

# Ogden Air Logistics Center

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## Field Verification of Sound Attenuation and Measurements of Seismic Impulses from the Detonation of Missile Motors

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*Innovation & Excellence*



# Authors



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# Open Detonation Participants



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- **Utah Test and Training Range (UTTR)**
- **Naval Surface Warfare Center, Dahlgren, VA**
- **Hill Air Force Base, UT**
- **Utah Division of Air Quality (SLC, UT)**
- **CH2M-Hill (Salt Lake City, UT)**
- **Utah State University, Logan, UT**



# Outline



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- **Goals of the Field Study**
- **Regulatory Background**
- **Sound Mitigation Program**
- **Previous Detonation Activities**
- **Field Results from 2006 Sound Study**
- **Seismic Impulse Measurements**
- **Conclusions**



# Open Detonation Field Study Goals



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- **To Evaluate The Effectiveness of the UTTR Noise Models as Predictive Tools Used to Support UTTR Detonation Decisions**
- **To Compare the Measured Sound Levels at Multiple Locations Along the Wasatch Front to Those Values Predicted by the SIPS Sound Model**
- **To Explore the Relationship Between the Net Explosive Weight of the Motor and the Seismic Impulse Generated**



# Regulatory Background



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- The Utah Test and Training Range (UTTR) Is the Only Location in the US Where Energetic Materials Containing More Than 10,000 Pounds NEW Can Be Detonated as a Means of Disposal
- In 1993, the US Department of the Navy (USN) Requested that UTTR Personnel Dispose of POSEIDON Stage-2 ICBM Missile Motors (16,000 Lb NEW) by Open Detonation

Cont.



# Regulatory Background, Cont'd



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- **In 1994, Following Numerous Public Complaints and Physical Damage Caused by the Detonation Sound Waves, the Utah Department Of Environmental Quality (UDEQ) Mandated the Implementation of a UTTR Noise Abatement Plan.**
- **Sound Models Adopted in The UTTR Noise Abatement Plan Include the Blast Operation Overpressure Model (BOOM) and the Sound Intensity Prediction System (SIPS)**



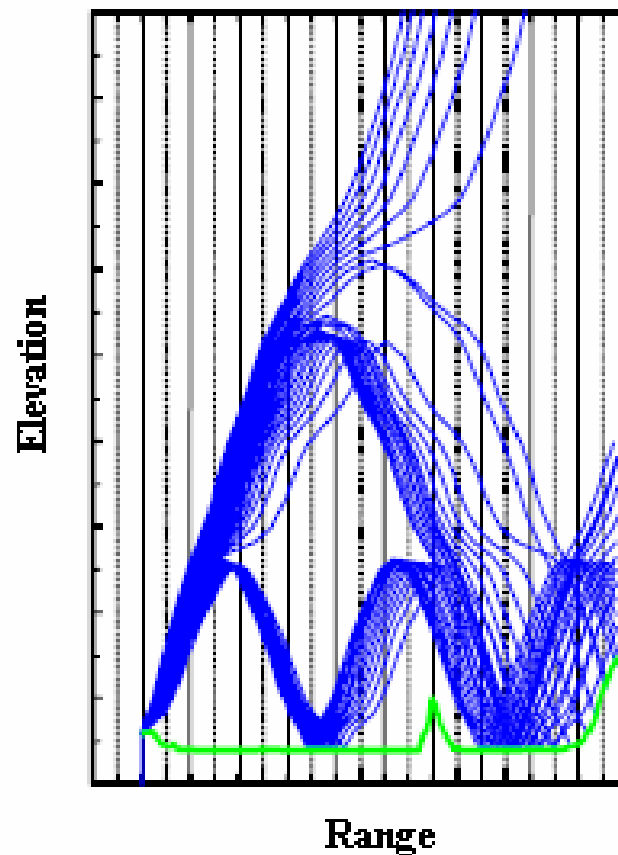
# SIPS Model



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- **The Sound Intensity Prediction System (SIPS) is an acoustic ray tracing computer code to determine the locations of both noise enhancements and noise reductions that occur during explosive operations.**

Ray Paths







# Regulatory Background



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- **Utah Division Of Environmental Quality Limits the Peak Sound Level Detected in Populated Areas as a Result Of Missile Motor Detonations to No Greater Than 134 dB.**
- **As a Safety Precaution, The UTTR Will Not Conduct a Detonation if Either Model Indicates That the Peak Sound Level at a 30 km Distance From the Site Is Greater Than 120 dB.**



# Current Regulatory Conditions at UTTR



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- **42,000 Pounds NEW per Event increased last year to 84,000 Pounds NEW per event**
- **84,000 Pounds NEW per Day**
- **6,550,000 Pounds NEW per Season  
(March through October)**



# 2003-2005 Detonation Activities



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- **120+ detonations of Trident Stage 1, 2, and 3 motors at the TTU**
- **4 Million pounds NEW destroyed**
- **Several studies were carried out including sound studies, pollutant modeling, and gas-phase sampling.**





