The Performance of the Patriot Missile in the Gulf War

An Edited Draft of a Report prepared for the Government Operations Committee, U.S. House of Representatives, October 1992

Joseph Cirincione

During the Persian Gulf War, dramatic images of missiles bursting in air flooded American homes through their television sets. Americans were told by the media that the video footage depicted Patriot missiles destroying Iraqi Scuds. Official Army, Raytheon and Administration statements confirmed that the Patriots had destroyed almost every incoming Scud. However, most of the illuminations in the sky were not caused by Patriots directly hitting incoming Scuds and destroying them, but by proximity fuzes that were programmed to explode as the Patriot neared a Scud, by the missile automatically self-destructing after missing a Scud, or by Patriots flying after false targets.

Original Views of Performance in the Gulf

During and after the Gulf War, the Patriot missile system was universally praised for its almost perfect record in destroying Iraqi Scud warheads. The Patriot Program Office reported to high-ranking Administration officials and Members of Congress that Patriots had intercepted 89% of the Iraqi Scuds launched against Saudi Arabia and 44% of the Scud warheads directed against Israel.[1]

Independent experts slowly began to question these claims based on Israeli evaluations and their own video tape record of the engagements. In December 1991, the Subcommittee on Legislation and National Security investigators questioned officials from the U.S. Army and the Raytheon Company, the prime contractor for the missile system. Initially, officials from the Army and Raytheon answered that they were confident that the Patriot had achieved a high rate of success, and they did not see any reason for the Subcommittee investigation. They believed the questions about the system's performance stemmed from Israel's interest in promoting the Israeli effort at tactical ballistic missile defense -- the Arrow -- and from one or two critics.

On January 24, 1992, four Army officers gave Subcommittee investigators what they described as the standard briefing on Patriot performance in the war. This brief had been given to the Secretary of Defense and the defense committees of the Congress. The Army evaluation asserted that:

. The Patriot was successful operationally, technically and politically.

---

[1] Representative Les Aspin, Speech before the American Institute of Aeronautics and Astronautics, May 1, 1991, p. 4.

- The Army had modified a system designed to kill aircraft into a successful theater ballistic missile killer.

- The Patriot had intercepted all but 2 of the Scuds it engaged.

- The vast majority of these interceptions resulted in killing the warhead of the Scud.

- The Patriot effectiveness was almost 60 percent in Israel, almost 90 percent in Saudi Arabia and 80 percent overall.

- "Effectiveness" meant the Patriot had either destroyed or dudded the warhead of the Scud (a "warhead kill"), or had knocked the Scud off course, away from the defended area (a "mission kill").

The army officers did not offer data to support these claims of success, and up to this point in time, such data had not been requested.

Then a member of the professional staff on Congressional Legislation and National Security Subcommittee, I (Joseph Cirincione) was requested by the Chairman to put together a team of investigators to look into these claims. The team consisted of majority and minority Subcommittee staff annd independent, nonpartisan experts from the General Accounting Office, the Congressional Research Service and the Office of Technology Assessment. On February 12 and 13, 1992, we gathered at the headquarters of the Patriot Missile Program in Huntsville, Alabama, and carefully examined the basis for the Army's evaluation. For two days, two dozen Army officials and representatives from Raytheon briefed us on their evaluation of the Patriot's performance. We uncovered serious problems with their analysis, and strongly agreed on five points:

1. The Army's analysis was seriously flawed.

2. The Army's shot-by-shot analysis of Patriot engagements was unreliable.

3. The Army claims briefed to senior officials and Members of Congress since last May were not supported by the available facts.

4. Much of the data in the Army analysis indicated either the Patriot missed, or the results were unknown.

5. The Army assessment did not contain conclusive proof that any Patriot had destroyed a Scud warhead.

Public Perceptions Were Formed Early in the Scud War

The American public's perception of the Patriot's success may have been formed by an event that never existed. The Army will no longer publicly discuss the first Scud interception claimed in the Gulf War. At the time, authoritative declarations of an intercept misled military experts, the media and the public. It was the first of many exaggerated claims.

The Scud attacks began on January 16, 1991, hours after U.S. forces began the bombardment of Iraq's capital city, Baghdad. Over the next two days, Iraq would launch dozens of Scuds towards Israel. The Scuds were wildly inaccurate. Most fell harmlessly into the sea or the desert. A few, however, fell in populated areas causing moderate damage and injuring 28 people. One scud that fell in a populated area never exploded, but outraged Israeli citizens recovered the dud and carried it through the streets in protest.

The psychological damage was more severe. Fear that the Scuds carried chemical warheads added to the terror of missiles streaking from hundreds of miles away, similar to the terror experienced by Londoners when German V-2 rockets slammed into their city during World War II. In this war, viewers around the world vicariously experienced some of the feelings of helplessness as they watched the air raid alerts sound and watched children in gas masks taking shelter from the attacks. This, in part, contributed to the collective sigh of relief when the Army announced that the first Iraqi Scud directed against Saudi Arabia had been shot down by an American Patriot missile.

