

Dear Dr Wyndham,

Thank you for your email concerning my paper (with T. N. Greening as co-author), on the characterization of a WTC dust sample. I must say at the outset that my first reaction to your email is one of concern that I am being criticized for things I didn't do, rather than the scientific content of my paper. For example, I am being judged on something I didn't say, but was said by the person who collected the sample - Ms. Sakoutis. I think your comment on this should be directed to, and answered by, Ms. Sakoutis.

Now, as to what appears to be your main complaint about my paper, namely that I did not refer to the work of Harrit et al. anywhere in my paper, my response is as follows:

My paper is first and foremost about the chemical characterization of a WTC dust sample. And, to put my results into perspective, I compared my analytical data to other published analyses. Thus, I refer to work by Lioy, McGee, Clark, Meeker and Lee (among others), who each provided tables of quantitative data on the chemical composition of their WTC dust samples. By comparison, Harrit et al's paper includes no such data, so there is no basis for me to compare my results to theirs. And significantly, all the authors mentioned above *failed to find any red/gray chips*, as was the case for my sample. And I should also mention that one of these authors has now published an entire book on the subject of WTC dust – See: P. J. Lioy: *Dust: The Inside Story of its Role in the September 11th Aftermath*, Rowman & Littlefield Publishers Inc, Lanham, Maryland, USA, (2010). In 260 pages of discussion of WTC dust there is no mention of red/gray chips.

An additional topic addressed in my paper is the particle size and morphology of WTC dust. I carry out a full particle size analysis of my WTC dust sample. Here again, Harrit et al. fail to do any such analysis on their samples, but offer only the vague statement that the red/gray chips “*are of variable size with major dimensions of roughly 0.2 to 3 mm*”.

You complain that my paper makes no reference to Harrit et al's paper as if this is a prerequisite of any paper on WTC dust. Worse yet, you accuse me of failing to “*deal adequately with the controlled demolition theory*”. I would ask you to consider the title of my paper: *Characterization of a World Trade Center Dust Sample*, and this is indeed what my paper is all about. It's precisely because I found no red/gray chips in my sample that I saw no need to address the *absence* of such particles, and focus on the particles I did find!

I have dealt with Ryan et al's paper (your reference [2]) previously – See my footnote 1 below:

I offer my response to Jones et al's paper on the high temperatures in the WTC rubble pile, (your reference [3]) in footnote 2 below:

Dr. Wyndham, you appear to see the destruction of the WTC as an EITHER/OR situation, thereby creating a false dichotomy. In your universe there are only *two* alternatives: The Twin Tower's destruction was by a gravity-driven collapse – the “Official Story” – or, a thermite-assisted controlled demolition – the A&E for 9/11 Truth Movement's view. This does not allow for any other options/theories such as aluminum-assisted collapse; ammonium perchlorate-assisted collapse; advanced technology weaponry collapse, micro-nuke collapse, etc, etc.

So, please do not claim that I do not follow the scientific method. The scientific method is about evidence obtained by observation. This is what my report on Christine Sakoutis' WTC dust sample is all about – nothing more, nothing less.

Sincerely,

Dr. F. R. Greening

Footnote 1: The Ryan-Gourley-Jones Paper from August 2008

Here are some comments on the paper in *The Environmentalist* by K. Ryan, J. Gourley and S. Jones (RGJ) entitled "Environmental Anomalies at the World Trade Center: Evidence for Energetic Materials"

The main topic of discussion in the RGJ paper is the very high levels of volatile organic compounds (VOCs) such as benzene that were detected in the air at or near Ground Zero for up to 6 months after the September 11th, 2001 attacks on the WTC. Thus, using data reported by the US EPA, RGJ present plots of the daily maximum concentrations of benzene, toluene, ethylbenzene, and styrene over the period September to November 2001 and note that these data show sharp peaks in the concentrations of these VOCs on certain days while remaining at relatively low concentrations at all other times. RGJ acknowledge that these VOCs are among the expected products of the combustion of common plastics such as PVC and polystyrene, but question the causes of the extreme spikes in their concentrations.

It would appear reasonable to assume that clean-up operations occasionally stimulated fires in localized areas of the rubble pile leading to acute releases of combustion gases from burning/smoldering plastic materials in the pile. However, RGJ point out that other less well-known VOCs such as propylene, 1,3-butadiene and 1,3-diphenylpropane (1,3-DPP) appear to be associated with the benzene, toluene, ethylbenzene, and styrene acute releases. RGJ go on to suggest that the detection of one VOC in particular, namely 1,3- DPP, is evidence for the presence of the pyrotechnic agent: sol-gel "nanocomposite" thermite. Now Steven Jones first mentioned this idea about two years ago, prompting me to make the following post on the PhysOrg forum on July 22, 2006:

See: <http://www.physforum.com/index.php?showtopic=7444&st=660>

"I AM a chemist, and I once worked under contract to ICI in the UK on the thermal degradation of polymers....

