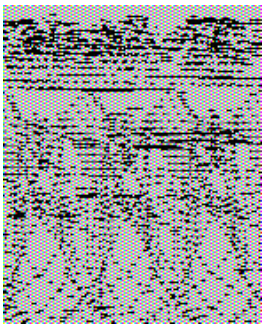

Third World Traps and Pitfalls

Ballistic Missiles, Cruise Missiles, and Land-Based Airpower

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Abstract

Two examples from twentieth-century conflicts demonstrate the potential that missiles possess to disrupt an opponent's land-based airpower and achieve significant political consequences. Iraq's use of Scud ballistic missiles in the 1991 Persian Gulf War produced nearly instantaneous political effects. The Scuds did not threaten the coalition military forces opposing Saddam Hussein, but instead threatened the existence of the coalition itself by nearly bringing Israel into the war. Negating this threat demanded an urgent response from land-based airpower, and large numbers of coalition aircraft were forced to perform a new mission: Scud Hunting. Almost 50 years before Desert Storm, the Allies in World War II had faced a similar threat from the V-1 and V-2. Thousands of sorties were diverted to bomb missiles that were chiefly fired at London and Antwerp. In both conflicts, coalition and Allied forces possessed enough airpower that the diversion did not prevent them from performing other necessary missions. Yet, in the future, as the United States Air Force (USAF) dwindles in numbers, the ability of land-based airpower to deal with the missile threat becomes problematic. In addition, the improved capabilities of ballistic and cruise missiles threaten airpower's ability to achieve the staple of modern combat operations—air superiority. The increased range and refined accuracy of missiles offers third world nations a chance to develop airpower on the cheap, and the missile forces created may well stymie America's ability to apply "conventional" airpower in a crisis. Because of the lack of success in thwarting the missile threat in the past, combined with the projected capability of future missiles and the continued "downsizing" of the Air Force, American leaders must carefully consider whether they possess the wherewithal to commit airpower on a truly global scale.

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Chapter 1

Hybris

[W]ar is nothing but the continuation of policy with other means.

—Carl von Clausewitz

Today's ballistic missile, with its ability to cause rapid, large-scale destruction, epitomizes this notion of Clausewitz. Even in its "tactical" mode, carrying a conventional warhead, the ballistic missile can produce near-instantaneous political effects, as illustrated in the 1991 Persian Gulf War. The Iraqi Scud attacks on Israel presented no direct threat to the coalition military forces, yet drew an intense air response—an air response intended to placate Israel as much as to destroy Scuds. Political and military objectives meshed on the battlefield. To keep Israel from retaliating against Iraq and disrupting the coalition against Saddam Hussein, the coalition air forces flew numerous sorties to destroy Scuds. Preserving the coalition by keeping Israel out of the war was a political objective accomplished by military forces—specifically land-based air forces. The "Scud Hunt" also had an impact on the coalition war effort, because it siphoned off airpower for these unplanned and unforeseen duties. The political significance of the Scuds elicited a response that had an operational impact on coalition forces by diverting essential resources and aircraft to look for mobile missile launchers whose political effects were disproportionate to their destructive power. All this consternation was caused by a missile with a 330-mile-maximum range and a meager degree of accuracy, possessing a circular error of probability (CEP) of over three nautical miles.[1]

The limited accuracy of Scud missiles is a transient problem for third world countries that possess them. Technological advances since the Persian Gulf War have remarkably reduced the Scud's CEP. Correspondingly, the theoretical and tested accuracies of tactical ballistic missiles (TBM) in general have increased. The changes in technology that so dramatically improve TBM accuracy have come in many forms, several of them being cheap, economical upgrade packages. Of more concern, several third world countries are supplementing or even supplanting their TBMs with modern cruise missiles.

The most widely known and most accurate cruise missiles in use today are the US Tomahawk and AGM-86C air-launched cruise missiles (ALCM). Both of these weapons were used against targets in Iraq with astonishing results televised to the whole world on Cable News Network (CNN). As

capable as these two missiles are, they are by no means the only such missiles in existence. Several countries, including France, Russia, and Brazil, manufacture, market, and sell cruise missiles of various types. The most common cruise missile on the international market has been the antiship missile, launchable from ship, shore, or aircraft. The French AM-39 Exocet is undoubtedly the most well-known example of the antiship missiles, sinking two British ships and seriously damaging a third during the Falklands War in 1982, and seriously damaging the USS Stark in 1987.[2] At least 123 countries have the Exocet in their inventories.[3] The French have recently perfected a cheap modification package that makes it a very accurate ship, shore, or air-launched land-attack cruise missile. Had Iraq possessed this modification before Desert Storm, its ability to challenge coalition airpower would have been substantially increased.

The Allies in World War II faced such an enemy armed with both ballistic missile and cruise missile capabilities. One week after the Allies landed at Normandy to open the second front, the Germans launched the first V-1 from France at London. Three months later, they added the V-2 rocket to the bombardment effort. Clausewitz was certainly not lost on the Nazis. The Germans sought both political and operational gains from the missile attacks on England. To blunt those designs, the Allies redirected a notable portion of their tactical and strategic airpower to find and destroy mobile cruise missile (V-1) and TBM (V-2) launchers and sites. This diversion of fighters and bombers detracted from the attacks on transportation and oil as well as from the direct support of the Allied ground forces.

The combination of modern TBMs and cruise missiles presents land-based airpower with a serious dilemma. First, as will be shown by examining missile operations in World War II and Desert Storm, TBMs and cruise missiles both require the defending air force to expend considerable energy finding and destroying them. Second, an analysis of current and projected missile developments will show that improved TBM and cruise missile accuracy compels land-based airpower to deal with a direct threat to its bases and logistics. How the US responds to these challenges will directly affect its ability to obtain and keep air superiority. In short, this report finds that the increasing capabilities of these weapons permit third world nations to reduce the effectiveness of American land-based airpower in three key ways: first, by siphoning off sorties to hunt them down; second, by forcing aircraft to defend against inbound missiles; and third, by making airfields vulnerable. All of these uses portend a loss in the capacity to secure control of the air.

Tactical ballistic missiles and cruise missiles have proven both politically and operationally significant in the past. Technological advances will make them devastating weapons in the future. The air force that ignores them does so at its own peril.

Notes

1. CEP is defined in this paper as the distance from the aim point or intended target in which at least half of the weapons fall. This definition does not address impact patterns either inside or outside this imaginary circle.

2. The USS *Stark* was fortunate not to have been sunk. Two Exocets fired by an Iraqi F-1E hit the ship, but one of them failed to explode. A detailed account of the damage can be found in *The Lessons of Modern War, Volume II: The Iran Iraq War,* eds. Anthony H. Cordesman and Abraham R. Wagner (Boulder, Colo.: Westview Press, 1990), 289, 553.

3. David A. Fulghum, "Mideast Nations Seek to Counter Air Power," *Aviation Week & Space Technology* 138, no. 23 (7 June 1993): 79.

Chapter 2

Anagnorisis I

Operation Crossbow 1943–1945

In their present form they are a toy, but their development will profoundly affect both war and peace.

—RAF Air Chief Marshal Arthur Tedder

The western front in World War II furnished the first example of a dominant airpower facing an opponent armed with ballistic and cruise missiles. The V-1 flying bomb—an early cruise missile—and the V-2 ballistic missile were recognized as potential threats to England well before the Nazis fielded them and launched them in combat. "Crossbow" sites, the Allies' designation for the V-weapons targets, were bombed as early as the spring of 1943. The Allies continued bombing them right up until D day, but halted the effort prematurely, as one week after Overlord began the Germans launched the first of thousands of V-1s at England. The attack shocked the Allied leaders, who earnestly began attacking Crossbow targets once more. The successful invasion of France eliminated England as a possible V-1 target when the Germans retreated out of cruise missile range. The Allies again halted Operation Crossbow as the threat faded. The Germans then surprised them a second time by attacking London with V-2s, and the Allied Crossbow bombing started anew. Detecting the V-weapons and assessing their impact proved difficult for the Allies, who devoted considerable attention to stopping the raids. From the German perspective, the missiles offered the chance to achieve military and political objectives that conventional forces had been incapable of accomplishing.

Detection and Assessment

British intelligence first detected and confirmed the V-weapon threat through a combination of human intelligence sources and photoreconnaissance. In a September 1939 radio broadcast, Adolf Hitler himself alerted the British to the German "long-range weapon program" that would use "secret weapons" to bombard England from the Continent. The British responded quickly with a flurry of intelligence activity.[1] Gradually, they received intelligence information from the underground networks in the occupied countries about German long-range guns, pilotless airplanes, and

rockets. The Allies soon concluded that the Germans in fact did have a long-range weapons program—but where?

