

The Tier 1 Occupational Exposure Banding Process: Using GHS Information

1.0. Tier 1 Overview

The Tier 1 technical criteria use hazard phrases, codes, and categories of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). GHS covers most hazardous chemicals and provides a uniform approach for communicating hazards related to chemical exposures. Under GHS, chemicals are assigned standardized hazard codes and categories based on their known toxicological characteristics [UNECE 2015]. As shown in Table 1-1, Tier 1 relies on the use of this information to assign OEBs. Bands A and B are not assigned in Tier 1. Since there are relatively low data requirements for Tier 1, there is not enough information to suggest higher exposure ranges for chemicals banded in Tier 1. This cautious approach decreases the likelihood of allowing overexposures. The GHS hazard codes and categories assigned to a chemical of interest can be found on an OSHA-compliant safety data sheet (SDS), as well as in a number of databases that address chemical safety. Detailed information on GHS hazard codes and categories is found in Section 1.1.

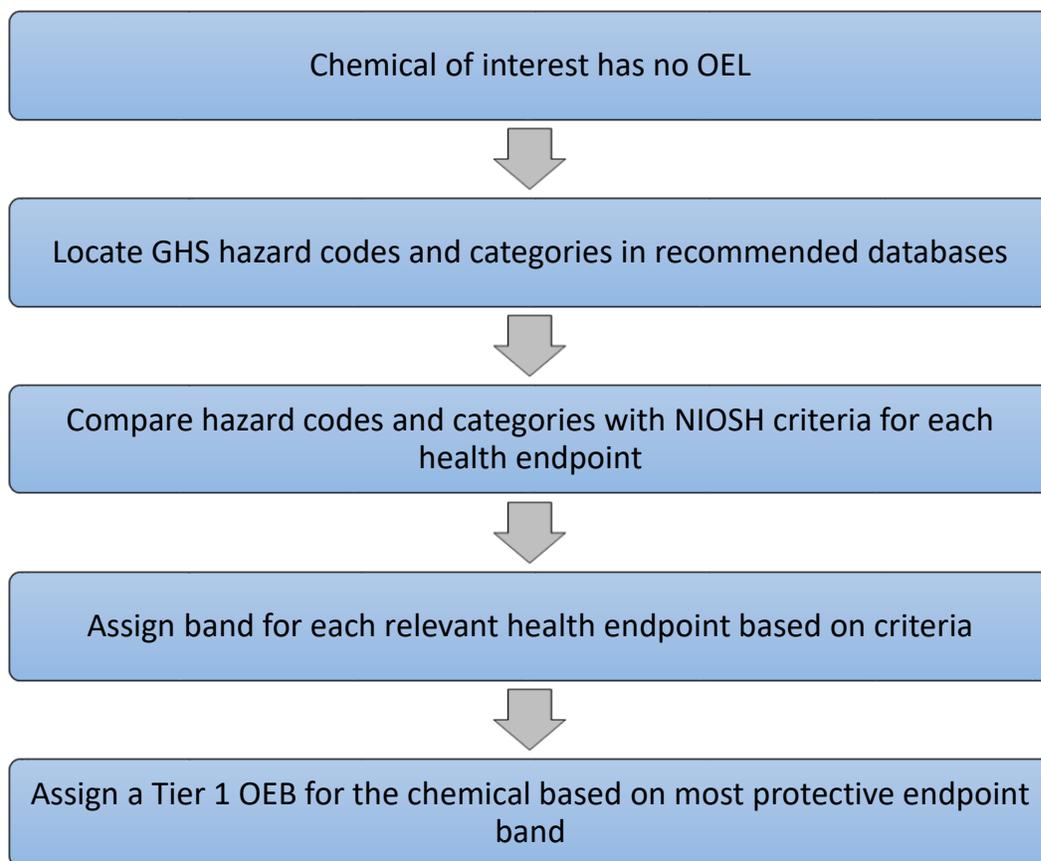
These codes and categories provide a basis to categorize chemicals based on the severity and reversibility of the health effects. Chemicals that have the potential to cause severe and irreversible health effects at relatively low doses, such as carcinogens, reproductive toxicants, acutely fatal compounds, and corrosive materials, are systematically assigned to the most protective bands. Chemicals that cause reversible health effects at higher doses, such as skin and eye irritants, are assigned less protective bands, given that the health outcomes are less severe. As shown in the Tier 1 Overview (Figure 1-1), GHS codes are used to discriminate between extremely potent chemicals (assigned to bands D or E) and those for which the criteria suggest a lower level of toxicity. If a chemical has not been evaluated in the GHS system, it cannot be banded in Tier 1. Additionally, chemicals that have been evaluated by GHS, but have not been assigned any 300-level H-codes cannot be banded. These chemicals require a Tier 2 evaluation for band assignment. In general, Tier 1 can be used as a quick screening method, but NIOSH recommends going to Tier 2 if the user expertise is available. Tier 1 would likely be more useful when banding a large number of chemicals and deciding which ones should be prioritized for elimination or substitution.

