Technical Dialogue

WHAT IS A TEEL? WHAT IS AN ERPG?

Users of the PEAC tool who press the PAD button (PAD = Protective Action Distance) may see TEEL-1, TEEL-2, and TEEL-3 numbers pop up on the screen. Sometimes instead of TEEL numbers, the user sees ERPG-1, ERPG-1, and ERPG-3 numbers. These numbers represent concentrations of chemicals in the air, and may be expressed in parts per million (ppm) or milligrams per cubic meter (mg/m^3 or mg/m^3). They are useful in establishing Initial Isolation Zone distances and Protective Action Distances in case of a chemical spill, and at least some of the chemical becomes airborne. What do these numbers mean?

Definitions

ERPG is an acronym for Emergency Response Planning Guideline. ERPG numbers are developed by the Emergency Response Planning Committee of the American Industrial Hygiene Association (AIHA). They are defined as follows:

ERPG-1: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

ERPG-2: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

ERPG-3: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

TEEL is an acronym for Temporary Emergency Exposure Limit. TEEL numbers are developed by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA), under the U.S. Department of Energy (DOE). Their definitions are as follows:

TEEL-1: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

TEEL-2: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

TEEL-3: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed without experiencing or developing life-threatening health

effects.

What is the difference between a TEEL and ERPG?

A careful reading of the definitions should show:

- TEEL as the name implies is a temporary number.
- TEELs are developed by the DOE, and ERPGs are developed by AIHA.
- The term "one hour exposure" appears in the ERPG definition but not the TEEL definition.

The ERPG concentrations developed by the AIHA are established by a careful peer-review process which emphasizes human experience to the extent that such information is available. Since human exposure data are rarely available except for low-level exposures, animal exposure data most frequently forms the basis for the ERPG concentrations. Rat 1-hour exposure tests are used where available. The most pertinent information is derived from acute inhalation toxicity studies. The focus is on the highest airborne concentrations not showing the effects described by the definitions of the ERPG-1, ERPG-2, and ERPG-3 levels. Long-term effects such as developing a hypersensitivity or cancer are not considered. The justification of the ERPG concentrations are published in documents available from the AIHA. The documents can be purchased over the Internet by visiting the AIHA website at http://www.aiha.org/

As of July 2002, the AIHA has published ERPG concentrations for 102 different chemicals. Typically the AIHA adds about seven chemicals per year to their list, and sometimes that organization will change a value that it has established previously. The Department of Energy has developed a methodology for deriving temporary emergency exposure limits (TEEL) to serve as *temporary guidance* until AIHA publishes ERPG concentrations. The TEEL numbers are considered as approximations to ERPGs to be used until the peer-reviewed ERPGs are published.

The DOE released their 18th revision of their TEEL list on Jan 31, 2002. This list is updated at least annually. Approximately 140 new chemicals have been added to the list this last year bringing the total as of Jan 31, 2002 to 1718 chemicals. The DOE TEEL list was originally developed to be used by DOE workers, DOE contractors, and adjacent general public; it is currently being used by other governmental agencies including the Department of Defense.

A one-hour exposure time is implied with the TEEL concentrations, but the term "one-hour" is not stated in the definition of TEEL. The reason is that the DOE makes a judgment as to whether toxic consequences of exposure to a particular chemical are concentration dependent or exclusively dose dependent. Hydrogen sulfide is an example of a concentration dependent chemical, and silica particulates is an example of a dose dependent chemical. Some chemicals such as benzene are both. All concentration-dependent chemicals are based on a 15-minute exposure time and dose dependent chemicals are based on a 60-minute exposure time. The DOE then adjusts the concentrations to the same exposure time (one hour) using a formula, adding the comment that the concentration at the receptor point of interest should be calculated as the peak 15-minute time-weighted average concentration. The details of this analysis are too lengthy to explain in this short article, but the DOE chose not use the term "one-hour" in their definition of TEEL.

Details of how TEELs are derived are explained in the publication,

D.H. Craig *et al*. "Derivation of Temporary Emergency Exposure Limits (TEELs)", Journal of Applied Toxicology **20**. pages 11-20 (2000).

A copy of this publication may be obtained off the Internet by visiting the DOE SCAPA website, http://www.bnl.gov/scapa/ and then pulling down the page, "DOE's Temporary Emergency Exposure Limits (TEELs)".

