Possible Implications of Faulty US Technical Intelligence in the Damascus Nerve Agent Attack of August 21, 2013

Richard Lloyd
Former UN Weapons Inspector
Tesla Laboratories Inc.|Arlington, VA
Voice: 509-979-3995; e-mail: rlloyd@tesla.net

Theodore A. Postol
Professor of Science, Technology, and National Security Policy
Massachusetts Institute of Technology
Voice: 617 543-7646; e-mail: postol@mit.edu

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What is the Main Policy Issue?

- The Syrian Improvised Chemical Munitions that Were Used in the August 21, Nerve Agent Attack in Damascus Have a Range of About 2 Kilometers
- The UN Independent Assessment of the Range of the Chemical Munition Is in Exact Agreement with Our Findings
- This Indicates That These Munitions Could Not Possibly Have Been Fired at East Ghouta from the “Heart”, or from the Eastern Edge, of the Syrian Government Controlled Area Shown in the Intelligence Map Published by the White House on August 30, 2013.
- This mistaken Intelligence Could Have Led to an Unjustified US Military Action Based on False Intelligence.
- A Proper Vetting of the Fact That the Munition Was of Such Short Range Would Have Led to a Completely Different Assessment of the Situation from the Gathered Data
- Whatever the Reasons for the Egregious Errors in the Intelligence, the Source of These Errors Needs to Be Explained.
- If the Source of These Errors Is Not Identified, the Procedures that Led to this Intelligence Failure Will Go Uncorrected, and the Chances of a Future Policy Disaster Will Grow With Certainty.
Statement on Syria

Remarks
John Kerry
Secretary of State
Treaty Room
Washington, DC
August 30, 2013

Our intelligence community has carefully reviewed and re-reviewed information regarding this attack, and I will tell you it has done so more than mindful of the Iraq experience. We will not repeat that moment. Accordingly, we have taken unprecedented steps to declassify and make facts available to people who can judge for themselves.

We know where the rockets were launched from and at what time. We know where they landed and when. We know rockets came only from regime-controlled areas and went only to opposition-controlled or contested neighborhoods. And we know, as does the world, that just 90 minutes later all hell broke loose in the social media.

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We have physical evidence of where the rockets came from and when.

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We are certain that none of the opposition has the weapons or capacity to effect a strike of this scale – particularly from the heart of regime territory.

So my colleagues, we know what happened. For all the lawyers, for all the former prosecutors, for all those who have sat on a jury – I can tell you that we know these things beyond the reasonable doubt that is the standard by which we send people to jail for the rest of their lives.

As confidently as we know what happened in Damascus, my friends, on August 21st, we know that Assad would read our stepping away or our silence as an invitation to use those weapons with impunity.
Statement:

Multiple streams of intelligence indicate that the regime executed a rocket and artillery attack against the Damascus suburbs in the early hours of August 21. **Satellite detections corroborate** that attacks from a regime-controlled area struck neighborhoods where the chemical attacks reportedly occurred – including Kafr Batna, Jawbar, 'Ayn Tarma, Darayya, and Mu'addamiyah. **This includes the detection of rocket launches from regime controlled territory early in the morning, approximately 90 minutes before the first report of a chemical attack appeared in social media. The lack of flight activity or missile launches also leads us to conclude that the regime used rockets in the attack.**

Issue:

Satellite technical intelligence is one of the most reliable technologies available to the US intelligence community. Satellite measurements provide highly reliable rocket launch point locations to fractions of a kilometer.
White House Map Published on August 30, 2013 Showing Government Controlled Area

**Syria: Damascus Areas of Influence and Areas Reportedly Affected by 21 August Chemical Attack**

**Areas of Influence**
- Opposition dominant
- Regime dominant
- Contested
- Areas reportedly affected by 21 August chemical attack

Note: Reports of chemical attacks originating from some locations may reflect the movement of patients exposed in one neighborhood to field hospitals and medical facilities in the surrounding area. They may also reflect confusion and panic triggered by the ongoing artillery and rocket barrage, and reports of chemical use in other neighborhoods.
White House Map Published on August 30, 2013 Showing Government Controlled Area and Ring of Maximum Ranges from Where Chemical Munitions Could Have Been Launched
Important Basic Observation – The Rocket Behaves Like a Balloon That Is, Its Range Is Dominated By the High Aerodynamic Drag from Its Body-Shape

- The Range Does Not Change Drastically with Significant Changes in the Body Weight or Due to Uncertainties in the Aerodynamic Drag Coefficient.
- Due to Volume and Fuel Density Constraints, Our Assumption of Rocket Propellant Carried by the Munition is at the Top End of What is Possible.