# Stage I Motor



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# Positioning of Motors



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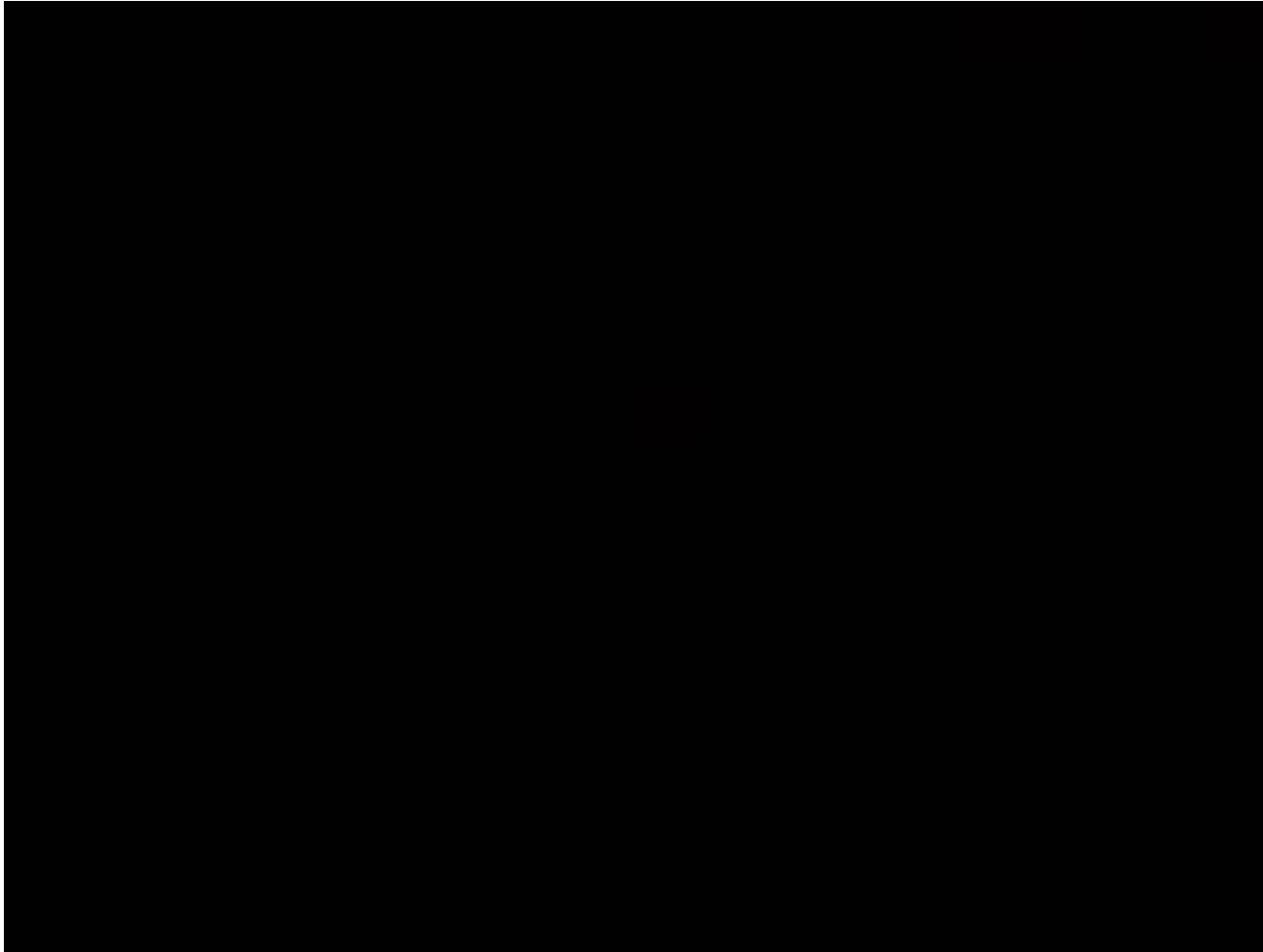




