

# **Utah Division of Air Quality**

## **PM2.5 Exceptional Event – Fireworks Ogden Monitoring Station**

**Event Date – July 4, 2008**

**EPA Submission Date – June 14, 2010**





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## Definition of Event (40 CFR 50.1(j)) and Introduction

The Code of Federal Regulations (CFR) provides the definition and criteria for determining whether air quality data is impacted by an exceptional event. The 40 CFR 50.1 (j) definition states that “exceptional event means an event that affects air quality, is not reasonably controllable or preventable, is an event caused by human activity that is unlikely to recur at a particular location or a natural event, and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event.” The demonstration to justify data exclusion, as outlined in 40 CFR 50.14, specifies that the following evidence must be provided:

1. The event meets the definition of an exceptional event;
2. There is a clear causal relationship between the measurements under consideration and the event that is claimed to have affected air quality in the area;
3. The event is associated with a measured concentration in excess of normal historical fluctuations, including background;
4. There would have been no exceedance or violation but for the event; and
5. The fireworks event was held on July 4, Independence Day, as part of a traditional or national culture event (40 CFR 50.14 (b)(2)).

An exceedance of the 24-hr PM<sub>2.5</sub> standard of 35 ug/m<sup>3</sup> occurred on July 4, 2008, at the Ogden monitoring station, located in Ogden, Utah. The Utah Division of Air Quality (DAQ) reported a PM<sub>2.5</sub> value of 42.8 ug/m<sup>3</sup>. The DAQ investigated the event and has determined that the exceedance is associated with fireworks events celebrating the national 4<sup>th</sup> of July holiday and exasperated by extensive illegal fireworks set-off near and around the monitoring station (per conversations held with Mathew Schwenk, Ogden Fire Marshal (in July 2008) and Greg Chamberlain, Ogden Deputy Fire Chief (in February 2010)). A large grass field adjacent to the Ogden station is used to set-off legal and illegal fireworks. Deputy Fire Marshal Chamberlain stated that the extent of the illegal fireworks had gotten sufficiently severe that the city imposed a new citation program in 2008. The city has aggressively cited landowners where illegal fireworks have been set off. Citations include a mandatory court appearance and fines. In cases where there is a history of illegal fireworks use, landowners/or renters received stiff fines. Deputy Fire Marshal Chamberlain stated that the city vigorously pursues the program, verifying that community/street based fireworks are being mitigated to a reasonable extent.

## Study Area

The Ogden monitoring station (O2) is located in Ogden at 3159 Grant Ave. The station is located adjacent to the Ogden Community Action Center and an open field where fireworks are set-off.

Nearby communities that are known to sponsor 4<sup>th</sup> of July fireworks events include; Riverdale (at Riverdale Park), Clinton, Sunset (at 85 W. 1800 N), Clearfield (at Fisher Park) Layton (Commons Park) and Ogden (at Pioneer Stadium).



## Affect Air Quality

### Fireworks Chemistry

Fireworks consist of 75% gunpowder (potassium nitrate,  $KNO_3$ ), 15% carbon and 10% sulfur. The materials react with each other when heat is applied from a fuse. Metal compounds and other elements described in Table 1 are added to generate desired color and or pyrotechnic effects.

Robenta Vecchi (Vecchi et al, 2007) reported that fireworks are one of the most unusual sources of pollution in the atmosphere; although transient, these pollution episodes are responsible for high concentrations of particles (especially metals and organic compounds) and gases. Vecchi measured air quality after a fireworks event and concluded that elements typically emitted during pyrotechnic displays increased in 1-hr as follows: strontium (120 times), magnesium (22 times), barium (12 times), potassium (11 times), and copper (6 times). Additional elements and or concentrations of these elements are directly dependent on the selection of desired color and effect; thus, individual fireworks events will have a specific tracer element. In Vecchi's case, strontium was recognized as the best fireworks tracer because its concentration was very high during the event and at/nearly at the minimum detection limit at other time intervals. Particulate level for the case study increased 6.7 times over background levels (copper, elemental carbon and nitrogen oxides).

