USING CHEMICAL MIXTURE METHODOLOGY (CMM) IN SCREENING AND EPHAS

QUESTION: What is the role of the SCAPA-approved Chemical Mixture Methodology in the hazardous material screening process of the Hazards Survey?

ANSWER: The Chemical Mixture Methodology (CMM) plays no explicit role in the hazardous materials screening process of the Hazards Survey. In general, the screening process is applied on a single container basis. The intent of the Order (as reflected in the EMG, DOE G 151.1-2, Appendix A, Section A.3.1) is to screen out *individual containers* with capacities less than quantities that can be "easily and safely manipulated by one person." Hence, individual containers that are being used, and small numbers of such containers kept in ready storage within or very near an end-user facility, may be screened out. However, larger numbers of such containers (capacity totaling greater than about 5-10 times the applicable “laboratory scale” threshold) in warehouses or other storage locations should be examined more closely before screening them out.

QUESTION: What is the purpose of the SCAPA-approved Chemical Mixture Methodology recommended for use in the EMG?

ANSWER: The mixture methodology is an analysis tool which can be used to estimate health impacts as the result of an atmospheric release of a chemical mixture or the concurrent release of different toxic materials. As such, it may be appropriate for use in the consequence analyses performed as part of an Emergency Planning Hazards Assessment (EPHA). The EMG, DOE G 151.1-2, Appendix F, Section F.4 states:

> “For chemical mixtures and concurrent releases of different substances, consequences should be assessed using the Mixture Methodology “Hazard Index” approach recommended by the SCAPA Chemical Mixtures Working Group (Craig, et al, 1999).”

The SCAPA-approved Chemical Mixtures Methodology (CMM) was developed to address several shortcomings of the simple methods commonly used to estimate health effects of mixtures. One such method involves adding the exposures from all the chemicals in a mixture using a sum-of-the-fractions approach, regardless of the target organs involved. Because different chemicals may affect different target organs, that method tends to be overly conservative. Another common method treats the effects of different chemicals in a mixture as if they are independent. That approach has the potential to be non-conservative because different chemicals may, in fact, affect the same organ and their impacts should therefore be treated as additive rather than as independent. The CMM assigns the effect of each chemical in a mixture to a particular target organ. The effects of the different chemicals on each target organ are then summed to produce a health impact estimate that is more realistic than the first approach described above (sum-

of-the-fractions) and generally more conservative than the second (treating all exposures independently).

It should be noted that the CMM makes no provision for synergistic effects (effects that are more than additive) or antagonistic effects (effects that are less than additive). It is also assumed that there are no target-organ interactions (i.e., each target-organ effect is independent of other target-organ effects).

Other descriptions, limitations, and assumptions of the CMM are on the SCAPA website at http://orise.orau.gov/emi/scapa/chem-mxt-wg.htm and http://orise.orau.gov/emi/scapa/hcn-table.htm, particularly in the published journal article.

QUESTION: The EMG states that the SCAPA-approved Chemical Mixtures Methodology is to be used to assess the consequences of *"…chemical mixtures and concurrent releases of different substances…"* and that concurrent releases should only be analyzed if *"…a plausible scenario exists by which quantities of different substances, each exceeding a laboratory scale threshold discussed in Appendix A, could be released from the same location at the same time."* What kinds of scenarios should be considered "plausible" in this context?

ANSWER: As noted above, a distinction is made in the Emergency Planning Hazards Assessment (EPHA) guidance between mixtures and concurrent releases of dissimilar materials. As used in this context, in a *mixture* the dissimilar hazardous materials are in a mixture prior to an initiating event, whereas in *concurrent releases* the event causes separate containers of different materials to be breached at approximately the same time and place. Use of the Chemical Mixtures Methodology (CMM) for a mixture of two or more different toxic materials that can be released from a single container is clearly endorsed in the EMG. However, when addressing concurrent releases from different containers, the guidance recommends the use of the CMM only if a plausible scenario can be identified by the analyst.

