Congress are naturally occuring in the terrestrial environment. While it is true that atmospheric fallout from nuclear testing has caused higher than natural levels, Knoll[15] says that cesiuml37, Zirconium95 Niobium95, Ruthenium? 06, Antimony125 and Cerium144 are present from fallout, yet the USEPA results do not agree. Figure 8 shows a typical background spectrum that dates to c1976. Since the half life of Strontium90 is 28.1 years while that of Cesium137 is 30.17 years one would expect that Strontium 90 would have been seen along with the Cesium137 if the nuclear satillite/ above ground hypothesis were correct.

A curious indication is that the abundance of U234 found in CKD seems to be elevated above what one would expect based on the naturally occuring abundance. When we calculate the ratio of U234SD/U234Nat we find that it is about 2 x10-3. Other calculations show that the ratios for U238 and U235 agree with the natural abundances. One possible explanation is that waste from some type of U234 enrichment process has been burned. We believe that this requires further inquiry. Perhaps by conducting a further study of CKD that included testing for the isotopes that we discuss above with particular attention paid to isotopic abundances would resolve the various hypotheses of the radioactivity of CKD.

It is possible that the radioactivity found in CKD is a combination of naturally occuring isotopes, fallout and the residues from the incineration of radioactive waste. Although the activities cited as found in CKD for the naturally occuring radionuclides are not severe they may indicate that more severe exposures could have resulted through emissions or worker exposure.

Some BIF's use a Geiger counter to test for radioactivity in hazardous waste fuels and that is not adequate for the following reasons. Sometimes a Geiger counter that will detect alphas particles in addition to betas and gammas is used to test incoming hazardous waste. Sometimes no test is performed. All Geiger radiation counters are incapable of identifying the radioactive species involved. The Geiger tube is limited such that “all pulses from a Geiger tube are the same amplitude regardless of the number of original ion pairs that initiated the process. A Geiger tube can therefore function only as a simple counter of radiation-induced events, and cannot be applied in direct radiation spectroscopy because all information on the amount of energy deposited by the incident radiation is lost[6]."

Although alpha emitters and beta emitters also emit gamma radiation, in general this is not the case.7 Although the daughters of some beta emitters may emit gamma this is not a guarentee that they will emit enough radiation to be useful for detection purposes. Also, the percentage of the gamma radiation that may accompany alpha or beta emission is often much smaller in magnitude than that of the alpha or beta radiation? therefore only monitoring the gamma radiation is not adequate.

The radioactivity test procedure does not use a shield to reduce the influence of background radiation on the testing of the fuel. (see reference 15, chapter 20). Therefore a small amount of radiation would not be differentiated from the background using typical procedures.

The hazardous waste fuel will greatly attenuate any alphas being emitted within the sample therefore resulting in an inaccurate indication of the radioactive contamination. For instance 4.5 MeV alphas have an average range of 3.0 cm (1.2 inches) in air. The average range is the distance at which half of the alpha particles have been attenuated [8,9]. The same alphas would have an average range in liquid hazardous waste that would be much less because the liquid hazardous waste is much more dense than air.

The Bragg-Kleenman rule[10] may be used to estimate the average range that alphas would have in liquid hazardous waste. $R_{hw}=\{3.2 \times 10\text{-}4 \times \mathrm{sqrt}(A_{hw})/\rho\} \times R_{air}$, where $R_{hw}$ is the average range of the alphas in hazardous waste; $R_{air}$ (=3.0 cm) is the average range of the alphas in air; $A_{hw}$(=100) is the average molecular weight of hazardous waste and $\rho$ (=0.9) is the density of the hazardous waste. When these values are substituted we get $R_{hw}$=0.01 cm. Therefore the alphas emitted from almost all of the sample except the top 0.01 cm (see Figure 9) will not reach the Geiger tube. The fraction of the activity in the sample container that leaves the sample is then approximated by the ratio of the top layer volume to the sample volume which is assumed to be approximately 100 ml.

That ratio is then (pd2h/4)/100 ml = (p (5.6 cm)2 x 0.01 cm)/100 cm3 = 0.0025, or 1/4 of 1% of the sample's activity leaving the sample. This self shielding is very significant and can drastically reduced the measured radioactivity resulting in an inaccurate indication of radioactice contamination.

The alpha particles also lose energy due to energy straggling [1 1]. This effect reduces the alpha's energy through collisions and can reduce the energy of the alpha to the extent that it would not be able to penetrate the Geiger tube's window.

The sample size will understate the total activity (true for any type of radiation) that may be contained in the tanker truck by at least the ratio of the volume of the tanker truck to that of the effective detected volume of the sample. Other factors that come into play are the attenuation due to the window of the Geiger counter, the sample detector geometry, etc.

The geometry of the sample and Geiger counter will not collect all of the radiation (true for any type of radiation) that is emitted into a solid angle of $4\pi$ steradians therefore reducing the indication of possible radioactive contamination.