Before the Nazis occupied Norway, the British obtained information from an anonymous German scientist who claimed the Germans were working on secret long-range weapons at Peenemünde.[2] Suspecting that the information was deliberately misleading, the British failed *for two years* to investigate Peenemünde until autumn 1942.[3] Then, new reports from underground sources, dubbed "Pingpong," identified Peenemünde as the primary research facility for German long-range weapons. Captured German generals Wilhelm von Thoma and Ludwig Cruewell inadvertently disclosed the existence of a rocket program in the fall of 1942 when General von Thoma told General Cruewell he was surprised London was not already in ruins by the V-2.[4] The Allies finally verified these reports with photoreconnaissance in early 1943 when they discovered unusual objects that appeared to be missiles at Peenemünde. By then they had lost valuable time. The Allies used the Pingpong reports to focus their reconnaissance efforts on Crossbow facilities they might otherwise have missed. The reports identified the "large sites" under construction in France at Watten, Siracourt, Mimoyecques, and Wizernes in the summer of 1943. These sites were puzzles until the agents described internal structures that would store and assemble rockets and small airplanes.

The large launch sites were designed to be bombproof; the Germans designed them to launch V-1s and V-2s continuously despite Allied air superiority in the West. Several of the sites could launch both V-1s and V-2s simultaneously at a rate of two each per hour. Supply sites for the V-1s were located in caves at Nucourt, St. Leu d' Esserent, and Rheims, and all were bombed before they were completed.[5] However, Nucourt continued to store V-1 components, launcher rail parts, and service and field assembly equipment.

The Germans began constructing what became known as V-1 "ski sites" (due to the resemblance of their sloping launching rails to Olympic ski jump ramps) in France in September 1943. The Allies detected them in November and quickly determined their purpose by comparing them with a similar structure in a photograph of Peenemünde. The orientation of the ski-site launching rails alarmed the Allies as almost all pointed at one target—London.[6] The location of the sites indicated the approximate range as well, as all of them were within 150 miles of London.[7] V-1 accuracy was unknown, but assessed to be good enough to have the V-1s fall in London ("a target eighteen miles wide by over twenty miles deep"), the obvious target, and to "produce unpleasant concentrated effects."[8] Intelligence estimated the Germans could launch a full attack in February or a partial attack in January 1944.[9] The Allies started bombing them in December 1943.

A month later, Allied intelligence had identified 96 ski sites. These "fixed" sites consisted of permanent structures and were relatively easy for aircraft to see and bomb. However, the first "modified sites" were discovered in April 1944. Most of their components were prefabricated for simplicity, ease of

construction, and concealment. Sixty such sites had been identified by 12 June 1944, when the first V-1 attack occurred.[10] The Allies had ignored the modified sites and deemed them decoys, or less capable sites, until the first V-1 hit London. They were believed to be decoys because of the apparent comparative lack of effort to construct them. The Germans, Allied intelligence concluded, would not commit so much effort to construct the fixed ski sites if the less numerous modified sites were more capable and required fewer resources and less time to construct, and were easier to conceal.

As well as identifying the launch sites, Allied intelligence also pinpointed production facilities and assembly plants in Germany. Mittelwerke, Volkswagenwerke, BrunsWerke, and Fallersleben in central and northern Germany were the four principal V-1 production facilities. Nordhausen was the primary V-2 assembly plant. All of them except Fallersleben were bombproof. The Allies also knew of several other subassembly plants such as Friedrichshafen and Wiener-Neustadt. Multiple bombproof plants assured a steady supply of missiles for the Germans. Based on their knowledge of these facilities, the Allies accurately estimated the actual production rates to within 10 to 20 percent. They thought that the Germans, if unimpeded, could produce 3,000 V-1s and 1,000 V-2s per month starting in October 1944 to support a launch rate of 100 V-1s and 30 V-2s per day. One estimate concluded the 96 ski sites could launch 1,000 V-1s in a single day.[11] While the accuracy of the V-weapons was uncertain, the Allies simply assumed they could hit at least a small city or the Overlord invasion area.

In late 1943, the presence of specially trained V-1 and V-2 regiments and support organizations near the launch sites in France and similar V-2 units in Holland greatly concerned the Allied Supreme Headquarters. The Allies knew of some technical problems delaying the V-2, but became extremely concerned when they received reports of logistical equipment and missiles moving forward. The Germans were obviously about to use the V-1, but the crucial question remained—*How* would they use it?

Determining German Intentions and Capabilities

As the Allies theorized about German intentions and V-weapon capabilities, there was one major disagreement over the purpose of the V-weapons. A key concern was whether the V-weapons were really weapons or elaborate decoys to absorb Allied sorties just before D day. This fear was especially true regarding the V-2, since there was a handful of scientists who doubted that the Germans could overcome all of the technical challenges to produce a rocket. The final consensus was that they posed a real threat, though a few detractors held on until the first V-1 hit London.

The Allies needed to determine the German intentions as well as the weapons' capabilities. They considered the weapons' "V" designation as indicative of their purpose: the original "V" for *Versuchmuster*, or experi-

mental type, was changed by German propaganda into "V" for *Vergeltungswaffe*, or vengeance weapons.[12] More than just vengeance, the Allied Supreme Command feared the Germans could achieve three major effects with the V-1 and V-2: (1) delay the Allied invasion of the Continent and disrupt it when it took place; (2) halt the Combined Bomber Offensive against Germany; and (3) produce a stalemate leading to a negotiated truce or permanent settlement.[13]

The rationale for the Allied fears was the possibility that long-range V-weapons could devastate London with biological, chemical, or some new "revolutionary" explosives.[14] The casualties and damage would compel the Allies to halt the Combined Bomber Offensive in exchange for the Nazis stopping the missile attacks. A stalemate would ensue, possibly leading to a truce. Alternately, if the invasion took place as planned, the V-weapons could disrupt it by causing maximum confusion on D day, with V-1s and V-2s hitting embarkation and disembarkation points and the beachhead itself.[15] The Allies knew that a successful invasion depended on smooth, intricate coordination and synchronization on a grand scale. The thought of rockets and flying bombs raining down on the assault unsettled even the most senior planners.

The V-weapons also threatened to undermine Allied war aims. Unconditional surrender, opening the second front, and keeping Russia in the war all hung in the balance. Without the air superiority promised by the Combined Bomber Offensive, Overlord was impossible—without an invasion, unconditional surrender was certainly in doubt. By early 1944, keeping the Russians in the war was less of a concern than the other fears because the Red Army maintained the initiative in the East, but even Russia's ultimate success would be jeopardized by a large movement of German ground forces from the western front. In short, the invasion was crucial. Anything that detracted from its success increased the probability something else would go wrong.

Operations and Results

The Allies sought very specific results from bombing Crossbow targets. The two effects they wanted to achieve were: (1) to delay, or if possible prevent, V-weapon attacks, and (2) to limit the intensity of the attacks if they did begin.[16] To achieve these objectives, in the autumn of 1943 and the winter of 1943–44 the Allies bombed research facilities, production plants, large launch sites, and the ski sites discovered in France. Later, in the spring of 1944, transportation facilities in the launch areas and the modified ski sites were added. The results, however, were mixed.

The first Crossbow target hit was Peenemünde. The Royal Air Force (RAF) first attacked Peenemünde in August 1943. The primary objective of the raid was to kill as many personnel involved in the V-weapons programs as

possible, therefore, the housing area was the main aim point. Two lesser objectives were to destroy as much of the V-weapons related work and documentation as possible, and to render Peenemünde useless as a research facility.

Unfortunately for the Allies, Peenemünde was attacked too late to inflict a mortal blow to the V-weapons, and the experimental work was unaffected.[17] The V-1 was all but complete and ready to be engineered for production. The V-2 program was essentially complete as well, though several technical problems remained and it still lacked sufficient launch and flight testing to enter production. The Germans had duplicated records and stored many at several locations, although the Peenemünde facility retained copies.

Nonetheless, two key scientists were in fact killed in the raid, which also disrupted work on V-2 engineering and technical production problems. As a result, the Germans moved the V-2 program to Nordhausen, a bombproof underground facility. They moved the flight testing to Blizna, Poland, out of Allied bomber range. The death of the two scientists and the V-2 program relocation delayed the V-2 attacks on London by two months.[18] The raid did not affect the V-1.

Attacks on the production plants in Germany from December 1943 through August 1944 had marginal impacts on weapon production. The raids caused no reduction in the V-weapon output.[19] The Germans had correctly forecast Allied bomber attacks on production centers, and had adequately prepared for that eventuality by dispersing this industry to three underground production facilities. Unknown to the Allies at the time, they could have achieved better results by persistently bombing hydrogen peroxide and liquid oxygen targets. They could have also hurt production by targeting nearby power transformers instead of the underground factories.

While key V-weapons research and production facilities were located in Germany, all of the storage depots and launch sites were in France or Holland. Accordingly, all of the known large sites in France were bombed in the autumn of 1943 to prevent the Germans from finishing them. The Germans, however, repaired the damage and pressed ahead with site construction. The large sites, therefore, required several reattacks by heavy bombers. The Germans had designed the sites to be impervious to bomber attacks, much like the famous hardened U-boat pens. They intended to use them to launch both V-1s and V-2s. The various large sites were periodically bombed until July 1944, at which time the Germans abandoned their efforts before the Allied ground advance overran them. None of the large sites were ever completed. Watten was converted to a liquid oxygen plant despite the heavy damage, which served as camouflage to convince the Allies the site was damaged beyond repair.

