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SUBJECT: RESULTS FROM PRLIMINARY PESTICIDE WORKPLACE EVALUATION OF A SULFUR DIOXIDE FUMIGATION FACILITY IN KERN COUNTY

On September 25, 2008 I traveled to Kern County to observe the operation of a sulfur dioxide (SO_2) fumigation facility south of Delano. This facility treats produce (in this case grapes) destined for overseas shipment (Australia and New Zealand). The County Agricultural Commissioner (CAC) had raised concerns as to potential exposure not only to the facility workers but also to CAC staff performing duties related to phytosanitary certification requirements. The purpose of this visit was to perform an observational walkabout and to assess the need for air monitoring.

On arrival at the facility in the early afternoon, I observed chambers being prepared for fumigation. Several pallets of grapes, each holding several lugs of grapes, were placed in a chamber. The majority of the chambers are dedicated to SO_2 fumigation, though two had been modified for methyl bromide fumigation. The SO_2 chambers are unpainted concrete enclosures measuring 14,400 ft^3 and have a recirculation fan at the far end of the chamber. The fan is designed to distribute the SO_2 evenly throughout the treated commodity. The chambers are loaded with pallets in such a way as to form a tunnel, flanked by pallets on both sides. A tarpaulin is lowered over this pallet array to optimize the circulation of SO_2 gas through the pallets.

Once the chamber is loaded (maximum capacity is 48 pallets), a drop-down door is lowered to cover the chamber opening. Workers then proceed to seal the door with clamps and torque-pressure bars, making the door air-tight. These chambers are United States Department of Agriculture certified annually, using a smoke bomb test. After securing the door, 105 pounds of carbon dioxide (BOC CARBON DIOXIDE: 99.95 % Carbon dioxide, EPA Reg. # 38719-5) gas are piped into the chamber and held for 15 minutes. This increases the CO_2 concentration from the atmospheric concentration of 0.04% to approximately 6%. The high CO_2 concentration increases the target pest's (black widow spiders: Latrodectus hesperus) respiration and also causes them to exit the grape cluster in search of "fresh air". Following this is the injection of 26 pounds of SO_2 (THE FRUIT DOCTOR: 100% Sulfur dioxide, EPA Reg. # 11195-1) into the chamber, which is held for another 15 minutes. Twenty-six pounds of SO_2 in this chamber is

roughly 11,000 parts per million (ppm) or 1% of the air volume. This is the killing phase of the application, resulting in death to both the arachnid pest and to certain weed seeds and fungal spores that may be on the produce and are prohibited for import into the destination countries.

After the 30 minute fumigation (CO_2 and SO_2), the aeration/scrubbing cycle begins. The fan continues to run, but in the plenum area behind the chamber (where the air drawn in from the chamber is recirculated by the fan back into the chamber) a fine water mist is added to the airstreams. Sulfur dioxide is highly soluble in water (17.7 % in water at 0º C) and is efficiently removed by the water spray, such that after 30 minutes SO_2 concentrations are less than 2 ppm. The Cal/OSHA Permissible Exposure Limit (PEL) for SO_2 is 2 ppm, with a Short Term Exposure Limit (STEL) of 5 ppm.

On the other hand, there is no specific procedure for reduction of the CO_2 levels in the chamber. Carbon dioxide is 2 orders-of-magnitude less soluble in water (0.2%) than sulfur dioxide. No monitoring was done for CO_2, even though the calculated concentration of 6% is above the Immediately Dangerous to Life or Health (IDLH) concentration of 4% and far above the Cal/OSHA PEL of 5,000 ppm or STEL of 30,000 ppm. The only observed “reduction” method was from the opening of the chamber door, causing an intermingling of chamber air with outside air. This may be sufficient but further characterization of the CO_2 concentration reduction is advised.

At the end of the aeration/scrubbing cycle, using a real time SO_2 monitoring device, the applicator monitors the SO_2 concentration in the chamber. Air is sampled through a monitoring port on the chamber wall. The probe of the SO_2 monitor is inserted into the monitoring port. When the monitor indicates the SO_2 concentration is 2 ppm or less, the cycle is considered completed and workers can begin the unsealing procedure.

After opening the chamber, the fruit may be unloaded or stay in the chamber. The forklift driver does not normally wear respiratory protection as he unloads the chamber. The CAC staff does not normally enter the chamber immediately after fumigation; their activities within the chamber are normally pre-fumigation. However, during days of high product throughput, the CAC staff can be entering to certify produce in a pre-fumigated chamber that was just recently a post-fumigation chamber for the previous load. This could possibly be a source of exposure to both CAC staff and workers at the facility.

The chamber section of the facility adjoins the chiller/storage area and is separated by a flexible plastic-strip door. The area was in good condition and exhibited excellent housekeeping procedures.

After observation of the facility operations, including the activities of the CAC staff as they perform their phytosanitary certifications, I would recommend the following items/actions be considered by the facility operators or the CAC:

1. CAC staff performing photo-sanitation certification at facilities using SO_2 should have access to real-time instant readout personal SO_2 monitors. These are relatively low cost ($400) and should be made available to staff who suspect they may be exposed to SO_2 concentrations, even if these concentrations are below the PEL. This would also eliminate dependence on the facility operator as the information source when evaluating the potential exposure of the CAC personnel to SO_2.

2. Facility staff should wait until the SO_2 concentration in the chamber measures 1 ppm or less before ending the aeration/scrubbing cycle. This provides an additional margin of safety for workers entering the fumigation chamber. Furthermore, there is reason to anticipate that the PEL for SO_2 will be reduced. The American Conference of Governmental Industrial Hygienists (ACGIH) has announced that it intends to change the Threshold Limit Value (TLV) for SO_2, from 2 ppm to 0.25 ppm. Though the TLV does not have the force of law, it can often be a bellwether for actions subsequently taken by Cal/OSHA. It would be very likely that Cal/OSHA would adopt the more stringent 0.25 ppm within 3 to 5 years (see, for example, methyl bromide). Facilities that use SO_2 for fumigation may want to consider developing engineering and administrative controls now to meet a potential exposure reduction requirement in the future.

3. The potential exposure of workers to CO_2 is not known. Other than opening the chamber and allowing intermingling of the chamber air parcel with the work area parcel, there does not appear to be any specific method for reducing the chamber concentration from 60,000 ppm to a more acceptable and safer level (either the STEL of 30,000 ppm, the PEL of 5,000 ppm or the standard atmospheric concentration of 400 ppm). Label directions require monitoring of the CO_2 concentration before employees are allowed to enter the enclosed fumigated area and may require supplied-air respiratory protection, depending on the measured CO_2 concentration. Measuring methods can be either a grab-sampler (i.e. Draeger tube) or a realtime monitor. The facility may consider the use of a permanent installation CO_2 detector and dispense with ad hoc monitoring (the preferred solution).

Worker Health and Safety should consider monitoring some SO_2 fumigation facilities in the coming year. Monitoring should include short-term samples using a real-time monitor; and the use of 8-hour colorimetric tubes, to assess compliance with the Cal/OSHA PEL.

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