# August 2003 57k Detonation



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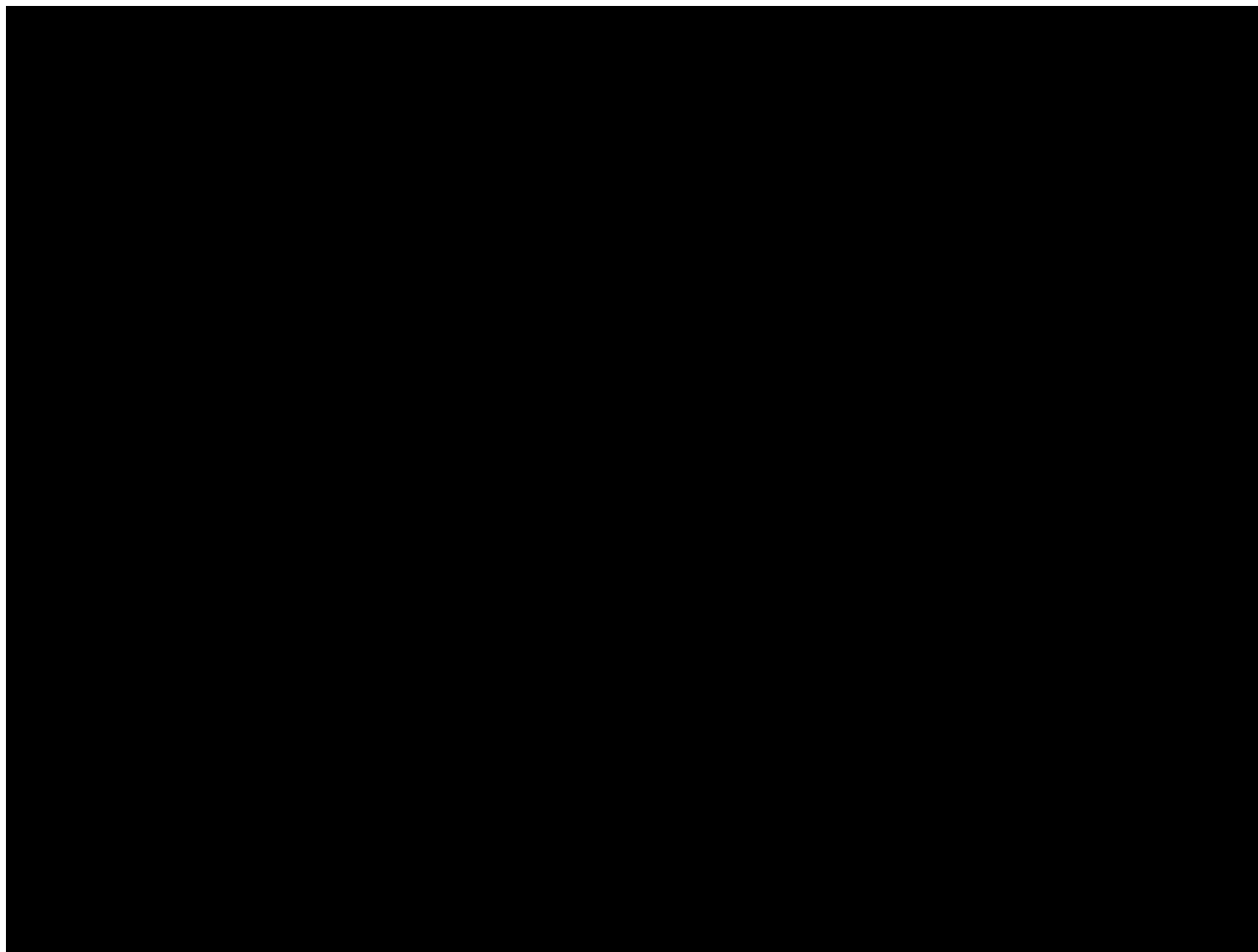




# August 2004 81k Detonation



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# UTTR Sound Study

## 18 September, 2006



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- **Simultaneous Detonation of Missile Motors (Combined Charge – 80,000 lbs NEW) Under Experimental Approval Order (DAQE-AN1284014-04)**
- **Nine Bruel and Kjaer Sound Leveling Devices Were Placed Near Population Centers Along Utah's Wasatch Front**