Thermal degradation of PVC yields mainly benzene, toluene, xylene, ethylbenzene, and various chlorobenzenes.

All of these species were detected by the EPA in air samples taken at various locations in NYC after 9-11.

Thermal degradation of POLYSTYRENE yields styrene, alpha-methylstyrene and 1,3-diphenylpropane.

The EPA website on air-sampling at NYC includes data for styrene, but curiously does NOT list data for 1,3-diphenylpropane. (However, I believe this may be simply because this compound is not on the EPA's "priority pollutant" list)

NIST and others have noted that TONS of PLASTICS burned in the Twin Towers and the rubble pile during and long after 9-11.

Polystyrene was surely one of those plastics! (By the way, the quote about 1,3-diphenylpropane being associated with PVC appears to be in error. I suspect the person meant polystyrene!)

So I would say that Prof. Jones, once again, has found something in a sample from the WTC site that can be explained WITHOUT INVOKING thermite/thermate.”

Let’s therefore consider the relative merits of the RGJ hypothesis for the origin of 1,3-DPP in the air above Ground Zero as compared to the alternative view that 1,3-DPP is simply an expected thermal decomposition product of the common plastic polystyrene. To begin the discussion, consider this paragraph from page 9 of the RGJ paper:

“Other studies have shown trace amounts of 1,3-DPP as a secondary product of polystyrene combustion or thermolysis. But such studies suggest that 1,3-DPP may only form in negligible quantities and under certain conditions (Boettner et al.(1973); McCaffrey et al. (1996)). In such experiments, the major product of the combustion or thermolysis of polystyrene, far outweighing others, is the monomer styrene. This leads us to the fact that, although styrene was a species of interest at 290 Broadway during the same time period as was 1,3-DPP, styrene detections were not reported in the FOIA provided data (EPA (2004)). Therefore, it appears that Swartz’ first suggested hypothesis, that 1,3-DPP resulted from combustion of polystyrene, is not probable.”

This paragraph, while somewhat confusing, is actually quite deceptive in view of what it implies:

- (i) That negligible amounts of 1,3-DPP are formed during the combustion or thermolysis of polystyrene.
- (ii) That the EPA did not detect styrene in the air at or near Ground Zero after 9/11.

Now both of these claims are untrue as other data, including some presented in the RGJ paper itself, amply demonstrate. Thus, Table 1 of the RGJ paper provides examples of EPA data for styrene in the air at Ground Zero including a value of 180,000 ppb reported for October 11th 2001, - a level that was about three times higher than the concentration of benzene for that day. However, and here we reveal another problem with the RGJ paper, it is important to note that the 180,000-ppb concentration for styrene is a peak value obtained from a grab sample collected at Ground Zero on the date in question.

The issue of the sampling locations and techniques used to measure VOCs at the WTC site after 9/11 is addressed in the EPA *Summary Report EPA/600/R-03/142*, published in 2003. Thus, on page 30 of this report we read:

“Most of the VOC data are from grab samples, which were not collected to characterize exposures but were intended to inform recovery workers within the restricted zone of the location of hot spots. As a result, the locations for most of the sampling were near the sources and plumes of smoldering fires, Although grab samples of VOCs can be valuable for indicating high levels at certain locations and give an indication of which chemicals are present, 24-hour samples would be much more appropriate for exposure assessment.”

Full day air samples were in fact collected by the EPA at eight sites along the outer edges of the rubble pile and confirm that average levels were much lower than many of the levels captured in grab samples which were collected “near smoldering fires” within the rubble pile over time intervals lasting “but a few minutes”.

Thus, in order to make useful comparisons to published data on 1,3-DPP at the WTC we need to consider where and how the sampling for VOCs was carried out – an issue not addressed in the RGJ

paper. If we read Swartz' paper, (See: Environmental Science and Technology 37, 3537, (2003)), we find that his sampler, which was located about ½ km from the WTC at 290 Broadway, operated for 11.5 to 23 hours and collected ~ 0.6 micrograms of 1,3-DPP per cubic meter of air, ($0.6 \mu\text{g}/\text{m}^3$), between October 4th and 21st 2001. Now, regrettably, Swartz does *not* report data for styrene since the emphasis of his research was polycyclic aromatic hydrocarbons (PAHs). However, there *are* post-9/11 airborne styrene concentrations reported at locations close to the perimeter of the WTC site by other researchers. For example, Olsen et al, (See: Atmospheric Environment 41, 5673, (2007)), report an average styrene concentration of about $2 \mu\text{g}/\text{m}^3$ at a site just north of the WTC between September 2001 and January 2002. Also, Geyh et al. (See: Journal of Occupational and Environmental Hygiene, 2 179 (2005)), report that the styrene concentration was about $5 \mu\text{g}/\text{m}^3$ at a number of sites at the perimeter of the WTC complex in October 2001.