The numerous ski sites were of more concern. The potential threat of V-1 attacks in January 1944 prompted the Allies to begin bombing ski sites in December 1943. On 15 December 1943, Eighth Air Force received overriding priority, at the request of the British chiefs of staff, to bomb the 96 ski sites in France when the weather was good enough to permit visual bombing.[20]

Selection of the Eighth Air Force reflected the need for precision bombing on the relatively small sites.[21] The half-dozen buildings and ski jump ramp made even the uncamouflaged sites difficult to find and hit, plus concerns over French casualties meant that British carpet bombing was out of the question.

No small effort was expended on the V-1 ski sites. An average of 237 sorties, dropping an average of 223 tons of ordnance, at an average cost of two aircraft, was required to inflict substantial damage to each of the 96 fixed ski sites.[22] Bombers rendered all but two of those sites useless by April, and only two ever launched V-1s.[23] If the original 96 V-1 ski sites had not been bombed while under construction, at least 92 of them would have been completed and ready for use by March of 1944.[24] Due to the large number of sites, the Germans were able to keep some repairs under way, and it became apparent to the Allies in April 1944 they would have to persistently bomb the sites to keep them out of commission.[25] The bombing definitely delayed the V-1 launches, but also prodded the Germans to develop and build the modified ski sites, which then presented a wholly different set of problems.

As indicated, Allied intelligence assessed the modified sites to be either decoys or less capable than the fixed sites.[26] After the fixed ski sites were destroyed and the large sites rendered useless, the Allied leaders—Winston Churchill and Dwight D. Eisenhower—thought the V-1 threat to England and the invasion was over.[27] The absence of V-1 attacks on D day seemed to confirm this conclusion. Once the Germans actually began launching V-1s in mid-June, however, the perception of the modified sites changed.[28] As a result of a meeting with the chiefs of staff and Churchill, they requested Eisenhower to "take all possible measures to neutralise the supply and launching sites subject to no interference with the essential requirements of the Battle of France." As a result, Eisenhower, who from mid-April to mid-September 1944 controlled all Allied heavy bombers, decided on 18 June 1944 that Crossbow targets ranked higher than anything for the Allied bomber force "except the urgent requirements of the battle."[29] Of note, this decision caused considerable concern among RAF and United States Army Air Forces (USAAF) air commanders about the conduct of air operations in support of Overlord. For example, Gen Carl A. Spaatz, commander of US Strategic Air Forces in Europe (USSTAF), reminded Eisenhower that the strategic air forces had weakened the Luftwaffe to the point it could not seriously interfere with the invasion. In direct support of Overlord, strategic air forces were continuing to keep the Luftwaffe from reemerging as a threat, and denying the German ground armies supplies and reinforcements to put up an effective defensive. Accordingly, he wanted to return to bombing Germany unless there was an urgent situation involving ground forces, and to ignore the V-1 sites.[30] Eisenhower, however, kept the V-1s as top priority.

An average of 180 sorties, dropping 426 tons of bombs, with an average loss of one aircraft, was required to inflict major damage to the modified ski sites.[31] Although they were heavily bombed in June and July of 1944, they continued to launch missiles at a steady rate.[32] After the attacks began on the modified sites, the number of new sites identified actually grew at a faster

rate than the number of those receiving crippling damage.[33] The growth in modified sites should be compared to the fact that by the end of May all 96 fixed ski sites had been hit, and at any given time through June only eight fixed sites could be kept under repair due to persistent Allied reattacks.[34] The Allies underestimated the numbers and capability of the modified sites to launch missiles.

Once the missile attacks began, bombing the modified ski sites had no impact on launch rates, except for a fortunate strike on the Nucourt supply site that caused rates to decrease dramatically for two weeks in mid-July 1944.[35] After the Nucourt attack, the Germans delivered V-1s to the firing regiments in France by rail directly from the factory in Germany, and two weeks later, had regained their previous launch rate. Very heavy bombing of the sites continued throughout July and August 1944.[36] The bombing then decreased as the launch units withdrew in the face of advancing Allied ground forces.

Attacks on the fixed ski sites were the single most effective method used to delay and reduce V-1 launches. It forced a "workaround" in the form of modified ski sites that took time to develop and field. Destroying the ski sites in France caused the Germans to develop and use the modified ski sites for almost all V-1 launches. They recognized an exposed operational weakness and corrected it. Since the Germans had produced an adequate supply of V-1s to begin an attack several months sooner than they actually did, the bombing of the sites and storage depots imposed a three or four month delay in the attacks on England.[37] One point was very clear—despite the results from the Nucourt bombing, the destruction of ski sites had much more of an impact than attempts at bombing missile storage facilities. The bulk of bombing attacks focused on the V-1 associated systems, leaving the V-2 program virtually untouched.

The attacks on the only known V-2 launch sites (the large sites) did not delay that weapon's use against England at all, since the missile still had production and technical problems that were not solved until September 1944. Once the problems were corrected, the V-2s were launched at England.[38] The Germans actually had time to correct an unrelated operational deficiency with the V-2. They manufactured mobile transporters that served as launchers, negating the need for vulnerable prepared launch sites. The Allies' attempts to find the V-2 sites after they began hitting London failed. The rockets were kept on mobile trailers that also served as erector-launchers, and usually hidden near roads in wooded areas. The only indication of a launch site was a small concrete pad for the launcher, which was virtually impossible to see from the air.[39]

After the launches began, the only measure the Allies took that had an impact on the V-2 campaign was the attack on transportation.[40] "Although there was practically no bombing of V-1 and V-2 launching sites in Holland and Germany, attacks on transportation and other targets probably were indirectly responsible for some reduction in the volume of fire in the early months of 1945."[41] "Against [V-2] firing from Holland, attacks on rail targets

by Mosquitos and fighter bombers appear to have had a greater disrupting effect than attacks against launching sites and forward rocket storage dumps."[42] The small launch pads used by the V-2 transporter-erector-launchers (TEL) remained nearly impossible to locate, and the Germans cut out the supply "middleman" by delivering rockets directly from the factory to the launch sites and firing regiments.

German Intentions and Objectives

The Allies were fairly accurate in their assessment of German aims. The Nazis changed their objectives several times, before and after the weapons became operational, but all three of the Allies' main concerns were ultimately reflected by the shifting German plans.

First, Hitler wanted to retaliate against England for the Combined Bomber Offensive.[43] He saw the V-2 as a high-leverage weapon that could relieve pressure on the Reich at a low production cost.[44] He also believed the Allies would be forced to divert a large percentage of their airpower to destroying V-weapons targets.[45] The large concrete structures at Watten, Siracourt, Wizernes, and Mimoyecques were kept under construction despite frequent RAF reattacks and heavy damage.[46] Gens Gerd von Rundstedt and Alfred Jodl pointed out the low probability of ever completing the sites while the Allies bombed them, and Hitler agreed, but wanted the sites kept under construction to keep some bombs from falling in Germany.[47] Hitler's diversion idea worked to a certain extent, if that was really the goal behind continuing the construction against long odds.

The Germans also wanted to prevent, or delay, the invasion, but failed because they were unable to launch any weapons until after D day. The two main targets for the V-1 and V-2 were London and Antwerp. The rationale for attacking London was twofold. First, the V-1s and V-2s were meant to undermine British civilian will to support the war. London would be under constant attack from an invulnerable, unstoppable, and superior German weapon. The Germans hoped flagging morale would bring about an early termination of the war on the western front, and allow them to shift their forces eastward to halt the advancing Red Army.[48] If the Allies continued to fight in the West, the Germans hoped to lure them into a trap by forcing them into a second invasion at Pas de Calais to capture the V-1 launch areas.[49] The Wermacht was prepared to launch a vigorous counterattack in this area, since that was where the Germans originally thought the Allies would invade. The idea of using annoying V-weapons to provoke an invasion of the launch area was not unlike a similar attempt by Iraq in 1991 to get Israel into the Persian Gulf War.

Attacks on Antwerp had similar objectives. The primary objective in attacking Antwerp was to reduce the port's usefulness to Allies.[50] At best, the objective was only partially achieved. Gen Carl A. Spaatz, commander of

USSTAF, wrote Gen Henry H. ("Hap") Arnold, chief of the Army Air Forces, that missile operations against Antwerp from 13 October 1944 to 26 March 1945, consisting of 5,600 V-1s and 1,440 V-2s that hit in and around the city had produced only slight delays moving supplies and cargo in and out of the port.[51] As a secondary objective, the Germans again wanted to attack civilian morale in Great Britain and force an early termination of war. They hoped that attacks on Antwerp would deny the Allied armies sufficient supplies to sustain operations, and the invasion would grind to a halt. A slowdown or halt in the invasion breakout might make the British public realize Germany still had a lot of fight left in her, and that the casualties would be high. Fears that the war might cause a loss of life on a magnitude with the trenches of World War I greatly concerned Churchill.[52] In any case, Antwerp was used despite the V-2 attacks.