On Friday, January 18, 1991, America awoke to an official announcement that a Patriot missile had intercepted the first Scud launched from Iraq toward American forces in Saudi Arabia. General Norman Schwartzkopf, Commander of the Central Command (CENTCOM) and overall commander of U.S. forces in the field, announced at a press briefing at 7:00 AM (EST):

> "There were seven Scuds fired early this morning against Israel, and there was one Scud missile fired against Dhahran. The one Scud missile that was fired against Dhahran was destroyed by a United States Army Patriot missile."[2]

All morning and throughout the day, news of what seemed to be a historic first was carried on all major networks. A video tape of the event flashed across the continents on major network news only hours after it occurred. Experts, including former military officials, were quick to add their prestige to the reports.

General Michael Dugan, the recently retired Air Force Chief of Staff, explained to CBS Evening News anchor Dan Rather that night, "What we have seen recently is the first use of an anti-ballistic missile system in combat." He narrated a video of a Patriot climbing into the night sky:

---

[2] Gen. H. Norman Schwarzkopf, CENTCOM Briefing. January 18, 1991 (7:00 a.m. EST), Riyadh, Saudi Arabia. Transcript, pp. 1-2. Cited in Testimony of Steven A. Hildreth to the House Government Operations Subcommittee on Legislation and National Security, April 7, 1992.

> "A Scud missile is heading towards us on the screen, You can't see it, but the Patriot's radar has detected this Scud. Here's the Patriot in slow motion. The Patriot's detected the Scud approaching and automatically alerted the operator to this threat. It asks the operator for permission to launch. He gives his consent, pushes a button and launches the Patriot to intercept and hit the Scud. And here in the clouds you can see a flash indicating the Scud was blown up."[3]

There was not, however, a Scud heading towards us on the screen. Nor was the public presented with any debris or evidence of a Scud. The video only showed a Patriot detonating in the clouds. There was no physical or video evidence to indicate that this Scud ever existed.

Yet, at that time, the Army claim went unchallenged. Instead of requesting evidence or proof, experts and journalists quickly went on record in support of the Army's assertion Stephen Myer from MIT told CBS News, "It worked very well."[4] James Blackwell of the Center for Strategic and International Studies said on CNN, that explosions on video tapes must show an intercept because there are not "any circumstances under which the warhead itself would detonate, so the bright glow is likely to be an intercept of something."[5] This view, that the Patriot detonations in the air must be intercepts of something, would the world's perception of the Patriot's performance throughout the war.

NBC News anchor Tom Browkow reported to his national audience that the Patriot "is now a highly effective weapon."[6] Using the January 18th video, reporter Katherine Couric narrated a news segment with the screen title "Missile Killer," explaining that, "Three miles above Dhahran in the early morning hours, a U.S. Patriot missile meets an Iraqi Scud missile." The report showed jubilant troops at the Patriot battery who declared, "We are the first Patriot battery in the history of the world to knock down a Scud missile."[7] This sincere enthusiasm was infectious, and variations of this story was repeated again and again throughout the first weekend of the war.

Several stories implied that Israel should be blamed for delaying the use of the Patriot. NBC's Couric cited unnamed sources who claimed that Israel should have accepted U.S. offers to field Patriots sooner, since, "In its first test in battle, the Patriot passed with flying colors."[8]

---

[3] CBS Evening News with Dan Rather, January 18, 1991.

[4] CBS News, January 18, 1991.

[5] CNN, January 20, 1991.

[6] NBC Evening News, January 18, 1991.

[7] NBC News, January 18, 1991.

[8] NBC News, January 18, 1991.

Wall Street also recognized the apparent success of the Patriot and other high-tech weapons in use. On January 18, Boston TV station WHDH reported:

> "For the Patriots manufacturer, Raytheon, the missile's performance is a major boost for morale and for the bottom line. It could mean growing sales for Raytheon, particularly on the international market. Defense stocks took off: Raytheon up 4 1/2; Martin Marietta, up 3 2/3; General Dynamics, up 4; McDonnell Douglas, up 4 1/3."

January 19-21: Patriot Appeared Perfect

On January 19, Patriot fire units were flown into Israel from U.S. forces deployed in Western Europe. Although there was also an announcement from CENTCOM that two Patriots were launched by mistake in Saudi Arabia for undisclosed "technical errors," there was a general sense of relief because, as Sam Donaldson reported from Saudi Arabia, "The Patriot missile in combat is now batting a thousand."[9] Secretary Cheney explained that the United States was now offering Israel the same protection.

There were now some journalistic notes of caution, and more objective expert views were beginnning to emerge. CNN reported that while a Pentagon spokesman claimed that an incoming Scud was intercepted, other military officials disagreed. CNN also televised an interview with former assistant secretary of defense and Raytheon executive Larry Korb, who expressed a more balanced view of the Patriot's capabilities. Though Korb accepted the official position at the time, and believed the Patriots would be able to handle the limited Scud threat, he also went on record explaining some of the vulnerabilities of the Patriot system.