Table 1-1: Tier 1 Criteria Overview: GHS Hazard Codes and Categories for Tier 1 Hazard Banding*

| NIOSH Tier 1 criteria | | C | D | E |
|------------------------------------|---|---|---|---|
| OEL ranges | Particle | > 0.1 to ≤ 1 milligrams per cubic meter of air (mg/m ³) | > 0.01 to ≤ 0.1 mg/m ³ | ≤ 0.01 mg/m ³ |
| | Vapor | > 1 to ≤ 10 parts per million (ppm) | > 0.1 to ≤ 1 ppm | ≤ 0.1 ppm |
| Acute toxicity | H301 Category 3 | H300 Category 2 | H300 Category 2 | H300 Category 1 |
| | H302 Category 4 | | | |
| | H331 Category 3 | H330 Category 2 | H330 Category 2 | H330 Category 1 |
| | H332 Category 4 | | | |
| | H311 Category 3 | H310 Category 2 | H310 Category 2 | H310 Category 1 |
| | H312 Category 4 | | | |
| Skin corrosion/irritation | H315 Category 2 | — | — | H314 Category 1, 1A, 1B, or 1C |
| Serious eye damage/ eye irritation | H319 Category 2, 2A or 2B | — | — | H318 Category 1 |
| Respiratory and skin sensitization | H317 Category 1B (skin) | H317 Category 1 or 1A | — | — |
| | H335 Category 3 | H334 Category 1B | H334 Category 1 or 1A | H334 Category 1 or 1A |
| Genotoxicity | — | H341 Category 2 | H340 Category 1, 1A or 1B | H340 Category 1, 1A or 1B |
| Carcinogenicity | — | — | H350 Category 1, 1A, or 1B | H350 Category 1, 1A, or 1B |
| | — | — | H351 Category 2 | H351 Category 2 |
| Reproductive Toxicity | H361 (including H361f, H361d, and H361fd) Category 2 | H360 (including H360f, H360d, and H360fd) Category 1B | H360 (including H360f, H360d, and H360fd) Category 1 or 1A | H360 (including H360f, H360d, and H360fd) Category 1 or 1A |
| Specific target organ toxicity | H371 Category 2 | — | — | H370 Category 1 |
| | H373 Category 2 | | | H372 Category 1 |

*Note that the following hazard codes will not be used for Tier 1 Banding: H200's, H303, H304, H305, H313, H316, H320, H333, H336, H362, and H400's. These H-codes are either not occupationally relevant, or are not sufficient to affect the Tier 1 banding result.³

Figure 1-1: Tier 1 overview for quickly banding chemicals in Tier 1.



1.1. GHS Hazard Statements, Codes, and Categories

Hazard statements, codes, and categories are aligned with a standardized hazard criterion for toxicological endpoints defined by GHS. These endpoints are called *hazard classes*. The health hazard classes defined by GHS are (1) carcinogenicity, (2) reproductive toxicity, (3) specific target organ toxicity, (4) genotoxicity, (5) respiratory sensitization (6) skin sensitization, (7) acute toxicity, (8) skin corrosion and irritation, and (9) eye damage/irritation.

GHS *hazard statements* are standardized phrases that capture the nature and extent of the potential risks to human health through contact with a chemical. A given chemical may have a hazard statement for one or more of these endpoints, and the statements will vary depending on the severity of the endpoint. For example, several GHS health hazard statements address the acute toxicity potentially associated with dermal exposure to a chemical. These statements include, “May be harmful in contact with skin,” “Harmful in contact with skin,” “Toxic in contact with skin,” and “Fatal in contact with skin.”

Each hazard statement assigned to a chemical by GHS is accompanied by an alphanumerical *hazard code*. Marked by simplicity and ease of use, hazard codes related to health endpoints always begin with the letter H followed by the digit 3. For example, “May be harmful in contact with skin” is represented by the code H313 and “Fatal in contact with skin” is coded H310.

Under GHS, chemicals are also assigned a *hazard category*. These categories compare hazard severity within a hazard class and are assigned according to specific toxicological cut-points (such as median lethal dose [LD₅₀]) values for acute toxicity) or expert judgement decisions, such as for assessing the potential for human

carcinogenicity. The hazard category can often provide greater distinction and more specific information than hazard statements and codes.

The full suite of GHS hazard codes, statements, hazard categories is listed in Table A3.1.2 of GHS (Rev. 5) [UNECE 2015]. As illustrated in Table 1-1 of this document, most of these hazard code and category combinations correspond to a band in the NIOSH occupational exposure banding scheme. To learn more about GHS hazard codes and hazard statements please visit the OSHA Hazard Communication Standard which provides detailed information and training on GHS [OSHA 2012].

1.2. Data Sources for Hazard Codes and Categories

A number of resources can be used to obtain hazard statements, codes, and categories. NIOSH recommends the following as information sources:

Safety Data Sheets

Safety data sheets (SDSs) are the primary channel through which manufacturers communicate chemical safety and health information to workers and emergency response personnel who may be exposed to hazardous chemicals. The OSHA hazard communication standard is now aligned with the GHS, meaning that manufacturers must provide a harmonized hazard statement for each hazard class and category [OSHA 2012]. As of June 1, 2015, OSHA-compliant SDSs will contain GHS hazard statements, codes, and categories that can be used for Tier 1 analysis (**Error! Reference source not found.**).