Table 1 – Fireworks Chemistry

Element - Ogden Site PM10 Speciation (ug/m <sup>3</sup> )	Oxidizer	Colorant	Propellant or Fuel	Stabilizer	Smoke	Glitter Effect
Aluminum - <b>2.2</b>		√				
Antimony – <b>0.1</b>						√
Barium – <b>1.3</b>		√		√		
Calcium – <b>6.1</b>		√				
Carbon – <b>14.2 as total carbon and 2.0 at elemental carbon</b>			√			
Chlorine - <b>3.2</b>	√					
Copper – <b>0.4</b>		√				
Iron – <b>1.7</b>		√				
Lithium – Not Tested		√				
Magnesium – Not Tested		√				
Potassium – <b>13.6</b>	√					
Phosphorus - <b>0</b>			√			√
Sodium – <b>4.6</b>		√				
Strontium – <b>0.3</b>	√					
Sulfur – <b>3.9</b>			√			
Titanium – <b>0.1</b>		√				
Zinc – <b>0.1</b>					√	
<b>Compounds</b>						
Chlorates – Not Tested	√					
Nitrates – <b>1.7</b>	√					
Perchlorates – Not Tested	√					

## Air Quality

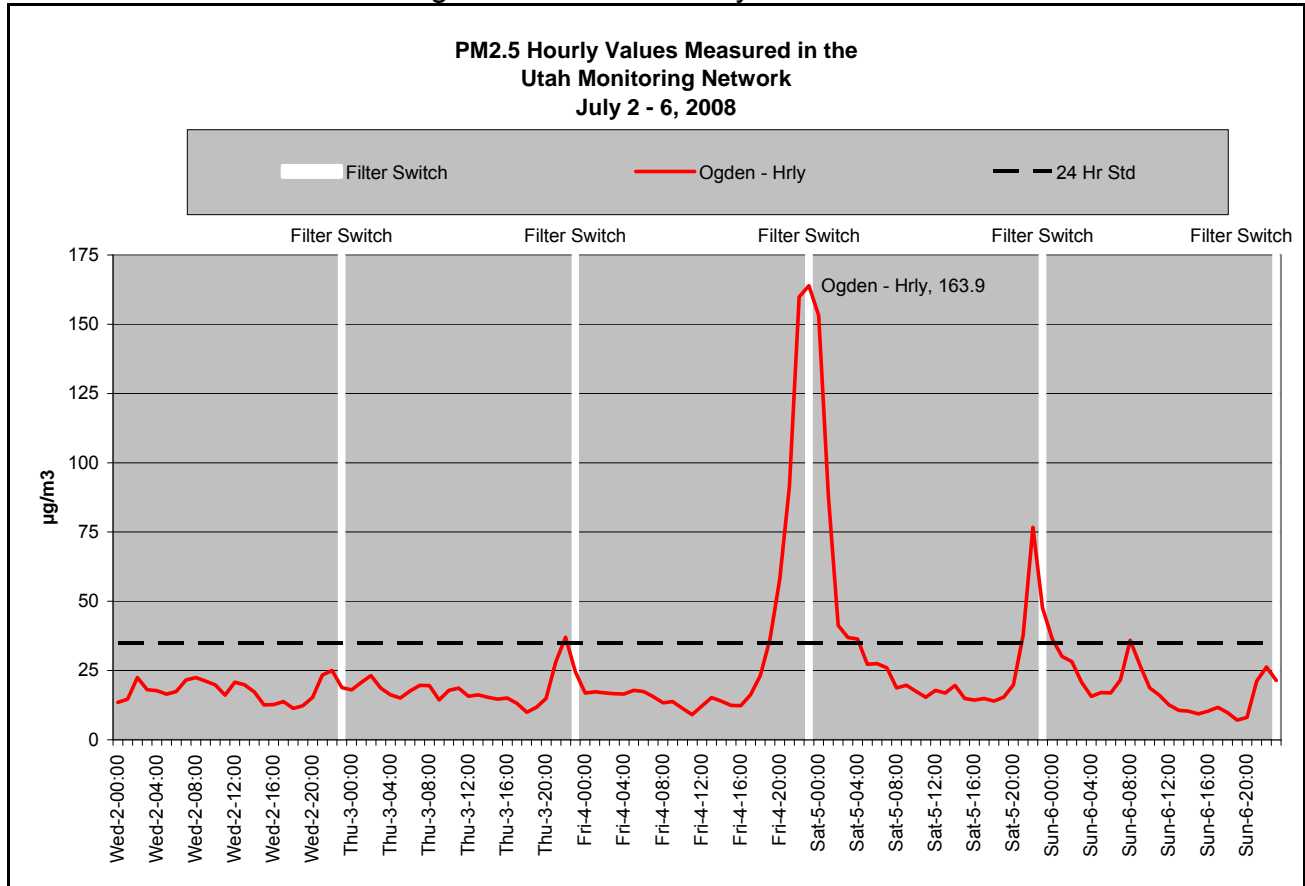
A PM10 sample speciation was conducted for the site and the concentrations found in the sample is shown in Table 1 (next to the element/compound in bold face). The levels of carbon, potassium and sulfur, amongst other elements, are very high and would be expected to be so, because they represent the fundamental components of fireworks.