> "This system has to operate almost out of human control...The computer determines whether, in fact, it is a real threat. It is similar to the situation we've had over the years where our strategic command at the North American Air Defense picked up false signals. That's the problem with the system as you have it. It can be easily deceived."[10]

On Sunday, January 20, afternoon television was interrupted by live reports from Saudi Arabia of a second Scud attack. NBC reporter Arthur Kent describing what he witnessed from a Dhahran rooftop:

> "Four Patriots, one minute apart, all in separate directions...One seemed to hug the earth. It took off straight behind us. We saw a loud flash and would assume it had intercepted a missile very close to our position. The other three took off and seemed to get lost in the sky...looking for a target, without finding one."[11]

---

[9] ABC News, January 19, 1991.

[10] CNN, January 19, 1991.

[11] NBC News Special Report, January 20, 1991.

Kent did not know what was actually happening at the time, nor has it ever been accurately explained to the public. The official view was presented by Pentagon spokesman Peter Williams later that afternoon:

> "There were two launches of Iraqi Scud missiles toward Saudi Arabia...Both of the Scud missiles were destroyed, they were both intercepted. Of the five Patriots fired, three of them hit the targets--two of them hit the targets, and one of them may have hit debris. We're not certain about that. It may be that by the time the other two of the remaining five got there, there wasn't anything left to hit...It means that the Patriot is a very effective system. You heard the report earlier in the operation of an incoming target at Dhahran which was shot down by a Patriot. Here's another example. I think it indicates to us that the Patriot is a good system."[12]

Later, Pentagon officials said there were three, not two, Scuds in the Dhahran attack. Iraq launched another Scud attack and on 8:30 Sunday night (it was already early Monday morning in Saudi Arabia), Lt. Col. Mike Gallagher briefed the press:

> "We now believe ten missiles were launched, and U.S. Patriot air defense systems shot down nine of them....In the second attack, about 12:45 a.m. this morning, January 21st, Saudi time, Iraq fired seven Scud missiles--four at Riyadh, two at Dhahran, and one in the waters off Dhahran. Six of the Scuds were shot down by Patriot missiles. The Scud missile landing in the water did not require engagement. We have no reports of damage or injuries."[13]

The Patriot's image as a miracle weapon was now firmly established. Perceptions of all future engagements would be conditioned by what people believed happened in these first encounters. Most of the information about the Patriot launches was not -- and still is not -- available to the public or the press. The official pronouncements of the Patriot's performance at the time claimed 100 percent success. Most importantly, because the Scuds caused so little damage, and because people thought the Patriot's aerial detonations indicated a successful intercept, the press and public thought they saw the proof of Patriot's success with their own eyes. Evidence to the contrary was neglected or dismissed.

Analysis Shows Early Claims in Saudi Arabia Incorrect

The initial inaccuracies in reporting and exagerated claims of success were understandable. As operator reports made clear, the soldiers in the field were tense, on alert for missile attacks and most often in chemical protection garb. The Patriot units were operated by only a few troops in a small metal van called the engagement control station. These soldiers

---

[12] Mr. Pete Williams, Assistant Secretary of Defense for Public Affairs, Pentagon News Briefing, January 20, 1991, (3:15 p.m. EST). Transcript, pp. 1-2.

[13] LTC Mike Gallagher, CENTCOM Briefing, January 20, 1991, (8:35 p.m. EST), Riyadh, Saudi Arabia. Transcript, pp. 1-2.

were to watch and report what they saw on their computer screens. The Patriot computers generated target information that was sometimes preserved on tape or in hard copy. Although this information is useful, it cannot provide irrefutable proof of interception and destruction of a Scud warhead by a Patriot missile. The Patriot computer console was an electronic display showing symbols sent from the Patriot computer. These projected symbols were misleading, but many of the crews could not know that at the time. They sent their impressions up the chain of command, and officers then briefed the press.

Though inaccuracies in the early reports are understandable and excusable, there are few excuses for the perpetuation of the exagerated claims. As the engagements continued, Army officials and Raytheon representatives did not recognize that something was wrong with their claims and correct the record. Indeed, Army officials and Raytheon executives continued to repeat these exaggerated claims after the war was over, despite the emergence of clear evidence that the Patriot had missed.

In February of 1991, Chairman of the Subcommittee on Legislation and National Security, John Conyers, Jr. wrote Secretary of Defense Dick Cheney about the apparent flaws in the Army analysis of this claimed success:

> "The problems with the Army analysis begin with the very first Scud the Army believes it shot down on January 18, 1991. The evidence presented by the Army in support of this claim strongly indicates that a Scud was never launched. Rather, this appears to be a Patriot misfiring at a false target presented by the Patriot's computer. Two similar Patriot misfires were reported by the Army at a press briefing in Riyadh on January 19, 1991. The details of the January 18 incident are still classified, but the computer indicators lasted for only a few seconds and showed a target coming in from a highly unlikely direction. The Army had no corroborating radar, satellite or visual evidence of a Scud launch, other than the uncharacteristic computer indications. Once you examine this data I believe you will agree that it seems more likely that this was a computer glitch than a phantom Scud."[14]

Yet, the Army maintained that the January 18 event was a successful interception and destruction of a Scud warhead. The Army reported in their progress report of December 31, 1991, that "On January 18, 1991 the first Patriot fired in combat successfully intercepted and destroyed an Iraqi Scud missile in Riyadh *(sic)*."