In Figure 10 the radiation being emitted from a sample is shown by the thin lines. They radiate in all directions. When the sample is an extended source, as it will be in a typical hazardous waste radiation test, the geometry of the sample and the detector (in this case a Geiger counter) and the distance between the sample and the detector are critical. It is not unusual for the geometry to reduce the radiation detected to a few percent of what is actually emitted.

The combination of the above effects will render the radiation detection method unable to detect any but the most radioactively contaminated waste.

Even slightly radioactively contaminated hazardous waste fuel can, over time, accumulate in the environment to dangerous levels while millions of pounds of slightly contaminated fuel could have been burned. As an example plutonium has been found in CKD. As little as 1 μg of Pu239 in the body has been shown to give a yearly dose of 105 rem/yr [11]. The permissible intake (inhalation) of Plutonium (Pu239) is 2.4 x $10^{-2}$ microcuries. The critical organ is the lungs, and the halflife is 8.9e6 days[17]. The LD50/30 is 450 +/- 100 rem[12] and corresponds to the dose of radiation that will cause death to 50% of those exposed within 30 days. Plutonium was not the only radioactive contaminant found in cement kiln dust as referenced earlier in this document. BIFs will burn hundreds of millions of pounds of hazardous yaste per year that are at present inadequately tested for radiation.

Using a nuclear spectroscopic technique such as alpha, beta and gamma spectroscopies and proper shielding techniques would alleviate many of these problems and provide a much more reliable means of screening for possible radioactive contamination of the hazardous waste fuel.

The use of a Geiger counter would only indicate gross radioactive contamination and would allow diluted low level radioactive waste to get through the screening system undetected.

DAILY **REAL TIME MONITORING**

Are the daily emissions meeting the regulating permit? Combustion experts have published[13] that "CO and THC do not correlate directly with organic destruction but are generally considered indicators of destruction efficiency." Yet these indicators are heavily relied upon to determine that the permit emissions are not being exceeded since they constitute a large part of the daily

**monitoring practice.** They continue that "nonetheless, low CO and THC is an indication of good combustion conditions. Therefore CO **and THC can be used as indicators of good combustion practice and indicators that the system is being operated at conditions similar to those during a compliance test. However they cannot be directly correlated with emissions and no single 'safe' value has been established for all types of waste combustion systems."** Similar does not say that the permit emissions are being met. They also say of the surrogate (POHC) technique that "there is still [as of 1990] significant uncertainty concerning the basic assumptions and implementation of the technique." Also, we would add that CO and THC indicate nothing about $SO_2$ which is a major emission and a pollution hazard with global environmental effects. CO and THC also say nothing about other emissions that may be present.

**DIOXIN**

According to experts in dioxin[19], 'The measured average daily intake as 2,3,7,8-TCDD toxic equivalents via food chain consumption is about 1 pg/Kg/day as the backgroung level of PCDD/F's to which the general population is exposed...It has been suggested that the tolerable daily intake of ,3,7,8-TCDD spans a range from 1 - 10 pg/Kg/day..." In table 1 of that reference they state that the incremental 70 year cancer risk to the general population for food stuffs contaminated with dioxins is 144 x $10^{-6}$. That is about 16 times the risk due to smoking (from that table also). From that same table we find that the risk from eating dioxin contaminated food is nearly 500 times the risk to the general population from waste incineration. These strongly suggest that the dioxins from incineration must be very stringently controlled.

**DO THE PRESENT REGULATIONS REALLY WORK?**

An article in SCIENCE NEWS[20] reports the results of health studies of people who live downwind from hazardous waste incinerators compared to those upwind and the health problems of workers at such facilities.

That article describes the findings of scientists that were presented at an International Congress on the Health Effects of Hazardous waste held in Atlanta, Georgia in 1993. Health studies were by Charles E. Feigley and co-workers at the University of South Carolina in Columbia, Dietrich Rothenbacher and colleagues at the University of North Carolina at Chapel Hill, Michael Straight and co-workers at the Agency for Toxic Substances and Disease Registry, by Melody M. Kawamoto of the National Institute for Occupational Safety and Health in Cincinnati and Woodhall Stopford of Duke University Medical Center in Durham, N.C. While the article points out that none of these studies proves that incinerators harm the health they do raise strong suspicians that the apparent links between incinerators and health are real. It seems plausible that even though these facilities are supposedly controlled by regulations and shown to be safe by tests that people's health has been damaged anyway.

**SUGGESTIONS**

We would suggest that the USEPA mandate the best available science to include the following:

A new definition of destruction to replace the DRE is indicated. We believe that the public is misled by the way that DRE represents the emissions. Emissions increases are masked by the nonlinear response of the DRE to emissions increases. We believe that an emission fraction is a direct indication. EF=(Wout/Win). It gives a linear indication of increased emissions and increases with an increase in emissions.