Figure 1 presents the hourly PM2.5 values at the Ogden station from July 2 to July 6, 2008. The PM2.5 levels increased from 39.7 to 92 ug/m<sup>3</sup> at 21:00, about the time fireworks are set-off by the general population. The PM2.5 level peaked at 23:00 and is logically related to the community based displays that generally occur around 22:00 (time confirmed for at least four community based events). Carry over occurred into the

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following day because the spike transpired over the filter change at midnight, declining quickly after the filter change. This timeline is consistent with the measurements made by Vecchi.

Figure 1 – PM2.5 Hourly Values





### **Normal Historical Fluctuation**

Table 2 presents the annual mean and maximum values for the 24-hr PM<sub>2.5</sub> at the Ogden station from its inception in 2001 until the end of 2009. The annual mean ranges from 9.9 – 14.6 ug/m<sup>3</sup>. The observed value for this event is 42.8 ug/m<sup>3</sup>.

Table 2 – Ogden 24-hr PM<sub>2.5</sub>

Year	Observations	Annual Mean (ug/m <sup>3</sup> )	Annual Max (ug/m <sup>3</sup> )
2001	50	12.4	66.6
2002	119	14.6	108.3 (4 <sup>th</sup> of July)
2003	118	9.9	38.3
2004	118	13.9	74.2
2005	115	10.5	42.4
2006	120	9.8	47.6
2007	121	11.7	76.8
2008	358	9.9	46.7
2009	343	10.2	56.4