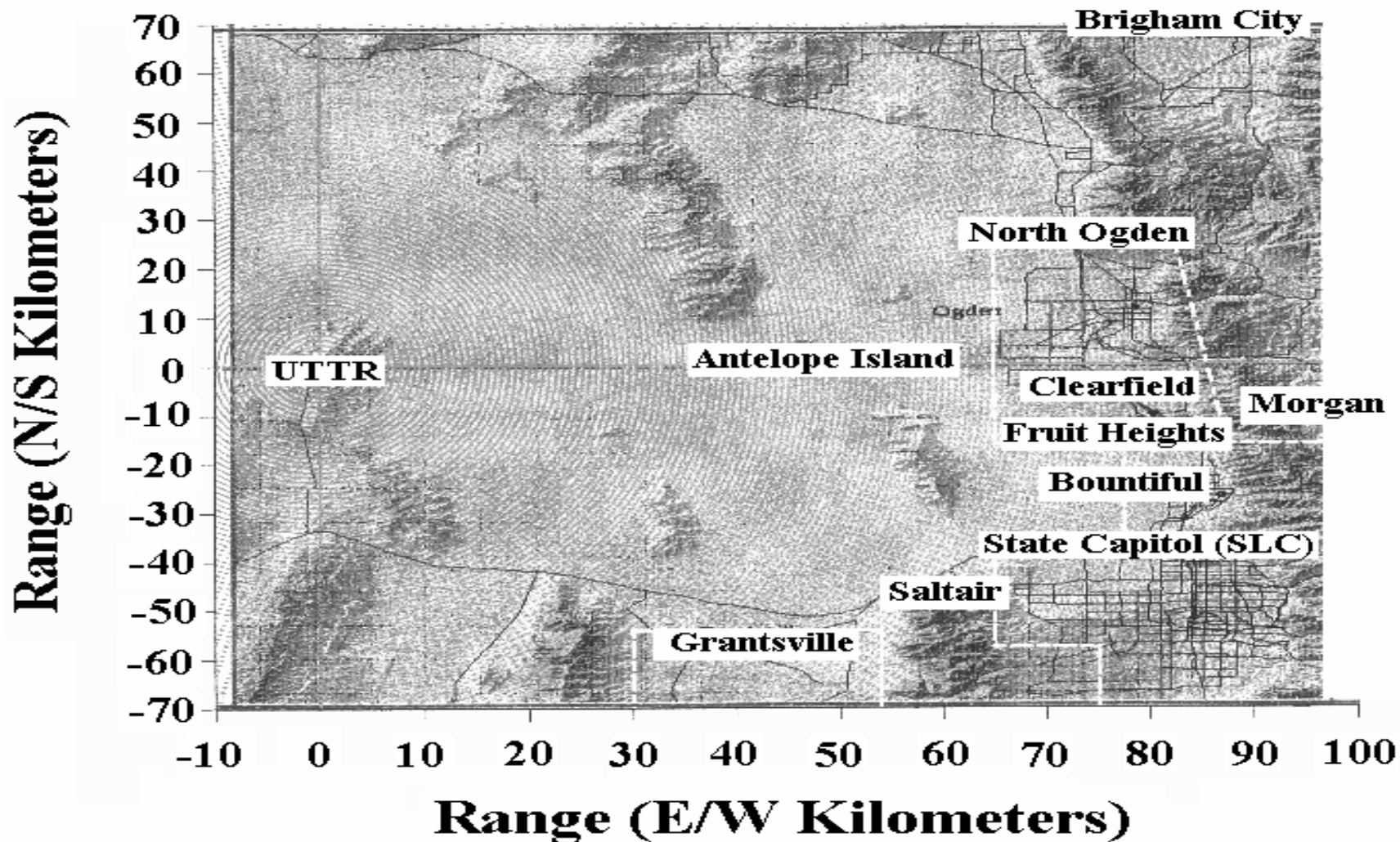






# Position of Noise Meters

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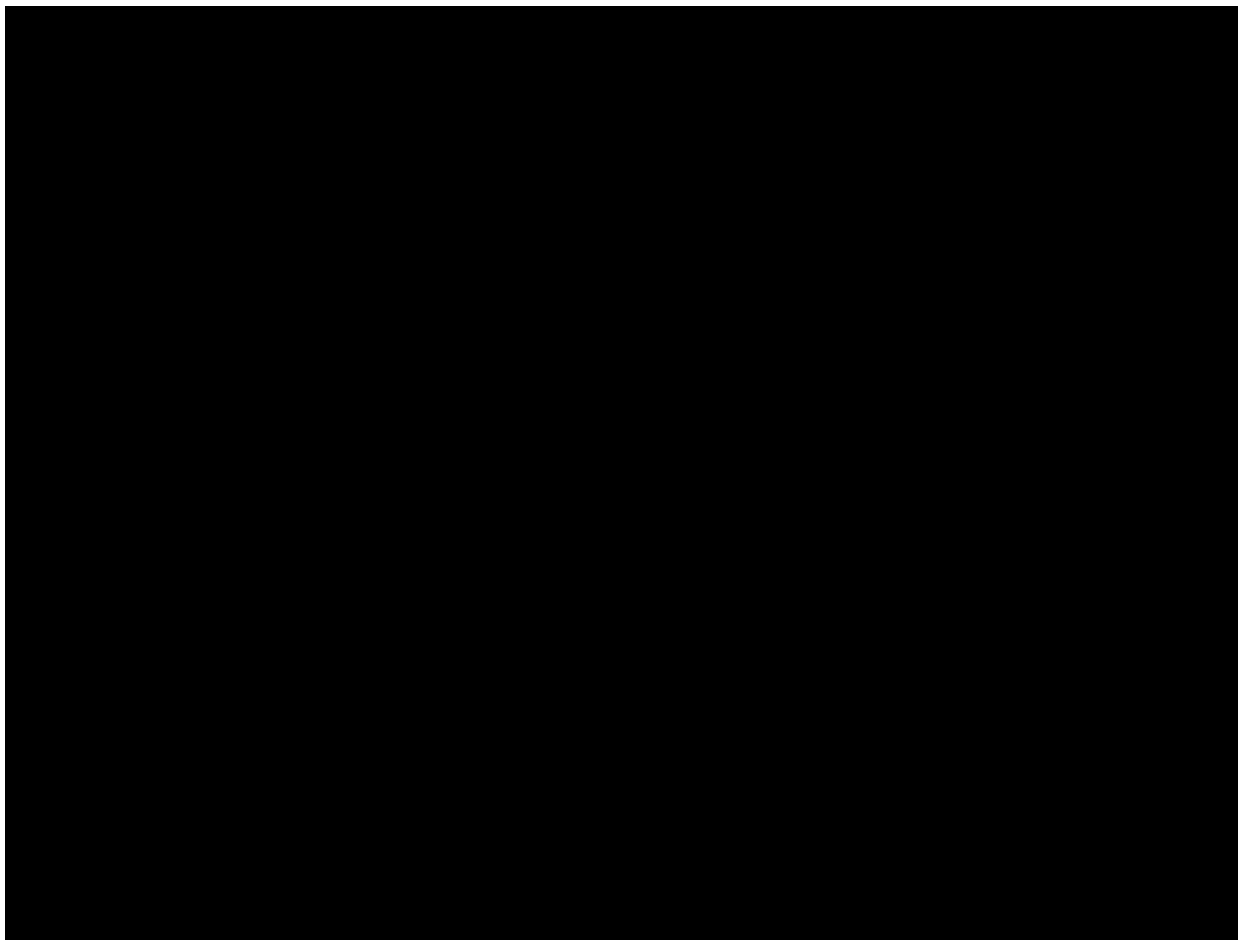