Thus, the key to the use of the CMM for concurrent releases is the identification of a plausible scenario that leads to the materials being mixed at the time of release or after becoming airborne. Because the word "plausible" lends itself to a range of interpretations, the following statements are provided to clarify the intent of the EMG regarding "plausible" concurrent releases:

- As used in the EMG, the term "plausible" was intended to convey the idea that the concurrent release scenario should be quite obvious to the analyst, even to the extent of being the most likely outcome if a particular initiating event occurs. The *clear and present* nature of the concurrent release hazard is to be contrasted with lower degrees of likelihood suggested by the terms "hypothetical," "theoretical," or "potential."

- A concurrent release *should* be considered "plausible" if the release of one substance means it is more likely than not that the other(s) will be released.
- It was intended that the specific mechanism or cause of a concurrent release be recognizable to the analyst from the conditions under which the different materials are stored and/or used in normal day-to-day operations.

- Mere physical proximity of containers or other barriers does not necessarily mean that a "plausible" release scenario exists and needs to be analyzed.

- It was **NOT** intended that the possibility of catastrophic or extremely destructive initiating events be used as rationale for designating as "plausible" the release of multiple substances in an affected structure, zone or location. The guidance specifically states (EMG, DOE G 151.1-2, Section 2.6.2 and Appendix F, Section F.4), "*Concurrent releases* of dissimilar substances that, because of separation by distance or physical barriers, could result only from *extreme* malevolent acts or *catastrophic* events (such as major fires, airplane crashes, severe natural phenomena impacts, and building collapse) need not be analyzed."

The intent of the EMG regarding concurrent release scenarios that should be considered "plausible" is illustrated with the following three examples.

Example 1: A non-catastrophic earthquake of a certain magnitude is predicted to cause physical displacement between portions of a structure that would break a pipe carrying toxic gas "A". A second pipe carrying toxic gas "B" occupies the same pipe chase and is designed to the same standards of strength and seismic support. For that particular seismic initiating event, failure of the "B" pipe should be considered at least as likely as failure of the "A" pipe and a concurrent release should be analyzed.

Example 2: Industrial chemicals are stored in drums on 4-high warehouse racks. Collapse of a rack due to structural failure or handling mishap could cause drums to fall to the floor. If such a storage rack collapse is predicted to spill the contents of one or more drums, it should be considered more likely than not that the same number of drum(s) of a different material stored on the same rack will also fail (i.e., the same damage ratio would apply).

Example 3: Storage tanks of toxic liquids "Y" and "Z" are located in the chemical storage building of an operating facility. Tanker trucks periodically refill the storage tanks through connections at a transfer manifold located outside the building. One identified spill release scenario is initiated by a delivery truck striking the manifold, breaking the fill piping and spilling the contents of a tank on the ground outside the building. If the physical configuration of the transfer manifold and its protective features (curbs, bollards, etc.) is such that the

postulated truck mishap would just as likely break both the "Y" and "Z" fill piping, the spill of one liquid should be considered at least as likely as for the other and a concurrent release should be analyzed.

The intent of the EMG regarding concurrent release scenarios that should not be considered "plausible" is illustrated by the following examples.

Example 4: The storage annex of a laboratory building routinely holds the working inventory of supplies and consumables, including several toxic chemicals in 55 gallon drums. "Structure fire" and "explosion" are among the postulated generic types of initiating events. Release of multiple chemicals stored in the building as a result of fire or explosion is not a "plausible" concurrent release scenario, as intended by the EMG.

Example 5: Several drums containing toxic liquid "M" are stored and used in one part of a research and development building. Cylinders containing toxic gas "N" are stored and used in a different wing of the same building. These materials are received from their respective vendor delivery trucks at a single loading dock and then transported within the building to their separate storage/use locations. If the deliveries happen to occur at about the same time, there are no physical or administrative controls to prevent the materials from both being present in the vicinity of the loading dock for a short period of time. In this case, the possible presence of both materials at the same time in the loading dock area is incidental to their normal use and storage within the facility. Release of both chemicals by a fire or other destructive initiators is not a "plausible" concurrent release scenario, as intended by the EMG.