Thus, the Germans failed to achieve the desired objectives set for the V-weapons. The Combined Bomber Offensive was diluted, but not stopped. The invasion was neither prevented nor disrupted, and British morale held firm. The gambit to get the Allies to invade Pas de Calais also failed (though this option was actually discussed in Allied meetings).[53] Yet if the V-weapons failed to achieve their goals, it should also be said that airpower played a marginal role in finally defeating the V-weapons. Ground occupation, not airpower, eventually stopped the launches.

Observations and Implications

The total Crossbow air effort from August 1943 to March 1945 was 68,913 sorties and 122,133 tons of bombs. Those totals represented a sizeable diversion from the Allied air campaign. Crossbow targets accounted for 5.6 percent of the total bombing missions and 6.8 percent of the total bomb tonnage dropped in Europe during World War II.[54] More significantly, this effort was concentrated in the 13-month period from August 1943 to August 1944 (inclusive). During that period, 14.9 percent of combined Eighth Air Force, Ninth Air Force, RAF, and Tactical Air Forces (TAF) sorties attacked missile targets, and 15.0 percent of the bomb tonnage fell on Crossbow targets. The TAF flew 16.7 percent of their sorties against Crossbow targets.[55] Daylight air superiority made the emphasis on V-weapons possible. Allied airpower in 1944 was virtually unopposed by the time of the Normandy invasion. What might have happened had the Germans possessed even a few squadrons of fighters to protect their launch areas?

Crossbow began receiving urgent attention after the first V-1 launch, although its high sortie counts did not necessarily indicate diversions from other targets. Forty percent of the RAF sorties from July 1944–August 1944 were directly dedicated to Crossbow. Those sorties were part of the overall bomber effort committed to invasion support. The German night-fighter forces had improved in quality and numbers of aircraft, and after March 1944 were

exacting a higher toll on RAF bombers. Additionally, the long summer days meant very short nights at the northern European latitudes. RAF losses might have been higher, and there is some debate as to whether or not they would have flown much more against Germany than they did even without flying Crossbow missions.[56] Additionally, USAAF sorties diverted that could not bomb primary targets. Medium bombers such as the B-25s, B-26s, and A-20s lacked the range to attack targets in Germany from Great Britain, and most Crossbow targets were in France. The shorter distance and longer days allowed a higher sortie rate because the bombers, using different crews, could fly two and sometimes three sorties a day. The shorter distance also allowed a greater trade off of fuel for bomb tonnage, since less fuel was needed by the bombers to get to France. Finally, missions over France needed minimum fighter escort, as daylight air superiority had been achieved because the Germans had pulled back their fighter force for home defense.

In the final analysis, the postwar *United States Strategic Bombing Survey (USSBS)* concluded that the Allied use of airpower against the V-weapons in the Crossbow campaign had an "insignificant" effect on the Allied prosecution of the war.[57] A diversion occurred, but not on the scale Hitler had hoped for, because of the vast numbers of aircraft and aircrews the Allies possessed in 1944. However, considering Eisenhower's concern over the impact of V-weapons on the ports and invasion beachhead, the attacks contributed and allowed invasion planning to go forward. If no bombing had taken place, the Germans could have launched V-1s as early as March, and the invasion may have been moved to Pas de Calais as the Germans desired.

The number of Allied bombers doubled from October 1943 to March 1944, and without those large numbers it seems remote that the Allies could have defeated the Luftwaffe, bombed transportation in France, and hit the ski sites. The Germans, on the other hand, could not react fast enough to overcome Allied invasion planning, and therefore wasted a certain amount of their industrial capacity that might have been better used to produce fighters. "The race was lost and the V-weapon campaign failed—failed to prevent or delay the invasion, failed to shatter Allied morale and failed to change the course of the war."[58] The V-weapons had little or no *military effect*.[59]

Several implications for future operations resulted from Crossbow. First, large numbers of mobile missiles are extremely difficult to stop with conventional airpower. Allied destruction of fixed sites absorbed sorties that might have been used to attack the Luftwaffe, oil, or transportation, but the diverted effort did not alter final outcome. All of these targets were destroyed. Unquestionably, destruction of the fixed ski sites and transportation near them detracted from the overall German capability, and, more importantly, the timing of their V-1 attacks. Without the Allied air attacks on the fixed sites, the V-1 assault would have likely begun in March 1944, and possibly affected the Normandy invasion. Eisenhower said the invasion of the continent would have been much more difficult and costly: "I feel sure that if [Hitler] had succeeded in using these weapons over a six-month period, and particularly if he had made the Portsmouth-Southampton area one of his

principal targets, Overlord might have been written off."[60] The Germans adapted and managed to launch a sizeable number. And despite the vast number of aircraft available, the Allies were incapable of locating mobile V-2 launchers. As today's air forces shrink in size, the sheer number of launchers may more than offset airpower's ability to deal with properly deployed missile threats.

Ground power—quite literally ground occupation—may have been the most important factor in stopping the first ballistic and cruise missiles. Not until Allied troops overran the modified V-1 sites and V-2 mobile launchers did the V-weapon threat truly come to an end.

Notes

1. David Irving, *The Mare's Nest* (Boston: Little, Brown and Company, 1965), 13.
2. Ibid., 15. Other information from sources within the German High Command had also been reported as early as 1939. In fairness to the British intelligence community, they were more concerned with the immediate needs of combat operations rather than unverified, improbable weapons. See Martin Middlebrook, *The Peenemünde Raid* (London: Penguin Books, 1988), 36–44.
3. Ibid., 34.
4. Ibid., 35. The British captured Cruewell in May 1942 and von Thoma in September 1942 in North Africa.
5. *United States Strategic Bombing Survey (USSBS)*, vol. 60, *V-Weapons (Crossbow) Campaign* (Washington, D.C.: Government Printing Office, 1947), 9.
6. Ibid., 6.
7. See maps 1–4. The V-2 range and accuracy were estimated in the same manner. The V-2 sites were known to be in The Hague area, giving them a rough range to London of 200–250 miles. The V-2 was also believed to be accurate enough to hit London, or the invasion assembly areas. Actual representative V-1 and V-2 results can be seen in maps 5 and 6.
8. Irving, 186.
9. *USSBS*, vol. 60, 9.
10. Ibid., 6.
11. *USSBS*, vol. 4, *Aircraft Industry Report* (Washington, D.C.: Government Printing Office, 1947), 113.
12. Wesley Frank Craven and James Lea Cate, eds., *The Army Air Forces in World War II*, vol. 3, *Europe: Argument to V-E Day* (Chicago: University of Chicago Press, 1951), 85 (note).
13. Ibid., 89.
14. Irving, 196–97. Some feared the Germans might spread radioactive waste in London, or possibly beat the Americans in the development of atomic weapons. The Germans actually considered using chemical weapons, but Hitler forbade their use because he believed the Germans would be at a disadvantage if they engaged in chemical warfare with the Allies. (Irving, 125 [note]) The British developed an evacuation plan in part as a response to this threat. (Irving, 80, 81, 271.)
15. Craven and Cate, 97.
16. *USSBS*, vol. 60, 1–2.
17. *USSBS*, vol. 2, *Overall Report (European War)* (Washington, D.C.: Government Printing Office, 1945), 88.
18. *USSBS*, vol. 60, 5.
19. *USSBS*, vol. 2, 88.
20. *USSBS*, vol. 60, 18; Craven and Cate, 95.
21. Even the Eighth Air Force B-17s with Norden bombsights could not always find these small targets. Concerning Crossbow missions on 20 April 1944, the official historian of the 1st

Combat Bombardment Wing (1st Bombardment Division) wrote that Crossbow targets "were fiendishly difficult for bombardiers to find in good weather. When they were obscured or socked in, the bombs had to be brought back, for random bombing in the occupied countries was forbidden." See "Headquarters, 1st Combat Bombardment Wing (H), 1st Bombardment Division, Eighth Air Force, U.S. Strategic Air Forces in Europe, U.S. Army Air Forces, Wing History for April 1944" (Maxwell AFB, Ala.: USAF Historical Research Agency [USAF/HRA], April 1944), 3 (File WG-1-H1 APR-1944).

22. *USSBS*, vol. 60, 26.

23. Ibid., 6.

24. *USSBS*, vol. 2, 88.

25. Irving, 211.

26. Ibid., 224–26.

27. Craven and Cate, 106.

28. *USSBS*, vol. 60, Exhibit 3.

29. Craven and Cate, 526–27. See also Richard G. Davis, *Carl A. Spaatz and the Air War in Europe* (Washington, D.C.: Center for Air Force History, 1993), 426–32. After Normandy, Spaatz was anxious to return to the oil targets, but the V-1s in June and the V-2s in September meant the bombers would be assigned to targets related to these due to "urgent requests." "The British, understandably, wanted the launching sites destroyed; but Air Marshal Sir Arthur Harris of RAF Bomber Command, citing the greater accuracy of the American forces, insisted that the Eighth Air Force should take on such missions. General Spaatz, also understandably, was not pleased to have his arguments on accuracy thus turned back on him." See David MacIsaac, *Strategic Bombing in World War II: The Story of the United States Strategic Bombing Survey* (New York: Garland Publishing, Inc., 1976), 77.