# 80,000-Pound NEW Detonation – 18 September 2006



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# 80,000 lb NEW Detonation

## 18 Sep 2006



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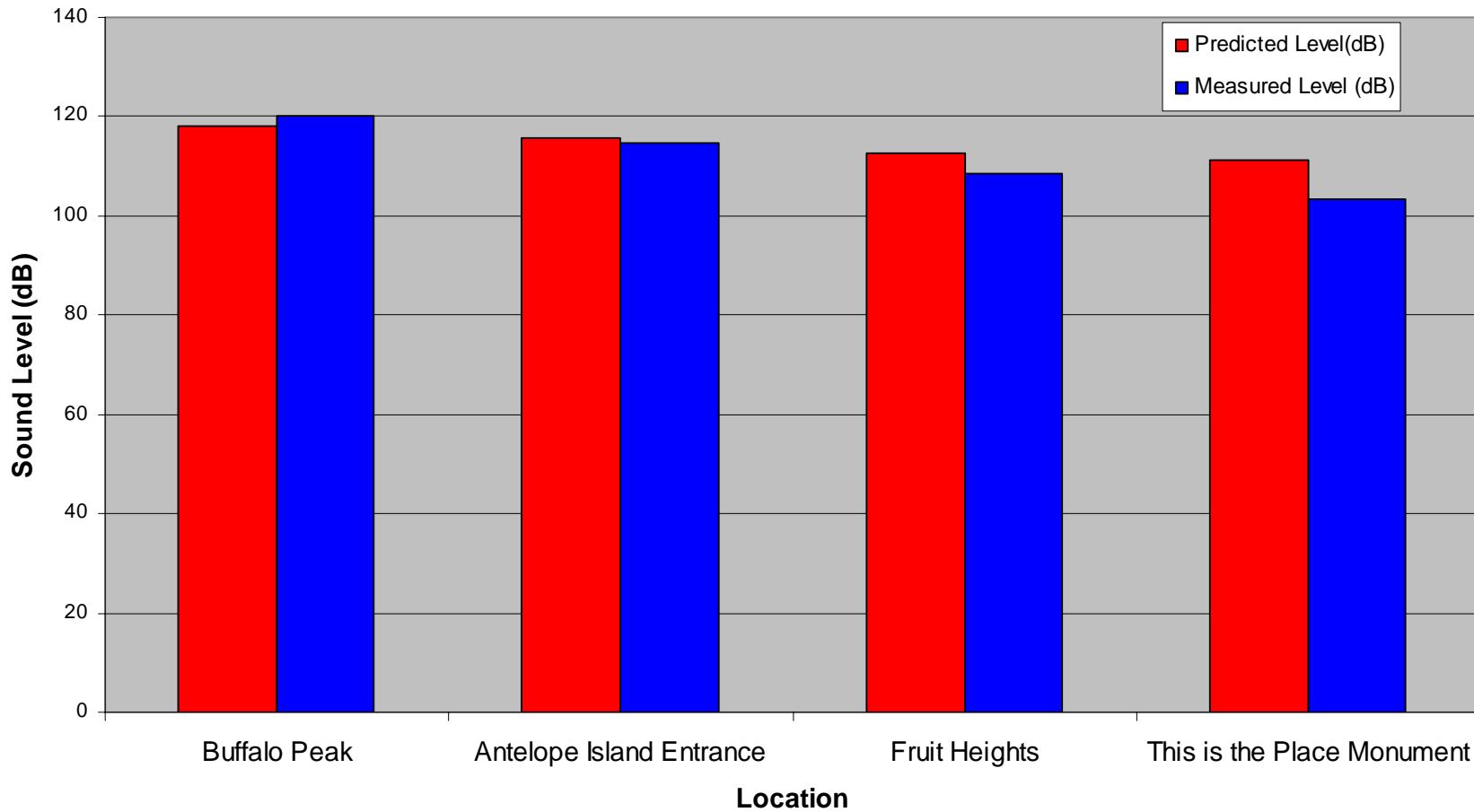
Place Name	Latitude	Longitude	Range (miles)	Expected Level (dB)	Measured Level (dB)
Ground Zero	41.130000	-112.900000	0.0	-	-
Oasis (UTTR Compound)	41.053000	-112.940000	5.7	139.8	125.3
Buffalo Peak (Antelope Island)	41.033540	-112.264100	33.9	117.9	120
Antelope Island Entrance	41.089400	-112.120000	40.8	115.6	114.5
Salt Air	40.746800	-112.187783	45.7	114.3	-
Brigham City	41.523217	-112.024567	53.0	112.4	-
Fruit Heights	41.022183	-111.910000	52.2	112.6	108.5
State Capital	40.776389	-111.889417	58.2	111.3	-
This is The Place Monument	40.751967	-111.890000	58.9	111.2	103.5
Knolls	40.729417	-113.258667	41.1	115.5	-