This Means that Our Estimated Maximum Range of 2 km for the Improvised Munition Is Close to its Upper Possible Range!
In Turn, It Means That the US Government’s Interpretation of the Technical Intelligence It Gathered Prior to and After the August 21 Attack CANNOT POSSIBLY BE CORRECT

Remainder of Talk

- Shows Why the Range Estimate of Roughly Two Kilometers Hardly Changes If the Munition Carries a Lighter Payload.

Appendices

1. Source Data on GRAD Aerodynamic Drag Coefficient
2. Source Data on the GRAD Rocket Motor Characteristics
3. Description of Capabilities of Space-Based Sensors Used to Detect the Rocket Launches in the Damascus Attack
What Does the Improvised Chemical Munition Look Like and How Was It Constructed

GRAD Artillery Rocket NYT September 5, 2013

ESTIMATED DIMENSIONS

Canister for holding chemicals
Estimated capacity of 13 gallons

Rocket parts were found distorted by the impact, but not fragmented, indicating that they carried a small quantity of explosives. This helps keep the integrity of the chemical agent.
### Technical Characteristics of the GRAD Artillery Rocket and Its Rocket Motor

**TACTICAL AND TECHNICAL CHARACTERISTICS OF THE 122mm ROCKETS “GRAD” AND THEIR MODIFICATIONS**

Basic characteristics of the existing “GRAD”, “G-M” and “G-2000” at nominal

<table>
<thead>
<tr>
<th>Characteristic</th>
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**Possible Adaptation of GRAD Artillery Rocket Motor for Chemical Munition Used in Damascus**

Full Rocket Motor Contains 20.45 kg of Propellant
Half Motor Contains 10.22 kg of Propellant
60% Motor Contains 12.27 kg of Propellant
(112 cm of 189 cm GRAD Rocket Motor)

Specific Impulse of GRAD ($I_{sp}$) = 198 sec
Rocket Motor Length = 188 cm
12.45 kg Propellant Mass
$\rightarrow 0.1088$ kg/cm of Propellant in Motor
GRAD Artillery Rockets are a Ubiquitous Weapon

9M22U (M-21OF)
Possible Adaptation of GRAD Artillery Rocket Motor for Chemical Munition Used in Damascus

Full Rocket Motor Contains 20.45 kg of Propellant
Half Motor Contains 10.22 kg of Propellant
60% Motor Contains 12.27 kg of Propellant

If Rocket Motor Is 112 cm Long
~ 5 cm - 0.5 kg Less Propellant; 10 cm ~ 1 kg Less Propellant

Rocket-Motor Back End Housing of Chemical Munition Used in Damascus Attack of August 21, 2013
Remnants of a Sarin Container from One of the Chemical Munitions Used in the Zamalka Attack

Rocket-Motor Being Removed from “Soup Can” Type of Rocket (Warhead is Probably High Explosive)
Evidence of the Thin Inner Skin of a Rocket Motor Casing on the Back Plate of the Chemical Munition

Diagram of Improvised Chemical Artillery Rocket from UN Report of September 18, 2013
Data Used to Estimate Thickness of Steel Sheets and Pipes Associated with the Chemical Rocket Munition Used in Damascus Gas Attack of August 21, 2013

**Rought Estimate of the Possible Weight of the Chemical Munition Without Its Inserted Rocket Motor**

Pipe Structure for Rocket Motor and for the Axial Mechanical Support of the Sarin Container

\[
\pi \times (12.2^2-11.8^2) \times 130 \times 0.0079 = 30.9736
\]

\[
\pi \times (12.2^2-11.9^2) \times 130 \times 0.0079 = 23.3270
\]

End Plate: \( \pi \times 18^2 \times 0.5 \times 0.0079 = 4.0206 \) kg

Two End Plates: 8 kg

Rear End Plate Strengthening Ring: \( \pi \times (12^2-6^2) \times 1 \times 0.0079 = 2.6804 \) kg

Six Fins = \( 6 \times 22 \times 9.5 \times 4 \times 0.0079 = 3.9626 \) kg

Fin Strengthening Ring = \( 2 \times \pi \times 15.5 \times 5 \times 4 \times 0.0079 = 1.5388 \) kg

Sarin = 55 kg

Metal Skin of Sarin Container = \( 2 \times \pi \times 17.5 \times 70 \times 0.2 \times 0.0079 = 12.1611 \) kg

\( 2 \times \pi \times 17.5 \times 70 \times 0.15 \times 0.0079 = 9.1208 \) kg

Metal Skin for Rocket Motor Casing = 7 kg?