Raytheon executives repeated this claim on numerous occasions. In an article published in the journal International Security, Summer 1992, a Raytheon official was quoted:

> “On January 18, within 24 hours of the coalition's initial air strikes, Iraqi-modified Scud tactical ballistic missiles (TBMs) were launched into civilian areas in Saudi Arabia, where force of the United States Army had been deployed with their Patriot Air Defense

[14] Letter from Chairman John Conyers, Jr. to Secretary of Defense Dick Cheney, February 28, 1991.

Systems since the previous August. On that night, Patriot achieved the first-ever wartime engagement of a ballistic missile in history, and it was successful."[15]

The claims made by the Army and Raytheon about the January 18th incident, demonstrated several important flaws in the Army assessment that reappeared in their analysis of subsequent alleged Patriot intercepts. This raised serious doubts about the reliability of the evidence presented in support of claims of warhead kills. The Army will no longer publicly discuss the January 18th claimed interception.

Early Claims in Israel Also Incorrect

On January 22, officials announced that Patriot missiles had intercepted the first Scud missile launched against Israel since the Patriot had been deployed. They were wrong.

High-ranking Israeli military officers had gathered in the underground command center of the Israeli Air Force on January 22 as air raid sirens warned of a Scud attack. An Israeli journal described what happened next:

> "Until that night, the 22nd of January, Israel had already absorbed eleven missiles. The terror generated from possible chemical attack was still in the air, and feelings were low and the sense of frustration was high. The Patriot battery in the north of Tel Aviv was now going to be the final answer to the Scud missiles. On the screen in the shelter in the command center, a hit was announced, and some of the staff began to look for a bottle of champagne...
>
> "A few minutes after that, preliminary information began to arrive on the falling of the Scud on Aba Hillel street, in Ramat-Gan, and as the hours passed there were streams of disquieting reports from the field. At the end of the war it would be concluded that this particular Scud was the most lethal of all. One dead woman, ninety-seven wounded, a ruined apartment building, heavy damage in twenty nearby building, and blast damage for a radius of 300 meters..."[16]

Scuds Proved a Difficult and Complex Target

The exaggerated claims made during the early days of the war were caused, in part, by the unexpected behavior of the Iraqi Scud missiles as they reentered the atmosphere. The Scud was designed to fly about 300 kilometers. To increase the range, Iraqi engineers lengthened the missile and lightened the warhead. This increased the range to about 600 kilometers, but it had the unintended effect of destabilizing the missile in flight. The launch carried the Scuds out of the atmosphere into a brief flight in space. They peaked at about 100 kilometers altitude and

---

[15] Robert M. Stein, supra note 21, at p. 199.

[16] Arriella Ringel-Hoffman, "Not to Be Trusted," Yediot Achronot, January 10, 1992.

then fell back towards earth. As they reentered the atmosphere, the Scuds were often too light to point the nose of the Scud downward as intended. Instead, the missiles hit the air flat, like a paper airplane without a paper clip to keep it aerodynamic. The resulting stress tore the missiles apart. They would disintegrate, sometimes in great fiery tumbles, sometimes streaking like comets with its busted fragments trailing behind.

The Patriot computer misinterpreted this break-up. It depicted on its screen not one but two, three or a dozen Scuds streaking in towards the Patriot fire unit. As Raytheon executive Robert Stein explains:

> "Upon reentry, the resulting forces caused the missile to break apart into several pieces. These extra pieces looked to the Patriot software like targets that were diving at high speed and were going to impact in the areas that the defense design was laid out to defend. In effect, they became 'decoys' that were indistinguishable from TBMs to the Patriot radar, since no discriminations features had been implemented in anticipation of these types of targets.
>
> "The anomalous behavior that the operators were seeing was created by the aerodynamic instability of the warhead section after the missile started to break up. It was spiraling, rather than travelling on an expected ballistic trajectory, because of changes in its center of gravity and center of aerodynamic pressure after breakup. In addition, its radar reflectivity had dropped significantly because of its smaller size. In effect, what Iraqi engineers had created, purely unintentionally and by poor workmanship and design, was a high-speed, low radar-cross-section, maneuvering reentry vehicle (RV), accompanied by decoys...its accuracy was very poor..."[17]

Eventually Israeli and U.S. analysts recognized this problem and efforts to correct the software were rushed into the field in early February. In the first week of Scud attacks, however, this phenomenon contributed to confusion and exaggerated claims of success from Patriot operators. Coupled with poor or no efforts to assess ground damage in Saudi Arabia, it led them to believe erroneously that they were phenomenally successful in shooting down Scuds. The Army now believes that almost half of the 158 Patriots that were launched during the war were fired at false targets and debris (15 percent at false targets, 30 percent at Scud debris).[18]

Going back over the engagements, the analysts from the Army and Raytheon now believe they can distinguish the real Scud warheads from the debris in most instances. In these cases, they often claim that a Patriot hit the Scud, causing the debris to appear, or that while some Patriots did hit debris, others hit the warhead. These claims rest on two principle sources of data: ground damage reports and tracking data. Neither are reliable evidence, as described below.

---

[17] Robert M. Stein, supra note 37, at p. 212.

