remove the limited exemptions, the following scenarios will be considered:

1. Remove the exemptions but leave the existing VOC limits,
2. Remove the exemptions and increase the VOC limits, or
3. Adopt a toxic rule or prohibit the use of tBAC (Group II exempt compound).

Option 1 would be contingent on a technology assessment to determine if comparable compliant non-tBAC containing coatings exist in the marketplace. Option 2 could lead to backsliding on VOC emission reductions. In addition, removing the exemption for tBAC as a VOC and increasing the VOC limit may not necessarily lead to the reduction in use of tBAC unless there is an explicit prohibition of use. Option 3 would reduce the use of tBAC in the Basin. Options 1 and 3 may require time for manufacturers to reformulate as substituting tBAC with other solvents may affect product performance. Staff will continue to collaborate with OEHHA, CARB, the U.S. EPA, and the stakeholders on tBAC and other compounds that could potentially be exempted from the definition of VOC.

Based on this analysis with the new draft CPF and usage assumptions, staff is not recommending any changes to the current limited exemptions. The following summarizes our findings and recommendations:

**Rules 1113 and 1151 – no changes at this time**

- Off-site analyses are within acceptable risk thresholds, even with the new draft cancer potency factors.
- If cancer potency factors increase based on the final SRP findings, reassess limited exemptions.
- On-site analyses were not originally conducted and there is no currently established methodology or threshold to assess significance.

**Rules 1107 and 1168 – move forward with amendments without the tBAC exemptions**

- Previous analyses indicated off-site risk to be above CEQA thresholds and the new cancer potency factors increase the risk even more.
- On-site risk was determined to be significantly higher than the established CEQA thresholds for off-site risk but there is no established threshold to assess on-site risk.
- Keep existing VOC limits where stakeholders indicated tBAC or DMC was necessary for reformulation, e.g. do not risk increased toxicity to achieve VOC reductions.
- If cancer potency factors decrease based on the final SRP findings, reassess possible exemption.

**On-site Analysis**

Although the SCAQMD may not be obligated to conduct an on-site worker exposure analysis, the Governing Board can direct staff to conduct an evaluation to determine whether the change in VOC limit could result in an increased toxics exposure. CEQA may also require such an analysis under certain circumstances. Under either scenario, the SCAQMD does not currently possess the expertise, guidelines, methodology or established risk thresholds to complete the appropriate on-site analysis; therefore, staff would need to develop additional resources.

Even if an on-site analysis determined the worker risk was too high, the SCAQMD does not have the authority to regulate worker safety (e.g. require PPE or engineering controls) because OSHA is the regulatory agency responsible for worker protection. If the policy of the Governing Board is that staff should seek an appropriate method to address on-site exposure, staff suggests the potential options listed below. Alternatively, the Governing Board can direct staff to rely on OSHA for this analysis.

1. Rely on OSHA to address and enforce occupational exposure, unless it is determined that an analysis of such exposure is required.
2. Use an outside source to develop a methodology and threshold to assist staff in assessing occupational exposure.
3. Use mass balance type modeling as a screening tool to calculate the on-site exposure, to ensure worker exposure does not exceed applicable toxicity limits.

Even if the Governing Board does not require an on-site analysis, and it is not required by CEQA, staff recommends continuing to use a conservative approach when considering exempting compounds such as tBAC.

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