Other Hardware = 5 kg

\[
30.9736 + 8 + 2.6804 + 3.9626 + 1.5388 + 12.1611 + 7 + 55 = 126.3165 \text{ kg Total Weight Without Rocket Motor}
\]

\[
23.3270 + 8 + 2.6804 + 3.9626 + 1.5388 + 9.1208 + 7 + 55 = 110.6296 \text{ kg Total Weight Without Rocket Motor}
\]

We Estimate a Weight-Range Between 100 and 130 kg

We Choose a Baseline Weight of 115 kg
How We Estimated the Maximum Range of the Improvised Chemical Munition Used in the August 21, 2013 Nerve Agent Attack on East Ghouta

Important Basic Result – The Rocket Behaves Like a Balloon That Is, Its Range Is Dominated By the High Aerodynamic Drag from Its Body-Shape

- The Range Does Not Change Drastically with Significant Changes in the Body Weight or Due to Uncertainties in the Aerodynamic Drag Coefficient.
- Due to Volume and Fuel Density Constraints, Our Assumption of Rocket Propellant Carried by the Munition is at the Top End of What is Possible.

This Means that Our Estimated Maximum Range of 2 km for the Improvised Munition Is Close to its Upper Possible Range!

In Turn, It Means That the US Government’s Interpretation of the Technical Intelligence It Gathered Prior to and After the August 21 Attack CANNOT POSSIBLY BE CORRECT
Differences in the Flight Trajectory of Baseline Chemical Munitions Due to Uncertainties in Weight, Propellant Loading, and Aerodynamic Drag

For Weight Differences of +15 kg to -30 kg

Differences in the Flight Trajectory of Baseline Chemical Munitions Due to Uncertainties in Weight, Propellant Loading, and Aerodynamic Drag

Very Significant Changes in the Munition's Body-Weight Result in Only Small Changes in Its Maximum Range

Forces Acting on GRAD Artillery Rocket During Powered and Free Flight

THRUST
Characteristics of GRAD Rocket Motor

DRAG
Characteristics of Rocket Aerodynamics

GRAVITY

GRAD
Speed Immediately After Burnout ~ 690 m/s (Mach 2.1)
Drag Forces Immediately After Burnout ~ 280 lbs
Motor Generates About 9000 lbs of Thrust for About Two Seconds

Improvised Chemical Munition
Speed Immediately After Burnout ~ 220 m/s (Mach 0.66)
Drag Forces Immediately After Burnout ~ 600 lbs
Motor Generates About 5000 lbs of Thrust for About Two Seconds
### Technical Characteristics of the GRAD Artillery Rocket and Its Rocket Motor

**TACTICAL AND TECHNICAL CHARACTERISTICS OF THE 122mm ROCKETS “GRAD” AND THEIR MODIFICATIONS**

Basic characteristics of the existing “GRAD”, “G-M” and “G-2000” at nominal

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**The Drag Coefficient of the Syrian Chemical Rocket and the GRAD Artillery Rocket**

![Drag Coefficient Graph](image-url)
Comparison of the Trajectories of the GRAD Artillery Rocket with the Trajectory of the Syrian Improvised Chemical Rocket When Both Rockets Use Motors with the Same Propellant and Specific Impulse

Comparison of GRAD Artillery Rocket Trajectory with Trajectory of Syrian Chemical Munition When Both Rockets Use Motors With the Same Propellant and Specific Impulse

GRAD Rocket Motor
Isp=198 sec
Fuel Weight=20.45 kg
Total Rocket Weight=66kg

GRAD Artillery Rocket

Flat-Faced Syrian Chemical Munition

Flight Time to 20 km ~ 75 seconds
Flight Time to 2.2 km ~ 26 seconds

Our Trajectory Calculations Compared to Published Trajectory Data on GRAD Artillery Rocket

GRAD-Rocket Drag Coefficient (C_d) Near Mach 1 May be too High by About 7-8%
The Syrian Improvised Chemical Munitions that were used in the August 21, Nerve Agent Attack in Damascus have a range of about 2 kilometers.