30. Ibid., 531–32.

31. *USSBS*, vol. 60, 26.

32. Ibid., Exhibit 1.

33. Ibid., Exhibit 6.

34. Ibid., Exhibit 5.

35. Ibid., 22, Exhibit 1.

36. Ibid., Exhibit 7.

37. *USSBS*, vol. 2, 88.

38. Ibid., 88–89.

39. See figure 2 for a sketch of a typical launch site.

40. *USSBS*, vol. 60, 23.

41. *USSBS*, vol. 2, 89.

42. *USSBS*, vol. 60, 21.

43. Irving, 182.

44. Ibid., 85.

45. Ibid., 232. Hitler was not alone in his belief the V-weapons would tie down airpower. For example, Field Marshal Erhard Milch believed the ski sites in France would draw the attention of RAF bombers first, and then the USAAF because of its precision bombing capability. He thought the sites could be used to bring about great air battles that would destroy the Allied air forces and keep the bombing pressure off of Germany. See David Irving, *The Rise and Fall of the Luftwaffe* (London: Weidenfield and Nicolson, 1973), 231, 261. Ironically, Milch's idea to fight the Allied air forces in the air was exactly what the Allies wanted as well. See *USSBS*, vol. 59, *The Defeat of the German Air Force* (Washington, D.C.: Government Printing Office, 1947), 1.

46. *USSBS*, vol. 60, 20.

47. Irving, *The Mare's Nest*, 189.

48. V-1s and V-2s had a hand in the ultimate expression of Hitler's hope to knock the Allies out of the war—the Ardennes Offensive, or the Battle of the Bulge. From new sites in Germany, the Germans launched V-weapons at Antwerp, the offensive's objective. Hitler believed if he could force the British and Americans off of the continent and out of the war, he could create a stalemate on the eastern front. See B. H. Liddell Hart, *The German Generals*

Talk (New York: Quill, 1979), 275; and Jozef Garlinski, *Hitler's Last Weapons* (New York: Times Books, 1978), 176–80.

49. Winston S. Churchill, *The Second World War,* vol. 4, *Triumph and Tragedy (*Boston: Houghton Mifflin Company, 1985), 40. David Irving believes this false premise in Hitler's mind about the invasion location is one of the reasons he put the mass of his forces behind the German Fifteenth Army defending the Pas de Calais, one of the reasons that his belief persisted after the Normandy invasion for some time—the Allies susceptibility to political pressure to get rid of the threatening missile launch sites. (Irving, *The Mare's Nest,* 192–93, 239.) Mr Herbert Morrison, Ministry of Home Security and a member of the British War Cabinet, urged just such a second invasion at Pas de Calais on 11 July 1944. (Irving, *The Mare's Nest,* 232.) General Sir Alan Brooke wrote in his diary on 18 July 1944 that he was very concerned the Germans would be able to entice the Allies into such an invasion, leading one to the conclusion that the Germans very nearly did so. (Irving, *The Mare's Nest,* 267.)

50. Irving, *The Mare's Nest,* 291.

51. War Department, Spaatz to Arnold, paraphrased letter, 29 March 1945, USTAF Ref no UA 66619, DTG 291645Z (USAF/HRA 506.6521A 25 March 1945, 00207898).

52. David Eisenhower, *Eisenhower: At War 1943–1945* (New York: Random House, 1986), 229.

53. Irving, *The Mare's Nest,* 267. Curiously, Field Marshal Bernard Montgomery used a similar argument to convince Eisenhower to support Market Garden, a "single-thrust plan" to drive to Berlin. An additional benefit, as Montgomery believed, was the capture of the V-2 launch areas in Holland, neutralizing the rocket threat to England. See David Johnson, *V-1, V-2: Hitler's Vengeance on London* (New York: Stein and Day Publishers, 1981), 136.

54. *USSBS*, vol. 60, 26–27.

55. Ibid., 28.

56. Ibid., 33.

57. Ibid., 36.

58. Ibid.

59. Ibid., 16.

60. Dwight D. Eisenhower, *Crusade in Europe* (New York: Doubleday and Company, Inc., 1948), 260.

Chapter 3

Anagnorisis II

Operation Desert Storm Scud Hunt—1991

Mobile missile hunting was difficult and costly; we will need to do better.

—Secretary of Defense Richard Cheney

On 17 January 1991 Iraq responded to coalition air attacks by launching the first of 88 Scuds from mobile missile launchers. The missile's impact in Israel dramatically demonstrated the link between politics and war. A missile labeled "militarily insignificant" threatened to undermine the international coalition assembled to eject Saddam Hussein's forces from Kuwait.

The subsequent Scud Hunt for Iraqi mobile launchers yielded little fruit. Although coalition aircraft flew with relative impunity by the second night of the war, they could not completely halt the Scud launches. Efforts to eliminate the mobile Scud launchers diverted airpower away from other efforts and absorbed three times more aircraft than anticipated, according to US Air Force Chief of Staff Gen Merrill McPeak.[1] Since the Allies did not earnestly attack the V-2 launchers in World War II, the Scud Hunt marked the first time in history airpower had been used to pursue a ballistic missile force.[2] Its lessons may endure for some time.

Detection and Assessment

Unlike the slowly unfolding picture of V-1 and V-2 development that the Allies witnessed in World War II, the US and coalition commanders knew during Desert Shield that Iraq had ballistic missiles. Iraq had already demonstrated the ability to use missiles in combat. Observations from the 1980–88 Iran-Iraq War had provided a useful but limited amount of information about Iraqi Scud operations. The knowledge the US and coalition partners lacked was specific, unambiguous detail about those Scuds, particularly the Iraqi-modified Scud called the Al-Husayn. The intelligence officers and planners had two major concerns—the first was the number of Scuds and mobile launchers that Iraq possessed and the second was how Iraq would employ them against the coalition.[3] Filling in the details and accurately determining Iraqi ballistic missile capabilities proved to be a challenge

for the US intelligence community. The planners would use the estimates to help predict Scud targets and how best to attack the missiles.

The general capabilities of the Soviet-made Scud-B did not represent a real intelligence mystery. Planners considered the Scud-B's capabilities to be lacking. It could deliver a 2,100 pound warhead 300 kilometers (km) (165 miles) with a circular error of probability (CEP) of 900 meters (2,950 feet).[4] The Scud-B was designed to deliver conventional high explosives, nuclear, or chemical warheads. More importantly, the Scud could be launched from fixed sites or mobile launchers. The Soviets designed it to be transported and fired from a reusable mobile launch vehicle—an eight-wheeled MAZ-543 transporter-erector-launcher (TEL).[5] Iraq had obtained its first few Scuds from the Soviets in the early 1970s, and had acquired 12 MAZ-543 Scud-B TELs by 1980.[6] Iraq also had produced indigenous launchers that used a flatbed tractor trailer truck called a mobile-erector-launcher (MEL). During the war with Iran, the Soviets had resupplied Iraq with over 1,000 Scud-Bs. Even so, the missile was not considered a significant threat to coalition military forces.

United States intelligence knew some of the details of how Iraq had used its Scuds in the past. Iraqi Scuds had struck Iran as early as 1982, and were aimed at Iranian population centers and troop concentrations near the rear of the battlefield.[7] Iran, on the other hand, launched Scuds directly at Baghdad after acquiring them from Libya and North Korea in 1985. Baghdad was easily within range of Iranian Scuds at the Iran-Iraq border, while Teheran remained well outside Iraqi Scud-B range. To strike Teheran in retaliation for attacks on Baghdad, the Iraqis (with considerable foreign assistance) modified the Scud-B to extend its range.[8] Iraq successfully tested five of these extended-range Scuds, called Al-Husayn, in February 1988. The Al-Husayn possessed a range of 600–650 km (330 miles), and was used during the "War of the Cities" from 29 February 1988 to 20 April 1988.[9]

One hundred eighty nine Al-Husayns were fired at six Iranian cities in the eight week War of the Cities. Of these, Iraq fired 135 at Teheran.[10] The effects were dramatic. Over two and one-half million people—25 percent of Teheran's population—left the city.[11] As a result, the missile bombardment of Teheran produced a "severe disruption" of Iran's economy.[12] The Al-Husayn did not, by itself, bring an end to the war, but it did force Iran to stop missile attacks on Iraqi cities.[13]

Despite six years of use by Iraq, the US had almost no detailed information on Iraqi Scud doctrine, organizations, and field deployment operations. Subsequently, US officers built this part of the intelligence profile from scratch.[14] Iraq had used the Scuds and Al-Husayns to attack large targets, but there was no indication that they would use them against confined military objectives.