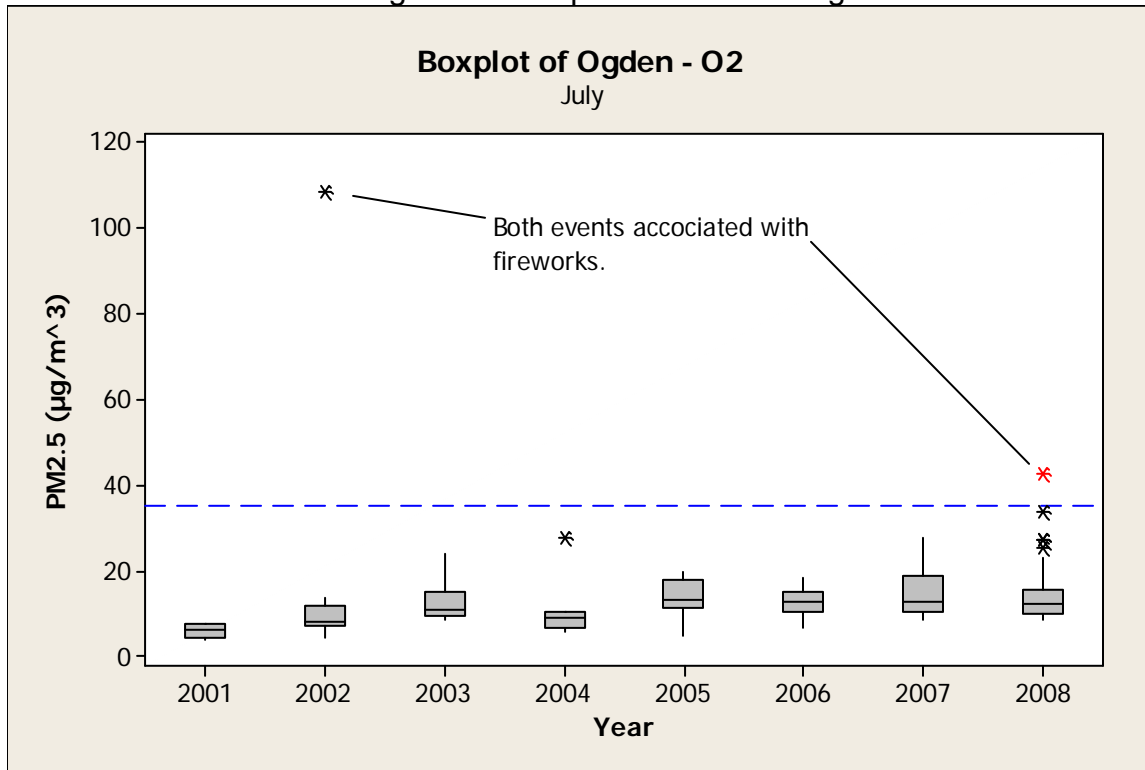
### **Ranking**

Guidance found at 72 Federal Register 55 March 22, 2007, pages 13560-81, states that a lesser amount of documentation would likely be necessary for “extremely high” concentrations (e.g. > 95th %ile) than for concentrations that were closer to “typical levels” (e.g. < 75th %ile.). Data collected at the Ogden monitor station since 2001 were used to calculate the %ile. When all data points were aligned in descending order, July 4, 2008, lands above the 98<sup>th</sup> %ile.

### **Boxplot**

Because this event occurred during July, a time of the year when high PM<sub>2.5</sub> values are not typically measured, it may be more valuable to only focus on other PM<sub>2.5</sub> values during the same time of the year. The boxplot presents the historical PM<sub>2.5</sub> values, for July of each year. The event value is marked in red. The blue dashed line represents the current PM<sub>2.5</sub> standard.

Figure 2 – Boxplot of PM2.5 at Ogden

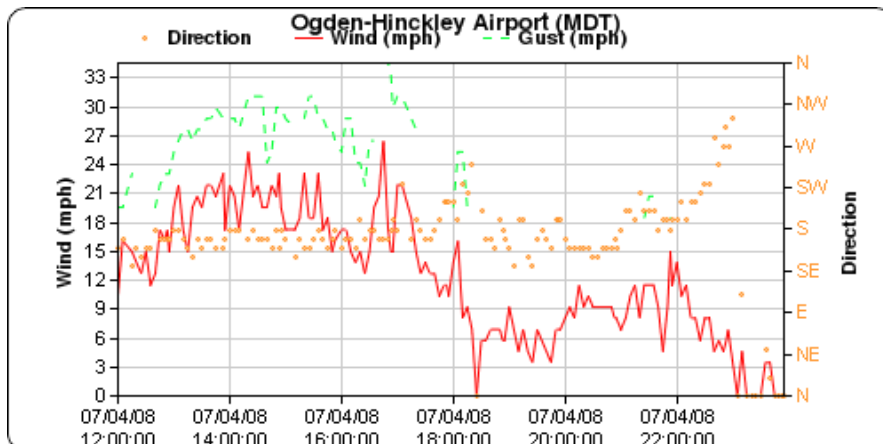


All events that exceed the current PM2.5 standard are associated with fireworks events. Analyses of the boxplot graph permit us to conclude that the event concentration is outside of normal historical variation.