This indicates that these munitions could not possibly have been fired at East Ghouta from the “Heart” or the Eastern Edge of the Syrian Government Controlled Area depicted in the Intelligence Map Published by the White House on August 30, 2013.

This faulty Intelligence could have led to an Unjustified US Military Action Based on False Intelligence.

A proper vetting of the Fact that the Munition Was of Such Short Range Would Have Led to a Completely Different Assessment of the Situation from the Gathered Data.

Whatever the Reasons for the Egregious Errors in the Intelligence, the Source of These Errors Needs to Be Explained.

If the Source of These Errors Is Not Identified, the Problems That Led to this Intelligence Failure Will Go Uncorrected, and the Chances of a Future Policy Disaster Will Grow With Certainty.
Appendix: How Aerodynamic Drag Occurs

Drag Force From Air Movement
\[ \text{Drag Force} = \frac{1}{2} \rho V^2 C_D A \]

\[ \delta V_{air} = C_D V_x \]

\[ M_{air} = \rho \delta X \delta Y \delta Z = \rho \delta Y \delta Z (V_x \delta t) \]

Drag Force Due to Air Movement
\[ = M_{air} A_{air} = M \left( \frac{\delta V_{air}}{\delta t} \right) = (\rho \delta Y \delta Z V_x) (C_D V_x) \]

Drag Force Due to Air Movement
\[ = (\rho \delta Y \delta Z V_x) (C_D V_x) = C_D \rho V_x^2 A \]

Where
- \( A \) is the projected area of the object in the flow field
- \( \rho \) is the density of the air
- \( V_x \) is the velocity of the object relative to the air

By Convention, \( C_D \) is defined so that the equation for drag can be written as,

Drag Force From Air Movement
\[ = \frac{1}{2} \rho V^2 C_D A \]
Difference in Drag Forces Due to the Different Geometries of the Air Flow

Drag Force From Air Movement \[ = \frac{1}{2} \rho V^2 C_D A \]

Explanation of How Aerodynamic Drag Forces Are Generated

Difference in Drag Forces Due to the Different Geometries of the Air Flow

Drag Coefficient Used in Our GRAD Artillery Rocket Trajectory Calculations

Drag Coefficient When Rocket Motor is OFF

Drag Coefficient When Rocket Motor is ON

APPENDIX

Appendix: Data Source on Rocket Motor Parameters of the GRAD Rocket

Data Source on Rocket Motor Parameters of the GRAD Rocket (Pages 1 and 2 of 8 Pages)

Rocket "G-2000" is fully compatible to the mobile multi tube rocket launchers such as BM-21 and BM-70, or similar existing launchers. Underlining that this rocket is a new unit with the latest state-of-art design, which is also a very small size. Welded with five rocket guide and contact cover are identical with the original rocket "GRAD".

Rocket "G-2000" is fully compatible to the mobile multi tube rocket launchers, such as BM-21 and BM-70, or similar existing launchers. Underlining that this rocket also may use the original units for range reduction.

Comparative technical characteristics of the rocket are given in Table T-1 and on Diagram D-1.
Answer to Question from the Press About the UN's Assessment of the Range of the Chemical Munition Used in the Nerve Agent Attack of August 21, 2013 in Damascus:
Åke Sellström, Head of Mission, of the United Nations Mission to Investigate Allegations of the Use of Chemical Weapons in the Syrian Arab Republic

Åke Sellström Statement

We have seen problems – like you have seen others performing whatever studies on these rockets and we have consulted with experts, and if you simulate the flight path it seemed not to meet – may be indicated from the report – you may draw a conclusion from the report two kilometers could be a fair guess. I would assume, but it all depends, you have to sort of set some parameters which we do not know to what extent they were filled or with what they were filled with. We don't know their weight or whatever, but two kilometers could be a fair guess.

Between 15:55 to 16:47 on the YouTube Video at: http://www.youtube.com/watch?v=5CFn9pWNKel

NOTE: Our calculations show that the exact weight of the munition is not an important determinant of its range.

Rough Sequence of Events with Regard to Public Awareness of This Issue
Tesla/MIT Draft Materials on Rocket’s Range Limitations Begin to Circulate on Blogs in Early December (12/4 or so)
UN Discusses Its Own Assessment in Response to Press Question on December 13, 2013