As potential targets for coalition airpower, the Scud-B and Al-Husayn were considered to be essentially equivalent. Granted, the Al-Husayn was about a meter longer, but the fixed and mobile launchers could launch either missile. Both missiles could hit targets with about the same degree of accuracy, and there was no practical way to distinguish them from the air. Intelligence

analysts did not have a firm estimate of Iraqi missile numbers, but believed the Iraqis to have 800–1,000 Scud-Bs and Al-Husayns.[15]

The total number of missiles was not as important as the exact number of launchers, because the missiles were of no value without the launchers. The US national intelligence community underestimated the total number of Scud launchers,[16] partly because Iraq had three different types of launchers when Desert Storm started. About 30 fixed launchers existed in western and southeastern Iraq (they were incapacitated in opening stages of the war); "several dozen" mobile launchers were built on modified Saab-Scania commercial trucks with an unknown number of trailers that could be used as launchers; and 12 MAZ-543 TELs. Analysts estimated the number of mobile launchers of all types to be between 30 and 40.[17] Illustrative of the uncertainty surrounding these numbers, one estimate credited Iraq with 35 to 50 TELs and 30 static launchers at the beginning of Desert Storm.[18] The launchers were known to be positioned in three areas—Basra, opposing Saudi Arabia; near H-2 airfield in western Iraq, facing Israel; and Baghdad, which probably served as a reserve force.[19]

During the War of the Cities, Iraq had launched its missiles from presurveyed sites in broken ground or tree groves for cover.[20] The normal setup, calibration, fueling, and launch operations during the Iran-Iraq War took about an hour. During these prelaunch operations, the Iraqi Scud crews normally transmitted a more or less standard pattern of radio messages and weather radar. Soviet procedures and times were similar.[21] The US intelligence and air campaign planning officers assumed Iraq would continue the same procedures during Desert Storm, using presurveyed sites, taking the same amount of time, and emitting the same electronic signature. However, during Desert Storm, the Iraqis set up, launched, and were on the move again in as little as 10 minutes, deviating substantially from their previous practices and dispensing with calibration and weather (wind) checks.[22]

Employment doctrine remained a mystery. Iraq had launched Scuds at both military and civilian targets, and retaliation had been the primary motive behind the Al-Husayn attacks on Teheran. Due to the large CEPs, the missiles were best suited to attack large targets. The key question seemed to be whether the missiles could threaten coalition military operations. Uncertainties about the Al-Husayn's range and payload, particularly chemical warheads, and questions about missile reliability complicated coalition planning.[23] The inaccuracy of the Al-Husayn led coalition commanders to assess it as militarily insignificant.[24] Leaders in Washington, however, worried that the Scuds could become political weapons, particularly if fired against Israel. President George Bush, Secretary of State James Baker, Secretary of Defense Richard Cheney, and Chairman of the Joint Chiefs of Staff Gen Colin Powell all knew keeping Israel out of the war was going to be tough if Saddam attacked Israel.[25] Lt Gen Charles Horner predicted air strikes would preclude Scud launches when he briefed Powell, Cheney, and Defense Under Secretary for Policy Paul D. Wolfowitz.[26]

Besides uncertainties about missile usage, the extent of Iraq's decoy program was a key unknown.[27] "Effective Iraqi use of deception techniques, communications security, and the desert terrain reduced the coalition's ability to detect, and thus target, the Al-Husayn units before missile launch."[28] Nonetheless, the planners did not devote a great deal of attention to the possibilities of camouflage, terrain, and decoys. Their failure to do so led to three erroneous planning assumptions: (1) the Iraqis would launch all of their Scuds from fixed, known sites (translating into a vulnerable target set for airpower); (2) any mobile launches the Iraqis might make would follow Soviet Central European procedures, and therefore be detectable through emissions that would allow for enough time to locate and destroy them before launch; and (3) decoys would provide little more than nuisance value in anti-Scud operations.[29] The coalition planners did not understand that Iraq—by design or accident—had made the Scud impervious to air attack.

The incremental deployment of Iraqi missiles from garrison and cantonment areas started as early as August 1990. The dispersion was detected, but the exact deployment locations were not discovered by US intelligence.[30] For planners and intelligence personnel alike, mobile Scuds proved to be an intractable problem.[31] When war began, this deficiency quickly became apparent.

While possessing only sketchy information on the mobile Scud dispositions, launch procedures and potential targets, the US intelligence community concluded that Iraq had the capability to launch chemical or biological warheads on the Scuds or Al-Husayns, with chemical warheads being the more likely.[32] Iraq and Iran both had used chemical weapons in the 1980–88 Iran-Iraq War, but they used aircraft and artillery, not Scuds, to deliver them.[33] In any case, the Iraqi rhetoric aggravated Israeli World War II Holocaust memories and fears about chemicals being used against Tel Aviv. US leaders were very concerned as well.[34]

Operations and Results

In the first days of the air campaign, the coalition attacked all 25 known fixed Scud sites. Twelve were destroyed and the other 13 were damaged.[35] Attacks against the mobile launchers also occurred. The intent of the coalition air strikes was to suppress Scud launches at Israel, Saudi Arabia, and the other Gulf nations. The efforts quickly ran into problems. For example, the presurveyed mobile launch sites and hiding places had not been identified before the air war started on 17 January 1991.[36] In any case, flying against these "scrape" sites was viewed as a hit-or-miss waste of airpower.[37] Much like Allied commanders had ignored the modified V-1 ski sites in World War II, coalition commanders in the desert war against Iraq similarly ignored mobile launchers until they started launching their Scuds on the first night of the war.

Stopping the Scuds depended on airpower accomplishing three tasks: (1) destroying the known fixed launch sites, facilities and storage bunkers; (2) maintaining a 24-hour Scud combat air patrol, or "Scud CAP," in each of the western and eastern launch zones (or Scud boxes) to find and destroy the mobile launchers; and (3) conducting armed reconnaissance to locate and destroy Scud equipment and facilities.[38]

Approximately 1,500 sorties were flown over 43 days against such Scud targets as mobile launchers, suspected hiding places, and production and storage facilities.[39] At least one-third of the more than 2,000 daily strategic air campaign sorties were diverted to the Scud Hunt.[40] This diversion, plus extremely poor weather, caused the first phase of the air campaign to take longer than the planned six days, according to General Horner, the Joint Forces Air Component Commander (JFACC). Theater commander and Army general Norman Schwarzkopf countered that "the bombing was so effective that the delays didn't hurt much."[41]

Fifteen percent of the coalition air campaign was dedicated to finding and destroying Scud launchers, and the overall air campaign took 39 days, nine days longer than planned.[42] The authors of the *Gulf War Air Power Survey* (*GWAPS*) considered the Scud Hunt one of two significant diversions from the planned execution of the air campaign.[43] Coalition planners had anticipated that Iraq might attack Israel with Scuds, but planned to bomb only the known fixed sites. The most threatening fixed sites to Israel were near H-2 and H-3 airfields in western Iraq, which were attacked on the first night of the air campaign.[44] The pressure from Washington to destroy the Scuds was tremen- dous, as President Bush wanted to keep the Israelis out of the war at all costs.[45] To achieve that objective, anti-Scud operations were continuous against the elusive mobile launchers.

Scud Hunt tactics essentially required aircraft to orbit over the known general area of the mobile Scud launchers, ready to strike when the Scuds were discovered. A variety of aircraft participated in the effort, including airborne warning and control system (AWACS), joint surveillance target attack radar system (J-STARS), F-15Es, F-16s, and A-10s. Ideally, the coalition wanted to destroy the mobile Scuds before they launched, but decoys, camouflage, and clever Iraqi tactics thwarted this aim. Aircrews tried to attack the sites immediately after launch (the crux of the Scud Hunt), but time, distance, space and decoys as well as "noise" (objects that could be mistaken for Scuds) all worked against this goal. One F-15E crew visually witnessed a launch at night, and attempted to find the launcher, but could not.[46]

These difficulties should not have come as much of a surprise. An exploitation exercise named "Touted Gleem" had been conducted in late 1990 to discern the problems and level of effort required in Scud hunting. The test consisted of an MAZ-543 TEL deployed at night in terrain conditions similar to Iraq. F-15E, F-111F, and F-16 aircraft, all equipped with state-of-the-art night-capable systems, tried to find the launcher after being given the precise coordinates. They discovered the MAZ-543 was impossible to find even when its coordinates were known.[47]

Iraq successfully fired 88 Scuds during the war: 38 at Israel, 41 at Saudi Arabia, and two at Qatar and Bahrain. (Seven broke up in flight.) Over 40 percent were launched during the first week of the war.[48] The decline in launches lends some credence to Air Force colonel John Warden's view that the sorties suppressed Scud launches in subsequent weeks even if they did not destroy any TELs. Iraq launched an average of 14.7 Scuds per week, with 29 launches occurring during the first week of Desert Storm at the rate of 4.1 per day; 24 during the second week at a rate of 3.4 per day; and four during the third week for a rate of less than one per day.[49] Optimistic aircrew claims, combined with a lull in launches, pointed towards Scud Hunt success. The possibility that decoys or other objects that resembled TELs had been hit was disregarded.[50] After the third week of the war, Scud launches increased steadily until the armistice.[51] The recovery belied the faith in the early success of the first three weeks of the Scud Hunt. The lull had also given false hope that the mobile launchers were being destroyed at the rate and in the numbers the aircrews had claimed.[52]

The Iraqis launched the majority of their Scuds at night. Only three were launched during daylight, and these occurred in the early daylight hours under heavy cloud conditions.[53] The emphasis on night launches was unquestionably due to the coalition's overwhelming air superiority,[54] and optimism by Iraqi commanders that darkness would protect the launchers from aircraft strikes. Because of the night launches, aircrews employed sophisticated onboard sensors to locate and identify the mobile launchers after they fired. Of 42 visual observations of Scud launches at night, only eight resulted in actual attacks on what aircrews believed were Scud launchers.[55] Weather also aided the Iraqi Scud efforts. Heavy cloud cover "precluded effective identification of Scud locations from space and hampered the subsequent aerial hunt for Scud launchers."[56] The Touted Gleem exercise had turned out to be an accurate predictor of Scud Hunt results.