# Measured vs. Predicted Sound Levels



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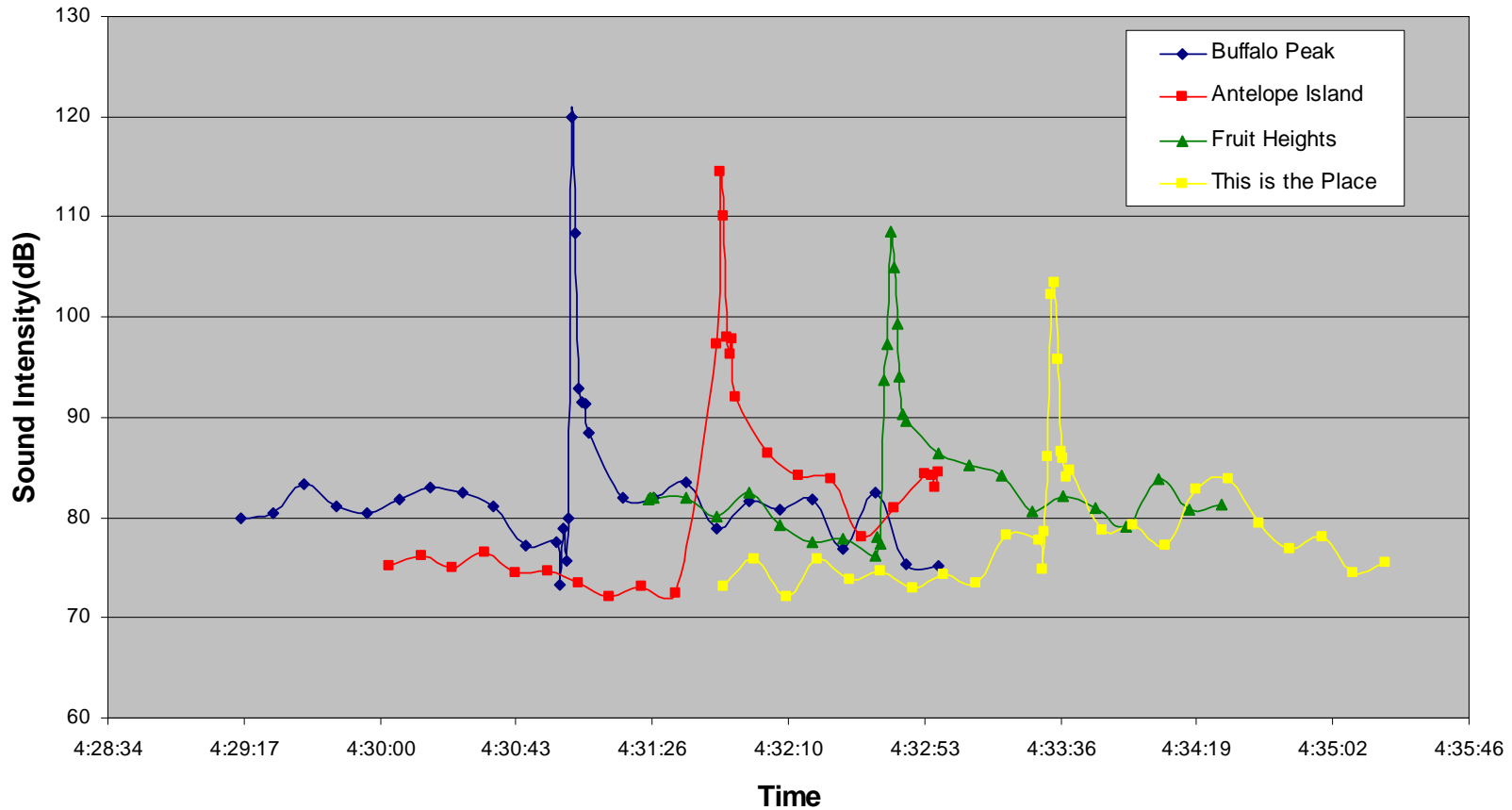