Based on these data it would appear reasonable to say that in mid-October 2001 the concentration of 1,3-DPP was about 20 % of the styrene concentration at the perimeter of the WTC rubble pile. And this brings us to the other point of dispute with the RGJ paper, namely the possibility that 1,3-DPP in the air at Ground Zero was produced by the thermal decomposition of polystyrene. Now the RGJ paper asserts that for polystyrene under conditions of combustion or thermolysis: "*1,3-DPP may only form in negligible quantities.*" However, only two references are cited to support this claim: a 1973 study of the combustion of a wide variety of plastics and a 1996 study of the thermolysis of a mixture of polystyrene and polyethylene. While it is acknowledged that these particular studies may indeed have failed to detect significant quantities of 1,3-DPP, it is worth asking if there are situations that could enhance the production of 1,3-DPP during the thermal decomposition of polystyrene.

A survey of the published literature on the pyrolysis of polystyrene reveals that the decomposition of polystyrene is a complex process that depends on a number of factors including the time and temperature profile of the pyrolysis experiment and the nature of the starting material. Potsuma, (See Polymer Degradation and Stability 91, 2979, (2006)), has shown that the pyrolysis of polystyrene yields measurable amounts of styrene, alpha-methylstyrene, ethylbenzene, cumene, 2,4-diphenyl-1-butene, toluene, 1,3,5-triphenylpentane, 2,4,6-triphenyl-1-hexene and 1,3-diphenylpropane (1,3-DPP). However, the composition of the mixture changes significantly with the amount of product formed and the temperature. In general, very little 1,3-DPP is formed during the initial stages of the decomposition reaction, but as the degree of decomposition increases, more 1,3-DPP is formed at the expense of toluene. Complete reaction at ~ 300 °C yields 39 wt% styrene and 9 wt % 1,3-DPP implying a 1,3-DPP/styrene ratio of about 1:4.

The chemistry of the thermal decomposition of polystyrene becomes even more complex when "real-world" plastics are involved. First it should be noted that because pure polystyrene is quite brittle and softens near 100 °C, additives are incorporated into commercial polystyrene to achieve improved material properties that are required for the intended end usage. Additives include organic and inorganic compounds and are used as cross-linking agents, plasticizers, fillers/pigments, heat stabilizers, antioxidants, uv stabilizers, impact modifiers, processing lubricants, anti-static agents, flame retardants, etc, (See Chromatographia, 56 (3/4), 165, (2002)). Valavanidis et al. (See Journal of Hazardous Materials 156, 277, (2008)), have collected particulate material from the combustion of plastics such as polystyrene, polyvinyl-chloride and polyethylene and found that samples decomposed at ~ 700 °C left residues containing Na, Ca, Al, Si, Fe, Zn, Ba, Pb, etc, that constituted up to 10 wt % of the starting material.

Another consideration in discussing the pyrolysis of commercial polystyrene is the fact that, apart from the well-known material Styrofoam, polystyrene is generally used in polymer blends - two popular examples being ABS and HIPS. ABS is an acrylonitrile-butadiene-styrene polymer while HIPS is high-impact polystyrene, an impact resistant material made from a styrene-butadiene grafted blend. ABS and HIPS are commonly used in TV housings and computer equipment and are reported to account for more than 50 % of the waste plastics found in discarded electric and electronic equipment.

Two studies of the pyrolysis of mixed plastics used in commercial electrical and electronic products are pertinent to the present discussion. In one study, Day et al., (See Journal of Analytical and Applied Pyrolysis 52, 199, (1999)), pyrolysed ABS alone and mixed with other plastics such as PVC or electrical components such as metallic copper at temperatures in the range 700 – 900 °C. ABS by itself released many organic species that included 1,3 butadiene, 1,3-diphenylpropane and styrene with the 1,3-DPP being about 3 % relative to the styrene – a concentration ratio expected for such high pyrolysis temperatures. However, pyrolysis of ABS in the same high temperature range in the presence of PVC and metallic copper increased the 1,3-DPP yield to about 6 % relative to styrene, illustrating the promoting effects of PVC and/or copper on the release of 1,3-DPP from polystyrene blended plastics.