[18] Department of the Army Press Release, "Patriot Missile System Effectiveness During Desert Storm," April 7, 1992.

Unreliability of Ground Damage Reports

Journalists would occasionally raise questions about the damage they saw but which did not show up in official briefings. For example, on January 20, 1991, in Riyadh, Saudi Arabia, at the CENTCOM Briefing, Lt. Colonel Mike Gallagher responded to questions:

> "Q: Are there any reports of errant Patriot missiles landing in the city here?
> A: No, we've not received any such reports, and we've not received any kind of damage reports either.
> Q: A number of us saw what appeared to be a missile landing in the southeastern horizon, as viewed from the hotel, landing with a flash on the horizon. I know you may not want to speculate, but would you guess that this could have been either an errant Patriot, or that it could have been a Scud?
> A: You're talking about the four in the Riyadh area?
> Q: I'm sorry, yes.
> A: I can't say what that might have been. But again, just to repeat on those, the ones in the Riyadh area, all four were engaged and destroyed.
> Q: Some of us have just seen a crater that looks like it was from a missile or something landing.
> A: The question was whether there was a crater. Right now U.S. CENTCOM has not received any such information."

The Army was also aware that their ground damage reports were not perfectly reliable. All reported ground damage for a given day was collected and recorded by the Army's Missile and Space Intelligence Center (MISIC). However, GAO reports:

> "Intelligence Center officials informed us that they had little confidence that the reports they had collected contained descriptions of all ground damage that had occurred or that all damage had been accurately portrayed...the reports...did not provide conclusive proof that Scud or Patriot damage did or did not occur. They added that one of the agencies that generated ground damage reports from interviews recommended caution in using these messages, stating that they provided preliminary, often unverified, and sometimes contradictory information. The agency also said some messages included what are now know to be erroneous or misleading statements."[19]

A Memorandum from the intelligence officials specifically warned Patriot Program officials about using the ground damage reports:

> "We recommend caution using these extracted statements in Congressional testimony. The messages provided preliminary, often unverified, and apparently contradictory information. Some extracts present what is now known to be erroneous or misleading statements."[20]

---

[19] General Accounting Office Report, supra note 1, at p. 8.

[20] Memorandum from USCINCENT MacDill Air Force Base, Florida to Joint Staff Washington, D.C., March 1, 1992.

The Army assessment given to the Subcommittee and the Army testimony before the Subcommittee on April 7, 1992 did not contain this cautiounary statement.

The Army report also cites "investigative teams" as sources of ground damage reports. The GAO found that these "teams" were individuals who did not investigate all engagements, nor prepare written reports at the time of the events. "Rather, they prepared their reports from memory at the request of the Patriot Project Office months after the actual events occurred."[21]

Unreliability of Tracking Data

The Patriot computers generated target information that was sometimes preserved on tape or on paper. The Army relied on this data to show when the Patriot system detected a target, if the system engaged the target by launching a missile, and whether the system reported that it had probably killed or failed to engage the target. If the predicted impact point was in a populated area, and the Army then had no damage reports, the evaluators assess this as "high confidence" evidence that the Patriot must have destroyed the Scud warhead. It reported a "probable kill" if the missile traveled to a point in space that the system computed to be the the intercept point and then failed to communicate with the ground.

However, these projections assumed a smooth ballistic trajectory. As Mr. Stein notes, however, the spontaneous disintegration of the Scuds also meant that Scuds often did not follow smooth, predictable flight paths. They would often violently change speed and direction as they descended. This raises serious questions about the accuracy of the predicted impact points. If the predicted impact point was projected based on minimum data, as was sometimes the case, it could produce an inaccurate prediction of impact. In other words, two readings taken from one part of a spiral could produce a straight line to a predicted impact point, when, in fact, the Scud could have spiraled away into a less populated area, the desert or the sea, thus reducing the likelihood that any damage would be reported.

In addition, the "probable kill" data can not determine lethality. It cannot determine how far away from the target the Patriot was when it detonated, whether the Patriot fragments had a reasonable chance of penetrating the target's warhead, whether the fragments hit any target, or even whether the target was a Scud warhead.

Most importantly, GAO found that the "probable kill" indicator was not reliable evidence of a warhead kill:

> "To have a high probability of destroying a Scud warhead, the Patriot missile must detonate when it is **within a few meters of the Scud**...The Chief Engineer said that Patriots fuze can sense its target and detonate at **up to six times the required miss distance, resulting in an extremely low or no probability of kill. However, the system would still record a kill."**[22] (emphasis added)

---

[21] General Accounting Office Report, supra note 1, at p. 8.

[22] General Accounting Office Report, supra note 1, at pp. 6-7.

Further, GAO reports that because of the unusual reentry anomalies exhibited by the Scuds, the Patriot might not have been able to get within the few meters needed to have a high probability of destroying the Scud. Even then, the Patriot's fuze "could have detonated, and the system would have recorded it as a probable kill."[23] The data also "does not reveal if the Patriot's fuze reacted quickly enough to destroy the Scud" as they flew by.[24]

Data Does not Support High Confidence that Patriot Killed Scud Warheads

Despite the severe limitation of both the tracking data and the ground damage reports, the Patriot Program Manager relied extensively on this data to support the assessment of warhead kills. Of the high confidence shots, 70 percent have a "probable kill" indicator, 90 percent have high confidence ground damage assessments, but only 18 percent have both.