# Sound Magnitude vs. Time



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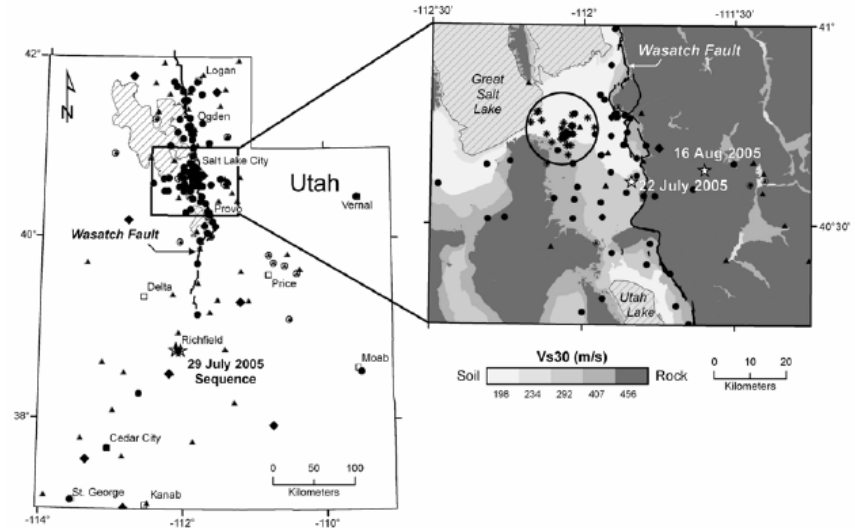


# Measurement of Seismic Magnitude



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- **Magnitude measured by University of Utah Seismograph Station**
- **Utah has a dense network of instruments for seismic measurements in the basins above the Wasatch and other faults.**
- **Magnitude ( $M_c$ ) is the measure of the vertical velocity of the earth**