Where Can I Find the Latest List of TEELs and ERPGs?

The lists of chemicals and TEEL or ERPG concentrations are updated once or twice per year. Remember that the TEEL concentrations for a particular chemical are temporary values until AIHA publishes their ERPG concentrations. The PEAC tool lists TEELs and ERPGs, but the user may want to obtain the latest list directly off the Internet. The DOE SCAPA website contains links to both the TEEL and ERPG lists, at http://www.bnl.gov/scapa/ , including contacts with the people who develop the lists. The TEEL list itself is located at http://tis-hq.eh.doe.gov/web/chem_safety/teel.html

The ERPG list is located at http://www.bnl.gov/scapa/scapawl.htm with details on how to purchase the backup documents at http://www.aiha.org/

Use of TEELs and ERPG to the Emergency Responder

TEELs and ERPGs are useful in establishing a level of concern in case of an actual or potential chemical spill or accident. If chemical becomes airborne, people can inhale the chemical. The Emergency Responder might model the spill situation using the PEAC tool or the ALOHA model as a part of CAMEO, and establish an evacuation distance based on some level of concern. A Protective Action Distance might be based on an ERPG-2 concentration (or TEEL-2 if ERPG-2 is not available). An Initial Isolation Zone might be based on ERPG-3 (or TEEL-3). The ERPG or TEEL numbers should not be the only criteria that are examined. The local situation and safety factors to allow for various uncertainties (changing weather, how much chemical becomes airborne, duration of the spill, allowances for sensitive individuals) should be considered in making decisions.

PPM or Mg/M^3

ERPG and TEEL values have units of ppm (parts per million) or mg/m^3 (milligrams per standard cubic meter, which may be displayed as mg/m^3). Gases and organic vapors are reported in ppm. Solids (which produce airborne dust or particulates) and some liquid aerosols including metal mists are reported in mg/m^3. The

DOE uses 77°F (25°C) temperature and sea level as their reference state for a standard cubic meter in developing TEELs. A chemical expressed in ppm can be converted to a mg/m^3 concentration if the molecular weight is known. It is not appropriate to convert solid particulates expressed in units of mg/m^3 to ppm. To convert ppm to mg/m^3, multiply ppm by the molecular weight and divide by 24.45.

$$mg/m^3 = ppm\ (MW)/24.45$$

The final number is rounded to one or two significant figures. This formula is valid for concentrations up to 10000 ppm (1% by volume).

Some Cautions

- ERPG or TEEL concentrations should not be the only criteria used to establish a level of concern for establishing evacuation distances or a protective action distance, but they may be helpful along with other factors in making decisions.
- Sensitive individuals, including infants, the elderly, and people with breathing difficulties may be impaired or experience a life-threatening situation at even lower concentrations.
- For some flammable gases, the DOE SCAPA website lists TEEL-1, TEEL-2, and/or TEEL-3 concentrations above the Lower Explosive Limit for that chemical. An example is ethane, which the DOE lists TEEL-1 as 150,000 ppm, TEEL-2 as 250,000 ppm, and TEEL-3 as 500,000 ppm (balance air, concentrations based on ethane acting as a simple asphixiant, from 18th revision list). The lower explosive limit for ethane is 2.9% (29,000 ppm). It is the opinion of the AristaTek staff that the TEELs should never be greater than the Lower Explosive Limit (LEL) concentrations, and for that reason, the PEAC tool does not contain TEELs for ethane and other flammables above the LEL.
- Oxygen level should also be considered in the case of a chemical spill. The Oxygen level should be at least 19% for confined space entry, according to OSHA regulations. In scanning the TEEL list of chemicals, the ERPG-3 values for some inert gases such helium, argon, and nitrogen are listed as 500,000 ppm based as a simple asphixiant. The balance is assumed to be air, which means that at 500,000 ppm of the gas spill, the oxygen content is estimated to be only 10.5%. This oxygen concentration dangerously close to asphyxiation. For individuals whose breathing is impaired, a 10.5% oxygen concentration for one hour could result in death.
- The TEEL concentrations published by the DOE are for the pure chemical in air. If more than one toxic chemical is present at the same time, estimated TEELs for the mixture can be calculated using procedures given at the DOE SCAPA website, http://www.bnl.gov/scapa/ .