The GAO found that only 9 percent of the warhead kills claimed by the Army were supported by the strongest evidence that an engagement resulted in a warhead kill:

> "The strongest evidence that a warhead kill occurred would be provided by (1) a disabled Scud with Patriot fragments or fragment holes in its guidance and fuzing section or (2) radar data showing evidence of Scud debris in the air following a Patriot detonation."[25]

Serious questions may be raised about even these few claims. The Army did not have evidence of any scientific analysis performed on a Scud warhead to determine whether, in fact the marks found on the Scud warheads were caused by Patriot fragments or by ground impact or by detonation. These assertions are based in each case on the opinion of a single individual, sometimes recorded months after the event. In one case, they are based on the opinion of a Patriot Program Office official who told GAO he had seen a classified photo of a warhead, and in his opinion, the damage could only have been caused by a Patriot. He refused to show the photo to the GAO on the grounds that it was highly classified, a claim that later proved to be incorrect.

Moreover, some Scuds that were not engaged by Patriots exhibited characteristics identical to those cited as evidence of Patriot interceptions. The Scuds flew in at high speeds, broke up into debris, and upon impact the warheads were found to be duds or only partially burned. In cases where Patriots had attempted to intercept such a Scud, this behavior would be cited as crucial evidence in scoring the engagement as a successful kill.

GAO notes that there is less evidence for the other 16 percent of the engagements that the Army classified as high confidence warhead kills. In these cases:

---

[23] General Accounting Office Report, supra note 1, at p. 7.

[24] General Accounting Office Report, supra note 1, at p. 7.

[25] General Accounting Office Report, supra note 1, at p. 4.

"The computer data proves that the Patriot missile came close to the Scuds, but it does not prove or disprove whether the Patriots came with the few meter necessary to have a high probability of killing the Scuds. Neither does the Army know whether the Patriots' fuzes armed and detonated before the targets passed the intercept points."

"In addition, no evidence exists to clarify what happened to the Scuds after the intercept occurred. Radar tracking data does not indicate debris in the air, and since the ground damage reports for these events did not result from a systematic search for ground damage, they do not provide a high level of confidence that all ground damage was reported or that reported damage was accurate."[26]

It is possible that Patriot missiles did kill more than a few Scud warheads, but it is difficult to have much confidence in that possibility.

Army Summary of Patriot Missiles Launched And Scuds Intercepted

The Army evaluation of the Patriot's performance was performed by a small team consisting of nine officials from the Patriot Program Office and related Army offices and others from the Raytheon Company. In addition, as of the April Subcommittee hearing, the Army had paid Raytheon $520,000 to provide additional analysis of Patriot performance in the war. On average, between three and nine Raytheon personnel supported the Army in the post-war performance analysis and approximately 12 Raytheon personnel provided support to the Army in Saudi Arabia and Israel in analyzing Patriot performance and operations.[27]

The Army now reports that during Desert Storm, 88 Scuds were launched by Iraq. The first 12 were launched at Israel prior to the deployment of Patriot units in that country. Of the remaining 76 Scuds, somewhat less than 47 were actually engaged by Patriots.

A total of 158 Patriot missiles were fired during the war:

- 86 Patriots were launched at Scud targets in Saudi Arabia and Israel;
- 30% of the Patriots were launched at Scud debris mistaken for targets;
- 15% of the Patriots were launched against false targets caused by radar backlobe and sidelobe interference (including one launched by accident in Turkey.)[28]

---

[26] General Accounting Office Report, supra note 1, at p. 11.

[27] Major General Jay M. Garner, Assistant Deputy Chief of Staff for Force Development, United States Army, Letter to U.S. Representative John Conyers, Jr., dated September 23, 1991, pp. 12-13.

[28] Deputy Chief of Staff for Operations and Plans, Department of the Army, "Patriot Performance Assessment in Desert Storm Roadmap," 15 July 1992, pp. 1-2 and p. D-2. (These are unclassified sections of this Secret report.) And, Department of the Army Press Release, "Patriot Missile System Effectiveness During Desert Storm," April 7, 1992.

The number of Patriots that exploded prematurely or exploded on the ground is still classified.

The Army now believes, with varying degrees of confidence, that the Patriot Missile System destroyed 52 percent of the Scuds it attempted to intercept in Israel and Saudi Arabia during the Persian Gulf War. The Army is highly confident that about 25 percent of the engagements resulted in warhead kills.[29]

Conclusions of the Subcomittee Invsetigation on the Patriot's Performance

Independent review of the Army's reveals that, using the Army's own methodology, a strong case can be made that Patriots hit only 9 percent of the Scud warheads engaged, and there are serious questions about these few hits.[30] It is possible that the Patriots hit more than 9 percent, but the evidence showing additional intercepts is much weaker. The speed of the Scuds, the limitations of the Patriot missile system, and the confusion and targeting difficulties caused by the break-up of the Scud missile as it re-entered the atmosphere seem to have contributed to the high failure rate.