The operational problems caused by the Scud threat were many. Patriot missile batteries were designed to defend against aircraft, not Scuds. The lack of mass Scud attacks made it easier for the coalition's Patriot missiles to target and intercept them. A large attack might easily have overloaded the Patriot system. However, the Iraqis were firing their Scuds without air superiority, and had they attempted to mass launchers in even a large area they would have risked losses.[57] Second, the JFACC had to designate a portion of his air force to hunt and destroy Scuds. These sorties could have been used to speed up preparation of the battlefield and attacks on strategic targets. The inability to stop the attacks also became a source of embarrassment to the United States government.

> In the Pentagon daily briefings on the war, Defense Department officials constantly stressed that destroying the SCUDs was a top priority. When asked why the SCUDs continued to function despite this effort, General Kelly admitted, "It's a tough target. The mobile launchers can move and hide. . . . Iraq is about 170,000 square miles. . . . Every day we are trying harder to get those SCUDs, and sooner or

later we're going to get them." This task was also complicated by Iraq's use of SCUD mock-ups as decoys for allied attacks.[58]

Excess airpower—in excess of requirements—allowed General Horner to "bleed" off sorties to hunt for Scuds.[59] Because of the coalition's large air force, the effect of Scud hunting was mostly to delay attacks on some targets, but it did not alter the outcome of the war—Iraq was still forced out of Kuwait. However, had Saddam Hussein been more effective in orchestrating a with- drawal from Kuwait or a cease-fire, the time and sorties used to hunt Scuds might have allowed other targets to have escaped unscathed.[60]

The sorties flown against the fixed launchers failed to suppress the Scuds, because the Iraqis used mobile launchers exclusively.[61] The fixed sites actually served as decoys of sorts—they had to be destroyed (like the V-1 ski sites in World War II) and diverted the planners' attention from the mobile launchers.[62] If the coalition did not bomb the fixed sites, more Scuds might have been launched. Yet coalition planners did not fully understand ballistic missile capabilities. Iraq made its missiles—by accident or design—as elusive and resistant to air attack as possible. The mobile Scud decoys were so realistic that they could not be distinguished at 25 yards on the ground, much less in the air.[63]

The difficulty in pinpointing the mobile Scuds made it impossible to confirm the destruction of *any* mobile launchers by coalition aircraft. Aircrews claimed over 80 were destroyed.[64] A-10 pilots alone claimed 51, and Special Operations Forces (SOF) claimed up to 11.[65] Obviously, many decoys and look-alikes were hit. Additionally, the maximum number of launches per day during the war never exceeded the number of mobile launchers known to have survived the conflict.[66] Most, if not all, of the 100-plus mobile launchers claimed by coalition aircrew and SOF were decoys or other vehicles.[67]

Almost 1,500 combat sorties flew against the Scud threat. This total includes missions that attacked fixed sites, suspected hiding places (culverts and highway bridges), production and support facilities, and mobile launchers. Half of these were targeted against fixed launch sites and suspected hiding places; 30 percent on support facilities; and 15 percent—215 missions—on mobile launchers. An additional 1,000 Scud patrol sorties attacked other targets.[68] On average, 6 percent of the daily sorties flew against Scuds.[69] Of specific USAF combat aircraft, 20 percent of F-15E sorties, 2 percent of A-10, 4 percent of F-16, and 3 percent of F-111 sorties were dedicated to the Scud Hunt.[70] Numerous other coalition—especially US—aircraft flew in the hunt.

According to Dr Thomas A. Keaney, staff member of the *GWAPS* team and chief of the *GWAPS Summary Report*, the Scud threat was underestimated. It was considered militarily unimportant, but strategically it held the key to keeping the coalition united. Keaney asserted that the coalition had no idea how to hit mobile Scuds, and noted there was no hard evidence that any were destroyed. At best, he thought that coalition aircraft might have suppressed the number of firings and degraded their accuracy.[71]

> [T]he actual destruction of any Iraqi mobile launchers by fixed-wing coalition aircraft remains impossible to confirm. Coalition aircrews reported destroying around eighty mobile launchers; another score or so were claimed by special operations forces. Most of these reports undoubtedly stemmed from attacks that did destroy objects found in the Scud launch areas. But most, if not all, of the objects involved now appear to have been decoys, vehicles such as tanker trucks that had infrared and radar signatures impossible to distinguish from those of mobile launchers and their associated support vehicles, and other objects unfortunate enough to provide "Scud-like" signatures.[72]

The Iraqis adapted to the air strikes and continued launching Scuds until the end of the war.[73] Their greatest success occurred the day before the cease-fire, when a Scud smashed into an American barracks in Dahran and killed 28 soldiers.[74]

At least 62 Scuds, 11 decoys, six Soviet-made MAZ-543 TELs, two Al Nidal and two Al Waleed indigenous TELs (based on commercial tractor-trailer rigs) survived the war.[75] Iraq declared that 19 TELs and MELs still remained by the armistice. The number was confirmed destroyed by a UN Special Commission team.[76] Fourteen launchers survived the war, and no more than 14 were launched on any single day,[77] which perhaps confirms that Iraq only had 14 mobile launchers.

Iraqi Objectives

Iraq fired Scuds at Israel and Tel Aviv to provoke an Israeli retaliation that would undermine the Arab support of the coalition. Saddam Hussein had made it very clear his first target would be Israel if hostilities broke out. Tariq Aziz, Iraq's foreign minister, said "absolutely" Israel would be attacked.[78] Hussein probably had more reasons for attacking Israel than simply widening the war, though certainly that was a fundamental objective. He seemed to take great pains to frame the conflict in different terms than the coalition, and continually attempted to justify it in terms of an Arab-Israeli conflict. If Israel responded with airpower, Israeli aircraft would have to fly through Jordan, Saudi Arabia, and Syria to get to Iraq. Hussein believed that those countries could not risk appearing to aid Israel against an Arab brother.[79] The use of Scuds may also have been an attempt to lure the coalition into an early ground campaign, so that Iraqi prepared defenses could be used before airpower demolished them.[80] The *GWAPS* further notes that coalition leaders considered a ground offensive in western Iraq to deny Hussein the territory to use to launch against Israel.

Hussein's emphasis on Scuds during the Desert Shield buildup may have been designed to deter coalition military action by creating coalition fears of extremely bloody operations. Several Scud test flights seemed to underline this idea, while demonstrating Iraq's resolve to use the weapons when war came.[81] The three flights were meant to exhibit the coalition's difficulty in detecting launches, the fact that the missiles functioned and Saddam would

use them, and, due to their orientation, the intent to draw Israel into the war.[82] Saddam also made references to Iraq's chemical and biological weapons, and threatened to use them against any country that let western troops stage in their borders. In actuality, he targeted only Bahrain and Qatar, and did so with Scuds containing conventional warheads. Qatar received only some debris from one of the launches but nothing more serious.[83]

Saddam Hussein may have believed the Scuds were unstoppable, devastatingly effective, and able to cause such public hysteria that the coalition would disintegrate and agree to peace on his terms. The Scud attacks were also symbolic.[84] Despite their limited damage, the Scuds demonstrated his ability to go on the offensive, the vulnerability of the Israeli and Saudi populations, and his attempt to refocus the war as an Arab-Israeli confrontation.[85] Nonetheless, Saddam refused to employ chemical or biological weapons, believing that the retaliation resulting from such Scuds would more than offset the advantages gained in their use. He feared the retaliation more than the loss of any chemical capability due to coalition air strikes.[86]

Why did Hussein refuse to use chemicals? Besides possible technical limitations, there have been two other reasons forwarded. First, Israel had made veiled threats about its response to a chemical attack. Such threats might have caused Saddam to believe that the Israelis could use nuclear weapons against him. Second, President Bush had hinted if chemical weapons were used, he would widen the war aims to include the removal of Saddam from power.[87] McGeorge Bundy points out that President Bush fairly clearly threatened a nuclear response to Iraqi chemical attacks in his 5 January 1991 letter to Hussein.[88] On the other hand, Saddam had used the Al-Husayn against Iran to stop artillery and rocket attacks on civilians. He had fired his missiles at Iranian cities until Iran agreed to cease all attacks on Iraqi cities.[89] Since the attacks had seemingly worked against Iran, Saddam may have thought that they could produce a halt to the coalition air campaign as well.

