Memo to: S. El-Alfy

CC: K. Blower, S. McAlpine

From: K. Morton

Date: March 7, 1988

Subject: ARSENIC RECLAIM PLANT - DESIGN CONSIDERATIONS

When dealing with highly toxic substances such as arsenic trioxide, controls for safety of the workforce must be among the first considerations when designing the plant. Fortunately, arsenic does not accumulate in the body, due to a detoxifying mechanism which apparently oxidizes trioxide to pentoxide and then to a methylated compound whose toxicicity is only 1/100 of the original. The rapidity of the process reduces the possibility of chronic toxicity from short term or occasional exposure. For those workmen who may be subjected to long term exposure however, the possibility of chronic toxicity is increased as the body may be unable to detoxify arsenic trioxide at the rate that it is being taken in.

The fatal dose for this substance is less than 5 mg per kg of body weight, the approximate equivalent an aspirin tablet. Under ordinary circumstances, it would be quite difficult to unknowingly ingest this amount of arsenic but there are other, more subtle effects that must be guarded against as well and chronic toxicity may be manifested in a variety of ways, ie. hyperpigmentation of palms of hands and soles of feet, reduced sense of touch, lowered nerve conduction rates, etc. There is also a strong suspicion that arsenic may be a carcinogen or, more likely, a co-promoter, enhancing the carcinogenic effects of other carcinogenic substances, such as cigarette smoke.

The usual way of measuring arsenic exposure is through urinary analysis, as it is through the kidneys that arsenic is eliminated from the body, usually within 48 hours. Average urinary arsenic concentrations of unexposed people ranges from .01 to .22 mg/l with a median of .04 mg/l. It has been Giant's practice to retest those employees whose urinary arsenic level exceeds .15 mg/l and to temporarily remove them from arsenic exposure areas if the results of the retest are still elevated. Unfortunately it is easy to misinterpret the test results, as arsenic exposure can be through eating of shellfish as well as on the job.

In order to maintain a healthy workplace environment, we must build in controls right from the beginning, both in operating practices and in plant design. We cannot expect people to take personal protection against arsenic exposure seriously if the plant is not designed to minimize that exposure.

Many of the following comments refer not only to the surface facility of the ARP but also to the underground and rail transfer portions of the plant as well.

Plant Design

One obvious way to reduce exposure is to isolate dirty work areas from clean ones and to try to have employees spend most of their time in the clean areas. To do this, equipment that may have high exposure potential should not require a great deal of operator attention, either for maintenance or for monitoring reasons. Instrumentation for remote monitoring and operation should be included in the design, as should selection of low maintenance equipment. At the same time, the plant should be easy to keep clean. Ledges where dust can collect, non-watertight equipment, etc. should be avoided. Waterhose stations and floor sumps should be strategically located, as should vacuum cleanup stations.

To separate clean areas from dirty ones, consideration should be given to airlocks, small chambers between clean and dirty areas with a door opening into each area. These could prevent airborne dust being carried into the clean area as a result of a door being opened. Air balance is also an important factor in the design. Fresh air should always be brought into the clean area and thence into the dirty areas. This means that the clean area must be maintained at a slightly higher air pressure than the dirty areas.

Partitions between clean and dirty areas should be airtight, the ventilation air distribution being controlled through ducting rather than through air leakage. The number of doors and other openings through the partitions should be minimized as well. Though this may be seen as an unneccesary inconvenience by the operators, it will pay off in reduced contamination of clean areas. In any case, if remote operation works as it should, there should be little need for quick and easy travel around the plant.

Personal Hygiene and Protective Equipment

Personal hygiene must be stressed among employees, and facilities to promote this attitude must be available. A washroom with shower to be used in the event of arsenic exposure should be installed and workmen should be encouraged to make good use of it. Full laundry facilities to keep workclothes clean will help to prevent contamination of clean areas as well. In the case of dust suits and coveralls, a small change room complete with a drench shower, a small vacuum cleaner, laundry bags, etc., may be installed as a place to remove and clean contaminated clothing before entering the clean area from a dirty one.

Personal protective equipment should include a variety of suitable respirators as well as fully enclosed dust suits with an external clean air supply. Clean breathing air should be piped to all areas of the plant to be used in the event of high arsenic exposure potential such as may occur as the result of a spill or a serious gas leak.

Ventilation and Dust Control

A target of an airborne arsenic concentration of less than 10 micrograms per cubic meter over eight hours should be established for all areas of the plant, to meet the OSHA requirements that are expected to be adopted throughout Canada very soon. To achieve this, it will be necessary, not only to control all leaks but to have a very efficient ventilation and dust control system. As mentioned, air movement should be from clean to dirty areas and a negative air pressure maintained in dirty areas to prevent airflow in the opposite direction. Heating units in dirty areas should not draw large volumes of outside air that could upset the air balance. Placement of dust collector pickups is very important and use of flexible ducting to control temporary dust leaks should be possible.

Equipment that may cause dust generation, ie. compaction equipment, bucket elevators, screens, etc. should be particularly well isolated from the rest of the plant and it may be worth considering a totally separate ventilation system for these areas. A negative air pressure will tend to promote dust leaks under these conditions, undoing the benefits achieved through controlled airflow.

Conclusion

Control of arsenic exposure may be the most difficult as well as one of the most important features of arsenic plant design and we would be well advised to take extraordinary precautions in this area. As Nerco Con has learned, even extraordinary precautions against employee exposure and cross contamination do not guarantee success. Their employees change clothes and shower each time they travel from dirty to clean areas and still their urinary arsenic levels average over .40 mg/l, probably 3 or 4 times what our Cottrell operators average. The answer seems to be to prevent exposure, not only through cross contamination but also in the workplace, preferably through control of emissions rather than placing undue reliance on the effectiveness of personal protective equipment.

K. Morton