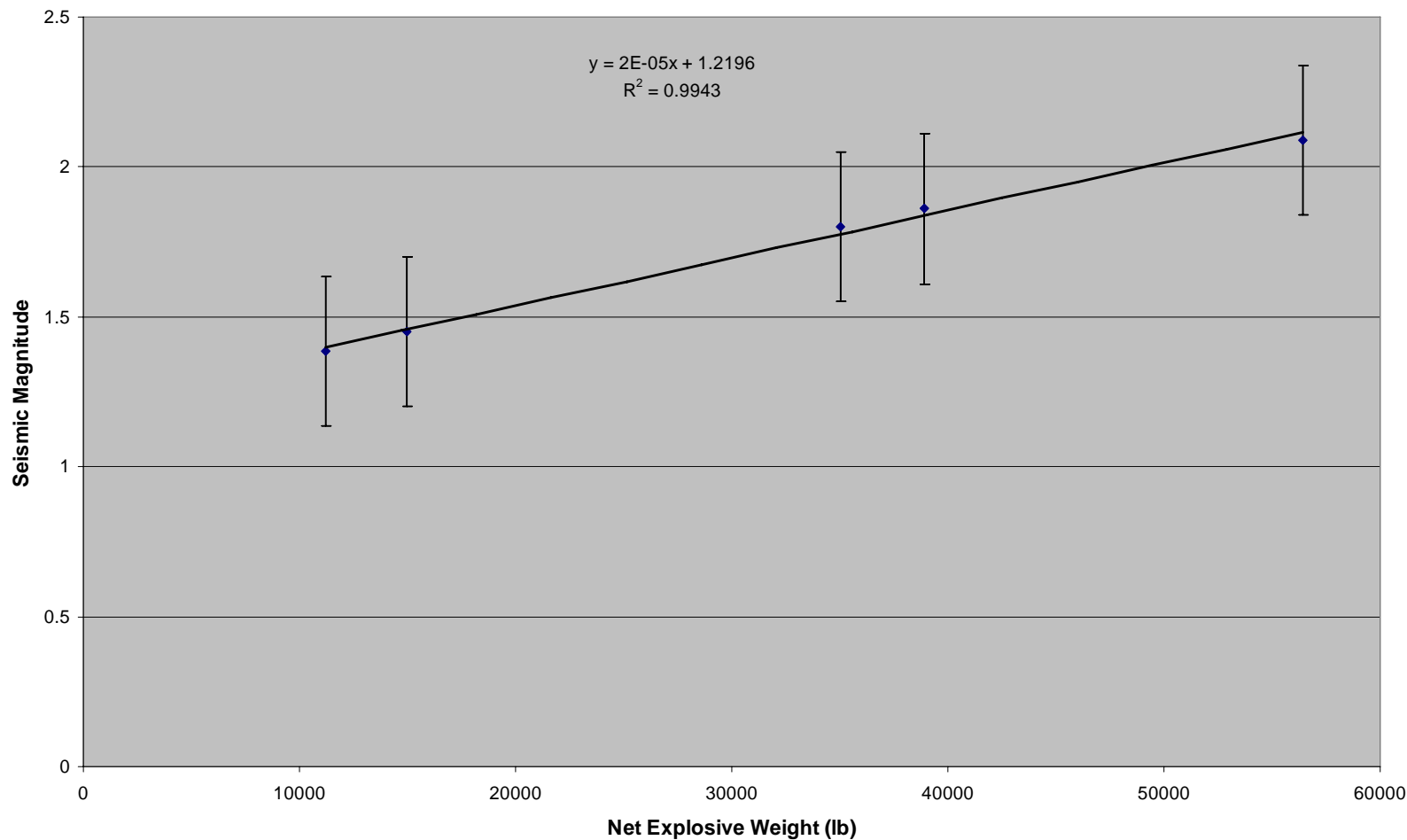


# Seismic magnitude vs. NEW

## 0 - 60,000 lb NEW



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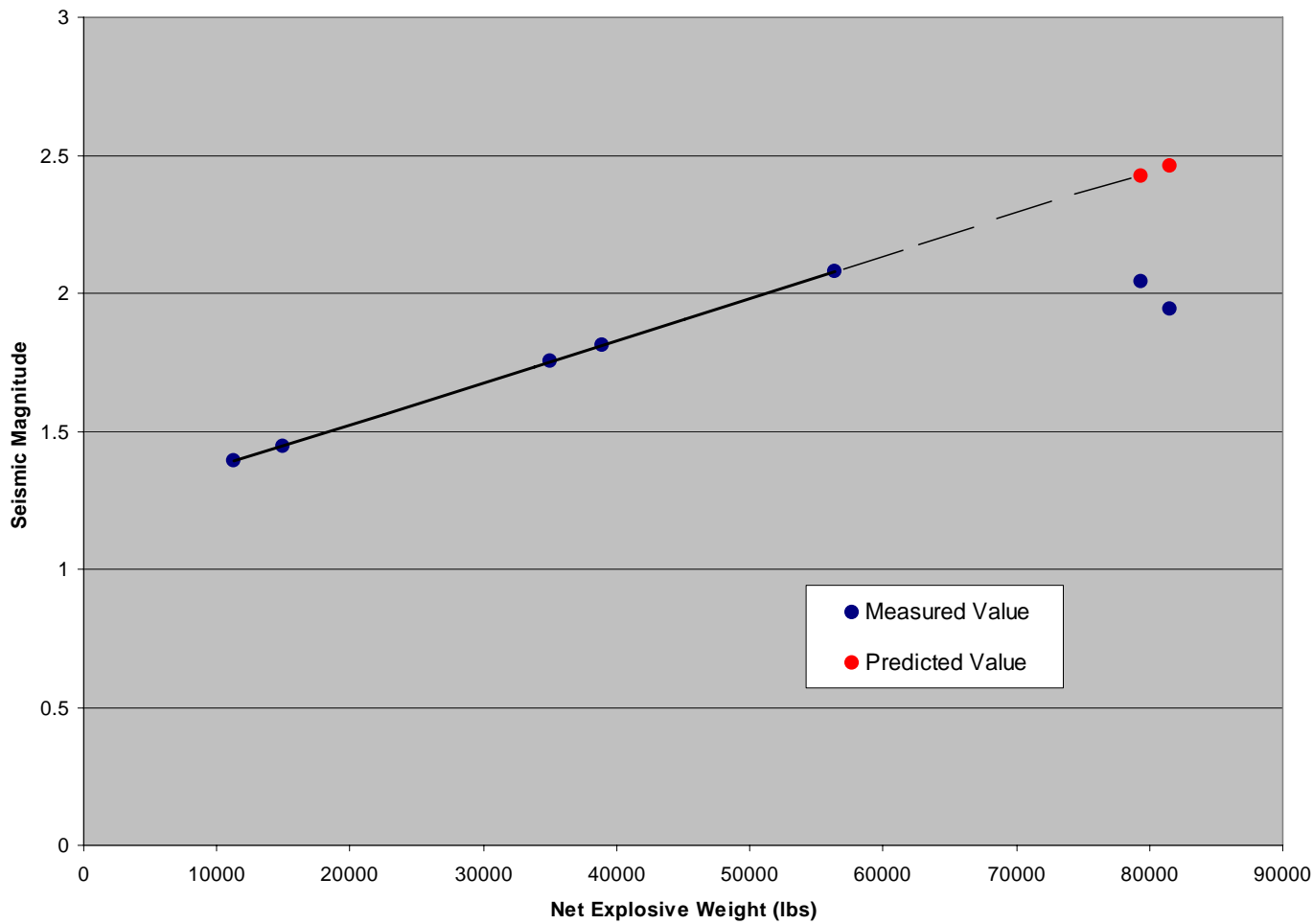




# Unexpected Seismic Magnitude (NEW > 60,000)



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# A Tale of Two Sizes



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- **Seismic measurements from 129 detonations utilizing net explosive weight values ranging from 10,000 to 60,000 pounds NEW show a very clear linear relationship with a correlation value of 0.994.**
- **For detonations with NEWs exceeding 60,000 pounds, the seismic magnitude was significantly lower than expected. It is possible that the geometry of the propellant and placement of the donor charge on these large detonations is affecting the seismic impulse delivered to the environment.**



# Sound Study Conclusions



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- **The Simultaneous Utilization of SIPS and BOOM Noise Attenuation Programs Was Found to Be Effective in Supporting UTTR Detonation Decisions**
- **The SIPS Sound Tracing Program Predicted Peak Sound Levels That Were Nearly Identical to Measured Sound Levels at Several Locations Along the Wasatch Front**



# ...Conclusions continued



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- **For Detonation of Motor Combinations Having Net Explosive Weights Less than 60,000 pounds, a strong linear relationship exists between the NEW and the Seismic Impulse.**
- **Motor combinations with NEW's exceeding 60,000 pounds had seismic impulses much less than expected. The cause of the discrepancy between the two size ranges is not yet known.**



# Questions?



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