## Causal Relationship (40 CFR 50.14)

### Meteorology

Meteorological data from the Ogden-Hinckley Airport shows the wind speed from 22:00 to 23:00 ranged from 3 -14 mph with a mean of 6.4 mph. The wind direction was directly south at 22:00, than started to shift slowly to the southwest by 23:00, indicating that the

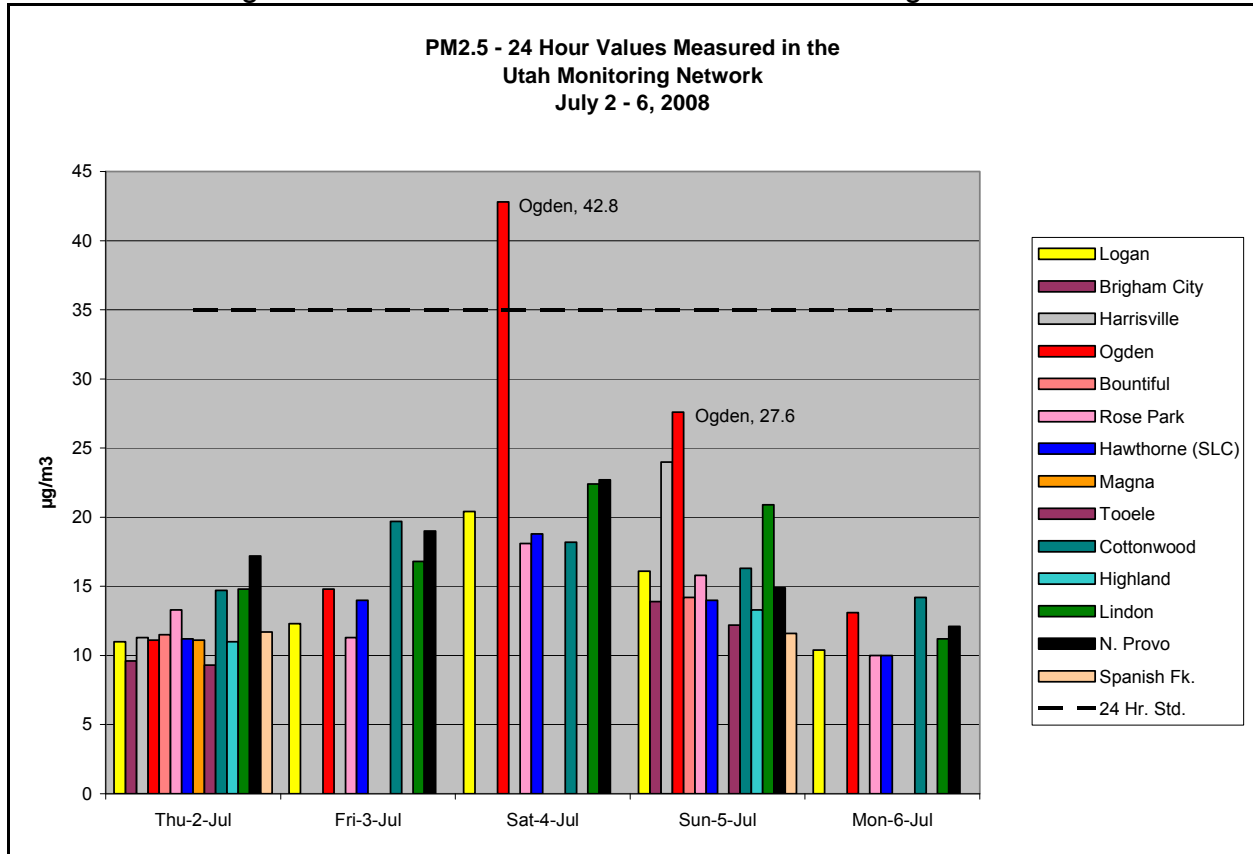


fireworks events from Riverdale, Clinton, Sunset, and Clearfield would impact the air quality at the Ogden station.

**No Exceedance or Violation But For the Event**

Figure 2 shows the PM<sub>2.5</sub> 24-hr values for the Utah monitoring network from July 2, 2008 to July 6, 2008. If it were not for the fireworks events, there would not have been an exceedance.