USEPA should develop a standard for which POHCs are most difficult to destroy and would therefore be good POHCs to mandate. Also special circumstances may require that additional POHCs be included as well.

The data should undergo significant digits analysis. This is a well established scientific practice and part of the requirement to express a number scientifically. It is well known that averaging of data can improve the accuracy[16,2], yet the Federal Register forbids this in DRE tests.

The % error in measurements and any calculated quantities should be presented in any presentation of results.

The number of data points should be sufficient so that statistical analysis of test data can be performed. At present it is possible that DRE values greater than 100% could result from measured values. Although some might claim that these values are non-physical, that is not a correct interpretation. If enough measurements of DRE would be performed and analysed statistically one would find that there would be a distribution of DRE values. In certain cases the errors in the values measured that are used to calculate DRE could result in DRE greater than 100%. One would then determine the mean and standard deviation of this set of measured DRE values based on a large enough number of data points to be statistically significant.

The incinerator testing methodology should be proven. It is unlikely that a small fraction of the actual components in a real hazardous waste stream when used in a test will faithfully represent destruction. We suggest an extended experimental study of the test methodology which would be conducted by independent scientists and open to public participation.

The daily monitoring and control should similarly be proved. At present CO and THC are heavily relied upon in permits. As an example coal/hazardous waste fueled cement kilns are permitted to release $SO_2$. $SO_2$ is a major emission from these BIFs and is also a world class environmental pollutant that causes respiratory problems, damages crops, trees and buildings. CO and THC say nothing about $SO_2$ and a permit's $SO_2$ emissions are not measured.

The uncertainty about identifying emissions is considerable. Toward quantifying that uncertainty more we suggest that tests include a precise accounting of the mass in the incinerator system. How much of the emissions can be tallied? This would help indicate if emissions are going undetected.

We also suggest that the workers' health and the public health of those living or working near hazardous waste facilities be monitored directly through an appropriate Federal agency.

Lastly we suggest that all points that were addressed in the SAB report referenced at the beginning of this paper, or in any followup reports, be resolved.

CONCLUSION

If America is to have a viable means of disposing of its hazardous waste then proper science and responsible decisions about which methods to employ are required. As we have demonstrated here the testing, regulation and daily monitoring of cement kilns and other BIFs suffer from a multitude of scientific inaccuracies, biases and misrepresentations. A more extensive study of the scientific basis of burning hazardous waste may reveal even more problems. It has been the experience of many of the American taxpayers who try to participate in the permit process that a significant obstacle to responsible decision making is the token nature of citizen participation in states such as Ohio. The needs of this nation can only be met through the democratic process, and for any state to negate the civil duty of its citizens weakens this nation in ways that go far beyond the original intent of those who are elected and appointed to represent the people of America.

If cement kilns, other BIFs and conventional hazardous waste incinerators are to be long term solutions to America's hazardous waste disposal needs then they must compete on a level playing field that has been established through proper science and it must be open to meaningful public participation in the process.

Not only is the impact of incineration upon the American health presently at unquantified risk, but the financial health of the business community and the prosperity of the nation are jeopardized. The unscientific testing and regulating of BIFs brings with it the risk that significant class action and individual litigation may bankrupt burners. The generators of hazardous waste have a different problem. As the generators become more dependent on an ever growing ill-based technology they risk loosing their means of disposal. If the hazardous waste can no longer be disposed of then the economic recovery of the nation is in perill. Some of the key factors to avoid such a fate are: **GOOD SCIENCE, PROPER CHOISES ABOUT WHICH TECHNOLOGIES ARE PERMITTED, SCIENTIFICALLY MEANINGFUL AND JUSTIFIABLE REGULATION OF INCINERATION FACILITIES AND A REDUCTION IN THE AMOUNT OF HAZARDOUS WASTES THAT ARE GENERATED.**

We would add that the USEPA has a responcibility to dispence swift corrective actions when any state's EPA violates its citizens' rights to fairly participate in the equitable solution of such a locally and nationally important issue.

We believe that the USEPA should examine the question: if industry suffers litigation as the result of harm to the public health and environment, is the USEPA accountable since it orriginated the regulations that may have allowed the harm to take place.

To date, these and other problems with incineration go unanswered while the practice of incineration continues to be relied upon to dispose our Nation's hazardous waste. What will be the effect upon those Americans who continue to be exposed to this unquantified hazard. What will be the effect upon those businesses which continue to rely on disposing of their industrial waste and those businesses which engage in the incineration of hazardous waste if the practice of incineration is not placed on a sound scientific foundation and controlled in a scientificlly meaning way? What will be the actions of the American taxpayer if something is not done? To avoid having to answer these questions through the immoral experiment of continuing incineration in its current form it is imperative that many changes take place to promote an honest evaluation of the degree of safety, or lack thereof, of incineration.

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