In the other study noted above, Bhaskar et al. investigated the pyrolysis of polymer blends mixed with HIPS containing decabromo-diphenylethane (DDE) – the most common fire retardant for plastics used in the manufacture of TV and computer housings. Bhaskar et al. report that pyrolysis of these HIPS-based materials at 430 °C released 1,3-DPP and styrene in a 1:2 ratio, while pyrolysis at 330 °C released approximately twice as much 1,3-DPP as styrene! Thus, we see that, in spite of RGJ's claims to the contrary, there is abundant experimental evidence for the production of 1,3-DPP by the thermal decomposition of styrene-based plastics. In addition, the production of 1,3-DPP is expected to be particularly enhanced in the thermolysis of polymer blends and debris mixtures known to be present in the WTC rubble pile.

Footnote 2: Aluminum Reactions in the Rubble Pile

The WTC rubble pile was a veritable stew of materials including body parts mixed with pulverized concrete, gypsum, glass fiber, vermiculite, chrysotile asbestos, mineral wool and glass as well as paper, plastic, copper wire and large sections of steel and aluminum.

Two factors should be considered in evaluating this mix of materials. First, because of the way it was formed amid fires and explosions, *the rubble pile was, from the very start, very hot*. In fact, it is probable that some molten aluminum made its way into the rubble pile. Molten aluminum burning on contact with concrete produces a calcium oxide/silicate slag covered by a white aluminum oxide ash which serves to insulate and contain the aluminum puddle, keeping it hot and burning.....

There is evidence that the WTC rubble pile was not just hot, but on fire, and it stayed that way for a long time. See for example Jonathan Beard's article in the December 2001 issue of *New Scientist*:

Ground Zero's fires still burning

Almost 12 weeks after the terrorist atrocity at New York's World Trade Center, there is at least one fire still burning in the rubble - it is the longest-burning structural fire in history. Deputy Chief Charles Blaich of the New York City Fire Department would not predict when the last fire might be extinguished. But compared to the situation at the end of September, when aerial thermal images showed the whole of Ground Zero to be a hot spot, conditions [today](#) are much safer for the workers clearing the rubble.

We will consider how the rubble pile could be on fire many days after 9-11 in a moment, but first we must discuss the second important factor controlling the chemistry of the rubble pile, namely *the presence of water*. The basement of the Twin Towers was severely damaged on 9-11 and flooded with water from sewer lines, fresh domestic water lines, steam pipes and condensate returns. Just days after 9-11, millions of gallons of water had already flowed into WTC basement floors and was being pumped out at a rate of about 3,000 gallons per minute. In the days and weeks following 9-11 water was continuously percolating through the rubble piles from firefighters' hoses and rainfall. Ironically, the WTC site was deliberately sprayed with water mainly to keep dust levels down during cleanup operations, rather than extinguish fires.

The US Geological Survey has measured the properties of water exposed to WTC dust and debris (See pubs.usgs.gov/of/2001/) These so-called "WTC leach solutions" are invariably very alkaline with pH ~ 10. Chemical analysis has shown up to 0.7 mg/liter of Al dissolved in the leach water. The USGS researchers concluded that: "*Of all the metals in the WTC dust, aluminum is leached in greatest amounts*".

The dissolution of aluminum in the WTC rubble pile water is readily explained by the well-known corrosion reaction:



What is most significant about this reaction is that aluminum enters solution as the aluminate ion, AlO_2^- , with the release of 3/2 moles of gaseous hydrogen. That this type of reaction occurred in the WTC rubble pile should not be surprising since hydrogen production reactions have been reported in similar environments involving aluminum in contact with water and cementitious materials. Thus, the Pacific Northwest National Laboratory recently published a report entitled: "*Potential for Generation of Flammable Mixtures of Hydrogen from Aluminum-Grout Interaction in the K Basin During Basin Grouting.*" (See PNNL Report No. 15156 by S.M. Short and B.M. Parker, issued April 2005.) In the introduction to this report we read:

"This evaluation was performed to assess the potential impact of imbedding equipment and debris within a layer of grout to provide shielding and to fix contamination. The presence of aluminum in the form of empty canisters, identification tags or other hardware will lead to the generation of hydrogen as high pH grout contacts and reacts with the aluminum metal."

The authors go on to explain that hydrogen generation from grouted aluminum occurs due to the reaction of aluminum with hydroxide ion from $\text{Ca}(\text{OH})_2$ present in the pore water of the grout. Measurements at 50° C showed a maximum hydrogen gas generation rate of about 5 cm³/min for an aluminum coupon with an area of about 20 cm² exposed to a saturated solution of calcium hydroxide.

Using this result and other quantitative data related to the rate of corrosion of aluminum in alkali media at temperatures up to 100° C, it is possible to estimate that tens of thousands of liters of hydrogen gas were released, *per day*, into the WTC rubble pile immediately after 9-11. Because of the presence of hot smoldering debris and localized fires at ground zero, this hydrogen would have burnt and contributed to the heat generation that kept the WTC rubble pile hot and cooking for months after 9-11.