The Patriot is not designed to explode upon impact with its target, thus, the explosions in the sky were a misleading indicator of success for both troops and the public. Nor can the system determine if the Patriot missile actually hit its intended target. It can only determine that it detonated near a point in space where it calculated the target should be, sending back a "probable kill" indicator or a miss. However, these indicators are inaccurate. Many of the targets turned out to be debris from the poorly designed Scuds as they broke up in flight. At least 45 percent of the 158 Patriots launched in the war were launched against debris or false targets.[31]

Even for those warheads correctly targeted, the Patriot must detonate when it is within a few meters of the Scud to have a high probability of destroying the warhead, according to the Army. However, the Patriot's fuze could detonate at up to six times the required miss distance, resulting in an extremely low or no probability of kill, yet the computer would still record the engagement as a probable kill, according to the Army.[32]

In addition to the probable kill indicator and other tracking data, the Army assessment relies heavily on reports of ground damage. In every case were a warhead kill is claimed, the

---

[29] General Accounting Office Report, supra note 1, p. 3.

[30] General Accounting Office Report: "Operation Desert Storm: Data Does Not Exist to Conclusively Say How Well Patriot Performed," September 1992, (NSIAD 92-340), p. 4.

[31] Fifteen percent of the Patriots were fired at false targets created by electromagnetic interference and thirty percent of the Patriots were fired at debris from the break-up of the Scuds as they reentered the atmosphere.

[32] GAO Report, supra note 1, at p. 7.

absence of ground damage is cited as evidence of Patriot success. However, intelligence officials that collected many of these reports from military personnel in the war say that they are unverified, contradictory, erroneous and misleading. Many of the Scuds claimed as warhead kills landed in the desert, the sea or sparsely populated areas.

Finally, some Scuds that were not engaged by Patriots exhibited characteristics identical to those cited as evidence of Patriot interceptions. The Scuds flew in at high speeds, broke up into debris, and upon impact the warheads were found to be duds or only partially burned. In cases where Patriots had attempted to intercept such a Scud, this behavior would be cited as crucial evidence in scoring the engagement as a successful kill.

Lessons and Consequences

Following the investigation, the Subcommittee recommended that the Secretary of Defense launch an independent evaluation of the performances of the Patriot system to assess its accuracy and reliability. Indeed, it is crucial that all weapons systems are reviewed by independent organizations. It is unreasonable to expect that those who have a vested interest in the success of a program can give an objective evaluation of that program. In addition, objective reviews should be facilitated by declassifying Army analysis and evaluations. Appropriate exceptions should be made to protect information vital to national security, but this should not be used as an excuse for not disclosing potentially embarrassing information. Finally, future theater ballistic missile systems should be tested under realistic condition against the threats they are likely to encounter in combat. The Patrio was never tested against the type of threat it encountered in the Gulf War. Questions remain about the realism and validity of current test programs for upgrades to the Patriot and other missile defenses.

Because the Army's evaluation of the Patriot was based on flawed evidence, it is likely that subsequent, pivotal decisions made by the Administration and Congress on the Patriot program and the future course for theater ballistic missile defense, were based on false impressions of existing capabilities. Overly optimistic assessments of our missile defense capabilities can lead to overconfidence in unreliable systems, and will unnecessarily endanger soldiers' lives and cause damage to military and civilian assets the system is supposed to defend. Imagine if a national missile defense system was deployed based on faulty or doctored feasibility data. This could induce the United States to undertake riskier adventures than it otherwise would, increasing the risk of a nuclear attack. If a nuclear ICBM attack occurred, there would be no opportunity to learn on the job. Failure to intercept this missile would result in a tragedy of epic proportions.

Appendix 1: History of the Patriot Missile

Developmental History of Patriot Missile

The Patriot Missile System is a surface-to-air guided missile system that was intended to provide air defense against aircraft for high value, rear area targets. Modifications to the system in the late-1980s were designed to give the system some limited capability to intercept short-range ballistic missiles. The combat elements of a Patriot fire unit are a radar, an engagement

control station, a power plant, an antenna mast and up to eight launchers. Each launcher has four missiles, sealed in canisters.

The Patriot program grew from a $17 million research effort in 1965 when the United States Army awarded the Raytheon Company a contract to develop a new missile known as the "Surface-to-Air Missile" or SAM-D. The program took an exceptionally long time to transition from concept development to deployment and was plagued with a series of technical problems. Secretary of Defense James Schlesinger halted the program in 1974 but it was restarted in August 1976 with a new name -- Patriot. Quality problems and rising costs continued to bedevil the program. In 1980 Defense Secretary Harold Brown declined to allow Patriot to enter full-scale production but did authorize limited, low-rate production. This decision was a tremendous disappointment for Raytheon executives. Raytheon's Patriot program manager saw no reason why the hardware could not be built at the same time the company tried to solve the system's problems.[33]

In June 1983, 18 years after research had begun, the first true operational test of the Patriot revealed serious problems. A Harvard University study of the program described the difficulties:

> "The equipment was not operational or 'available,' anywhere near enough of the time to perform the test adequately. The equipment was down so much, in fact, that it was hard to determine what the problems were. General James Maloney of the Army's Air Defense School summed it up this way to Congress: 'When you turned on the set, it didn't always work, or when it broke, we couldn't figure out what was wrong with it and get it back on the air quickly.'
>
> "The immediate problem was in the hardware itself, There were hundreds and hundreds of coaxial cables in Patriot, and many of them were performing quite poorly, causing disturbances as the signals passed through them. In addition, as the units were stressed during march order emplacements and temperature changes, cable performance was degraded even more."[34]

There were also problems with the power generators the Army was providing for the system, diagnostic procedures for detecting and fixing equipment failures, and disputes over how to measure "mean time between failures." The Army testers said that to measure the average time before a fault occurred they needed to count the time the system was actually operating. Raytheon insisted that only about 40 percent of operating time should be counted.

---

[33] Hans Fenstermacher, The Patriot Crisis, National Security Program, John F. Kennedy School of Government, Harvard University, 1990, p. 3.

[34] Id., at pp. 4-5.

By October 1984, the Army determined that the Raytheon Company had corrected many of these problems and had passed all applicable tests. The Army declared the Patriot fully operational and deployed the first two Patriot battalions in Europe in 1985.

In September 1986, a Patriot with modified software demonstrated in tests the ability to target a tactical ballistic missile for the first time. Official statements released at the time described the test as an intercept of a tactical ballistic missile. "Intercept" was not explained in the public statements at the time. In this case it meant that a Patriot had detonated in the air near its target and sent fragments into the body of the target, an Army Lance missile. The warhead was not hit in this test.

The target was a short-range missile with a range of less than 100 kilometers. It was traveling at 520 meters per second (or 1700 feet per second) at the time of intercept.[35] This was the approximate speed of short-range Soviet missiles deployed in Europe, such as the SS-21. This capability, called PAC-1 for Patriot Advanced Capability 1, was then built into all Patriot systems.

By 1992, the Patriot program had a total cost of almost $13 billion, and Patriot units were deployed in the United States, Europe and Southwest Asia. Foreign Military Sales of Patriot units through December 31, 1991 to Germany, Saudi Arabia, The Netherlands, Japan, and Israel totaled $2.75 billion.

Deployment of Patriot Units to the Gulf

At the time Iraqi forces invaded Kuwait in early August 1990, the Patriot had no capability to engage the extended-range version of the Scud missile -- referred to as the Al-Hussein. The extended range enabled the Scud to travel at speeds much higher than the Soviet missiles against which Patriot had been designed to defend. The Al-Hussein flies at speeds of between 6,500 and 7,200 feet per second.

However, the Army was testing a second improvement program (PAC-2) which provided a new fuze and warhead for the Patriot. The PAC-2 fuze is faster and designed to let the Patriot detonate in front of an incoming missile where the warhead is located. The PAC-2 warhead produces larger fragments to attempt to disable tactical missiles. During 1989, the Army had conducted 32 flight tests of the Patriot, but only one was against a tactical missile target -- another Patriot. The rest were against air-breathing threats.[36] In 1991, a limited number of tests were said to be successful against missile targets.

Since this improved software and warhead design were believed to give the Patriot a greater chance to hit these modified Scuds and no other tactical missile defense existed, Patriot

---

[35] Department of Defense Public Affairs Announcement, "Patriot Missile Intercepts Tactical Ballistic Missile," September 11, 1986, p. 2.

[36] Department of Defense, "Patriot Selected Acquisition Report," December 31, 1991, p. 3. This is an unclassified portion of a Secret report.

missiles with PAC-2 modifications were rushed into production and shipped to the Gulf. These missiles were in place when the war began on January 16, 1991.

Still, Raytheon officials said the Al-Hussein Scuds were 40 percent faster than the targets Patriots were designed to hit:

> "Since the Soviet threat was the focus of these modifications, all design and test activity centered around the Soviet Scud, SS-21, and FROG TBMS. No design or testing had been performed against the longer-range modified Scuds that were employed by Iraq in the Gulf War."[37]

Army officials told the Subcommittee that these Scuds traveled "over 2,000 miles per hour faster" than the missile the Patriot was designed to counter. As a result, General Jay Garner said, "We have an incoming Scud variant traveling at over 5,000 miles per hour. Fired up to meet it is a Patriot interceptor at over 3,000 miles per hour. We have a closing velocity somewhere around 9,000 miles an hour."[38]

Twenty-one Patriot fire units were deployed in Saudi Arabia and seven in Israel. The Patriot is designed to provide "point defense," that is, to defend as General Garner testified, "a well defined, rather small area on the ground near the Patriot battery."[39] These defended areas are a very small percentage of the thousands of square miles that were targeted by the 88 Scud missiles launched by Iraq during the war. Army officials assert that no Scud missile impacted on the small areas defended by the Patriot missile, except for the Scud that exploded in the Dharhan barracks on February 25, 1991.

---

[37] Robert M. Stein, ""Correspondence: Patriot Experience in the Gulf War," International Security, Summer 1992, p. 200.

[38] See testimony of Major General Jay M. Garner, supra note 15.

[39] Id.