Figure2 – PM<sub>2.5</sub> 24-hr Values for Utah Monitoring Stations



**Mitigation (40 CFR 51.930)**

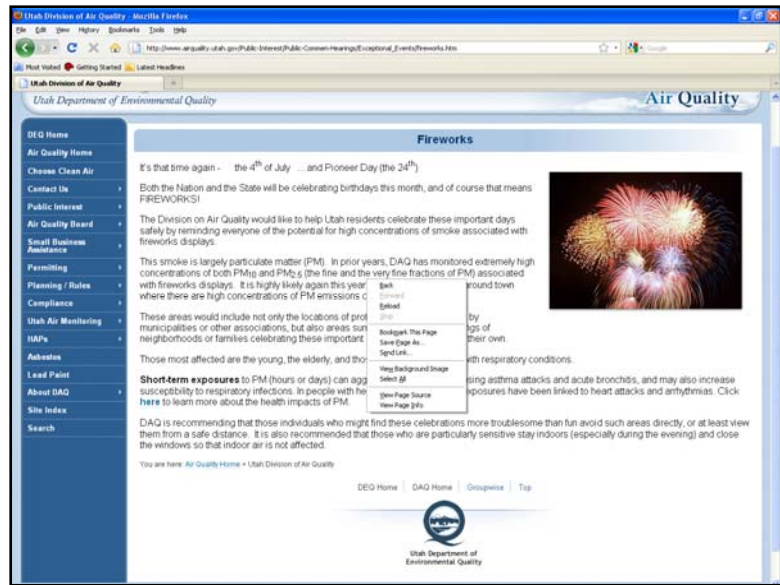
**Ogden Illegal Fireworks Prohibition program**

After dialogue between the Ogden Fire Marshal and the DAQ, the City passed an ordinance prohibiting illegal fireworks. The city has aggressively cited landowners where illegal fireworks were set off. Citations include a mandatory court appearance and fines. In cases where there is a history of illegal fireworks use, landowners/or renters received stiff fines.

**Utah Air Quality Public Notifications**

In order to improve the presentation of air quality information to the public, DAQ has improved our air quality forecasting webpage. The web page now shows the air quality forecast for today and the next two days. The Air Monitoring Center (AMC) provides air

pollution information based on daily air quality status. The AMC data is used to determine the relationship of existing pollutant concentrations to the National Ambient Air Quality Standards. There is a three tiered air quality alert system: Green, Yellow (alert days), and Red (actions days) that is used to implement winter and summer controls on the use of wood and coal burning stoves, fire places, and motor vehicles. There are five health advisory categories: good, moderate, unhealthy advisories A and B, and very unhealthy. The AMC advisory is calculated for five major pollutants including ground-level ozone, particulate pollution (particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. The new index now also



incorporates recommendations for actions to take on days when concentrations are in the red zone, to mitigate the effects of pollution for affected groups and recommendations for industry and citizens that help reduce pollution levels. The outreach program information consolidated in the three day forecast includes the Summer and Winter Control Programs and Choose Clean Air information.

The web site includes information on fireworks events, explaining the type of air quality impact from fireworks and warning sensitive populations to stay indoors.

## Public Comment (Preamble V.G.)

The DEQ established a 30-day comment period from May 1, 2010, through May 31, 2010. One comment was received supporting public messaging about air quality impact from fireworks. As indicated in the Mitigation section above, public messaging is included on the DEQ website, [http://www.airquality.utah.gov/Public-Interest/Public-Comment-Hearings/Exceptional\\_Events/fireworks.htm](http://www.airquality.utah.gov/Public-Interest/Public-Comment-Hearings/Exceptional_Events/fireworks.htm).

The announcement of the comment period was published eight times in the Salt Lake Tribune between April 17 and May 1, 2010. The proof of publication can be found in Appendix 1.

## Reference

Roberta Vecchi, Vera Bernardoni, Diana Cricchio, Alessandra D’Alessandro, Paola Fermo, Franco Lucarelli, Silvia Nava, Andrea Piazzalunga and Gianluigi Valli, 2007. The impact of fireworks on airborne particles. *Atmospheric Environment*, Vol 42, Issue 6, feb 2008, pgs., 1121-1132.

**Appendix 1**

**Proof of Publication**