Figure 1-2: Required elements in Section 2 of OSHA compliant safety data sheets as defined by the hazard communication standard (29 CFR 1910.1200(g)), revised in 2012.

| Section 2: Hazard(s) Identification |
|---|
| <p>This section identifies the hazards of the chemical presented on the SDS and the appropriate warning information associated with those hazards. The required information consists of:</p> <ul style="list-style-type: none">▪ The hazard classification of the chemical (e.g., flammable liquid, category¹).▪ Signal word.▪ Hazard statement(s).▪ Pictograms (the pictograms or hazard symbols may be presented as graphical reproductions of the symbols in black and white or be a description of the name of the symbol (e.g., skull and crossbones, flame).▪ Precautionary statement(s).▪ Description of any hazards not otherwise classified.▪ For a mixture that contains an ingredient(s) with unknown toxicity, a statement describing how much (percentage) of the mixture consists of ingredient(s) with unknown acute toxicity. Please note that this is a total percentage of the mixture and not tied to the individual ingredient(s). |

Annex VI to the Classification, Labelling and Packaging of substances and mixtures (CLP)

Annex VI is a European database of approximately 1300 chemicals that is part of the Classification and Labeling and Packaging of chemical substances and mixtures. This database can be found on the website of the European Chemical Agency [ECHA 2013]. Information on chemicals and mixtures, including GHS hazard statements, codes, and categories can be found in Annex VI.

GESTIS Substance Database

GESTIS is a hazardous chemical database of the German Social Accident Insurance that contains approximately 8000 chemicals [GESTIS 2012]. This website can be found at: <http://gestis-en.itrust.de/>. Information in GESTIS includes toxicological data, physical and chemical properties, regulations, and hazard statements, codes, and categories.

1.3. Steps in the Tier 1 Analysis

The first step in the Tier 1 analysis is to determine whether an authoritative (i.e., government, consensus, or peer-reviewed) or reliable internal OEL is available for the chemical under consideration. Examples include, but are not limited to NIOSH recommended exposure limits (RELs), OSHA permissible exposure limits (PELs), American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs)[®], American Industrial Hygiene Association (AIHA) /Occupational Alliance for Risk Science (OARS) workplace environmental exposure limits (WEELs), and European Union (EU) scientific committee on occupational exposure limits (SCOEL). Current OEL information can be found on an OSHA-compliant SDS, in the NIOSH Pocket Guide for Chemical Hazards [NIOSH 2010], or any updates provided by the organization that derived the OEL being considered. If one of these OELs is available, it is not necessary to define an OEB. Controls should be implemented to limit worker exposure to the available OEL. This step is important as it highlights the fact that OEBs are not a replacement to a traditional OEL, the latter typically having much greater data requirements and more in-depth data evaluation and peer review procedures. However, in the absence of existing government, consensus, or peer-reviewed OELs, occupational exposure banding can be used to make decisions about worker exposure and protection.

In gathering information for Tier 1, the user should identify the hazard codes and categories assigned to the agent. These can be found in the sources listed in Section 1.2 of this document. For hazard banding purposes, majority of the 300-level hazard codes are used, as they correspond to health hazards. Some 300-level codes are not included, as they represent health effects that are not sufficient for Tier 1 banding. The 300-level hazard codes that are not used for banding include: H303, H305, H313, H316, H320, H333, H336, and H362. Furthermore, 200-level hazard codes that correspond to physical hazards and 400-level hazard codes that correspond to ecotoxicology are also not used for banding purposes.

Using the hazard codes assigned to a given chemical for each toxicological endpoint, the technical criteria listed in Table 1-1 provide guidance on the selection of the corresponding OEB for that endpoint. The band for each health endpoint for which H codes are available is entered into the Tier 1 worksheet. Where multiple H-codes for a single chemical are found and those H-codes correspond to different bands, the overall OEB is defined as the most protective band. For example, if Tier 1 H-codes are found that correspond with band D and band E, the chemical is assigned band E in Tier 1.

To assist the user in completing the Tier 1 banding process, Appendix A contains the Tier 1 criteria along with a blank worksheet that can be used to record H-codes, hazard categories, and the corresponding endpoint specific band. The most protective of these bands is recorded at the bottom of the worksheet. This is the Tier 1 OEB for the chemical.

Users can also use the online [occupational exposure banding e-Tool](#) to complete the Tier 1 process. The e-Tool incorporates the occupational exposure banding process and allows users to apply toxicology and potency information to generate quantitative exposure guidance for chemicals. For Tier 1, the e-Tool integrates the Tier 1 criteria and links the e-Tool to the GESTIS substance database, allowing users to auto-populate GHS codes/categories for any chemical that is found in the GESTIS database. The e-Tool also gives users the ability to manually enter Tier 1 data using other recommended sources listed in section 1.3. The e-Tool is an easy and efficient way for users to band a large number of chemicals in a short period of time without having to rely on the paper worksheets or criteria.