Saddam Hussein perhaps put too much faith in his missiles and the notion that the US could not sustain high casualties. His overall strategy may have been deterrence by emphasizing the Scud's destructive potential. If that deterrence failed, the Scuds would inflict very painful blows. "The Iraqi strategy," Lawrence Freedman and Efraim Karsh surmise,

> was based on deterring and if necessary rebuffing the central thrust of the enemy campaign, by exacerbating the prospective war's stresses and strains on the political cohesion of the coalition while absorbing the enemy air assault. There was no obvious strategy for war termination other than inflicting such discomfort that the coalition would develop an interest in a cease-fire on terms other than the full implementation of all UN resolutions.[90]

Finally, Saddam may have desired a political, or "moral" victory of sorts in the midst of a military defeat,[91] similar to Egyptian president Gamal Abdel Nasser during the 1956 war against the British, French, and Israelis. Perhaps he achieved a measure of success on that score. When his first Scud hit Tel Aviv, the Egyptians and Syrians in Saudi Arabia cheered.[92] Yet

despite the operational difficulties, the Scud Hunt—in combination with Patriot missiles— managed to keep Israel out of the war.[93]

Observations and Implications

The Scud missiles were more effective as strategic weapons rather than operational or tactical vehicles. Saddam Hussein used Scuds to try and widen the war, weaken the coalition, and change the war's outcome. His efforts failed, but just barely. Many troubling questions remain with regard to the way in which Saddam employed his missile force.

The coalition was surprised by the mobile Scuds' impact on the conflict. Scud-B CEP was approximately 1,000 meters, while that of the Al-Husayn was 2,000 meters.[94] If Scud accuracy had been slightly better (resulting in a reduced CEP), their military and political impact might have dramatically increased.[95] As it was, a Scud nearly hit the USS *Tarawa*.[96]

> Unfortunately, the U.S. Central Command, appreciating the limited military utility of the missiles, appears to have totally underestimated their political utility. The missiles gave Iraq an offensive capability that it otherwise lacked. As a result, it was possible for Baghdad to strike Israeli targets in an effort to involve Israel in the war. If the missiles had caused larger numbers of casualties, it is possible that the Israelis may have felt impelled to retaliate, thus widening the war and complicating the coalition's efforts. As it happens, the missiles caused few casualties. The arrival of the Patriot surface-to-air missile batteries changed the picture substantially, but the danger never went away completely.[97]

Mobile TELs proved elusive and survivable. Fixed targets, however, were vulnerable. The technological race appears to be between the defender's ability to locate and destroy mobile missiles and the attacker's ability to decrease CEPs to airfield boundary size. Hussein's violation of the principles of concentration and objective may not be counted on again. Had he launched 14 missiles simultaneously on Daharan, the potential to inflict significant damage on coalition air operations was great. Improving Scud technology will heighten the missile's ability to deny an enemy command of the air. Should North Korea, for example, in some future war concentrate its Scuds (which are more accurate than those of Saddam Hussein) on Kunsan or Osan air bases, the impact on air operations would likely be tremendous. The disruptive effect of taking cover alone would significantly reduce the tempo of air operations.

Iraq continued to fire Scuds until the last day of the war. Its most devastating strike took place only hours before the war ended. What if that strike had been nuclear? Aside from the civilian loss, the impact on the coalition's air effort would have been massive. What the Iraqis accomplished with conventional Scuds, with limited accuracy, does not augur well for air forces in the future.

Although Saddam's Scuds failed to achieve his objective of drawing Israel into the war and destroying the coalition, coalition airpower failed to destroy

the Scud threat. The problems of finding mobile targets with airpower may prove very difficult to overcome.[98] First, the prevailing regional weather and open, flat terrain in Iraq actually favored the hunters. Continual overcast and rugged terrain, such as might be encountered in North Korea, would be even more challenging for the Scud hunters. Second, even a slight increase in the number of TELs and MELs would probably require an exponential increase in airpower to suppress, much less destroy, all of the launchers. Third, air forces of the future will be smaller, and a higher percentage of sorties for Scud hunting is likely to have a debilitating impact on an air force unless there is a revolutionary breakthrough in technology to locate TELs.

Moreover, a United Nations inspection team discovered Iraqi chemical weapon warheads for Scuds after the war—indicating a coalition intelligence gap.[99] Because Iraq did not use ballistic missiles to deliver chemicals in the war with Iran, some planners assumed that fuzing problems prevented them from doing it at all. Assuming that an enemy cannot accomplish a technologically complex task is a dangerous proposition when considering the highly volatile mixture of third world nations, Scuds, and warheads of enormous destructive potential.

The coalition kept Israel out of the war, and, because of the magnitude of the coalition air effort, the diversion of aircraft had minimal impact on the ability to achieve coalition objectives. In the next conflict, a "downsized" US Air Force may be incapable of achieving similar results, and the inability to do so may have catastrophic consequences.

Notes

1. *Gulf War Air Power Survey (GWPS)*, vol. 4, pt. 1, *Weapons, Tactics, and Training and Space Operations* (Washington, D.C.: Government Printing Office), 276 (note 74). The equivalent of three squadrons of aircraft were committed to the Scud Hunt. See Keith B. Payne, "Defence Against Missile Proliferation," *Jane's Intelligence Review* 4, no. 5 (May 1992): 235.

2. Payne, 276.

3. *GWAPS*, vol. 2, pt. 2, *Operations and Effects and Effectiveness*, 320.

4. The estimate that credits the Scud with the most capability—a range of 300 km/185 miles and a CEP of about 450 meters—is found in Duncan Lennox, "Inside the R-17 'Scud-B' Missile," *Jane's Intelligence Review* 3, no. 7 (July 1991): 302. Most estimates are closer to the one used in this paper.

5. *GWAPS*, vol. 2, pt. 2, 317 (note).

6. W. Seth Carus, *Ballistic Missiles in the Third World* (New York: Praeger, 1990), 37. Other sources quote either nine MAZ-543 TELs, as in Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War*, vol. 2, *The Iran-Iraq War* (Boulder, Colo.: Westview Press, 1990), 497, or 11 TELs (*GWAPS*); but all are within the same order of magnitude. The highest number this author could find is 12 MAZ-543s.

7. Cordesman and Wagner, 497.

8. W. Seth Carus and Joseph S. Bermudez, Jr., "Iraq's *Al-Husayn* Missile Program," pt. 1, *Jane's Soviet Intelligence Review* 2, no. 5 (May 1990): 204. The range was increased by reducing payload and increasing rocket motor burn time. This article lists in detail information released by the Iranians about the Al-Husayn. The Iranians claim the Iraqis had to use three Scuds to

obtain two Al-Husayns—a fact that might have been useful to coalition intelligence assessments of the number of missiles Iraq could field.

9. W. Seth Carus and Joseph S. Bermudez, Jr., "Iraq's *Al-Husayn* Missile Program," pt. 2, *Jane's Soviet Intelligence Review* 2, no. 6 (June 1990): 245 (map). The shortest range from the Iraqi border to Teheran was over 500 km, so all of the Al-Husayns fired represented ranges in excess of this.

10. Ibid., 242.

11. Ibid., 243.

12. Thomas G. Mahnken, "Why Third World Space Systems Matter," *Orbis* 35, no. 4 (Fall 1991): 564.

13. Carus and Bermudez, Jr., "Iraq's *Al-Husayn* Missile Program," pt. 2, 242.

14. Jill L. Jermano, and Susan E. Springer "Monitoring Road-Mobile Missiles Under START: Lessons from the Gulf War," *Parameters* 23, no. 1 (Spring 1993): 75.

15. Bob Woodward, *The Commanders* (New York: Simon and Schuster, 1991), 285.

16. *GWAPS*, vol. 5, *A Statistical Compendium and Chronology*, 543.

17. *GWAPS*, vol. 2, pt. 2, 320.

18. Joseph S. Bermudez, Jr., "Iraqi Missile Operations During 'Desert Storm'," *Jane's Soviet Intelligence Review* 3, no. 3 (March 1991): 131.

19. W. Seth Carus, "Missiles in the Third World: The 1991 Gulf War," *Orbis* 35, no. 2 (Spring 1991): 253–54.

20. Bermudez, "Iraqi Missile Operations During 'Desert Storm'," 134.

21. Ibid., 133.

22. Thomas A. Keaney and Eliot A. Cohen, *GWAPS Summary Report* (Washington, D.C.: Government Printing Office, 1993), 124.

23. Andrew Hull, "Motivations for Producing Ballistic Missiles and Satellite Launch Vehicles," *Jane's Intelligence Review* 5, no. 2 (February 1993): 87.

24. H. Norman Schwarzkopf with Peter Petre, *General H. Norman Schwarzkopf, the Autobiography: It Doesn't Take a Hero* (New York: Bantam Books, 1992), 412.

25. *GWAPS*, vol. 1, pt. 2, 246.

26. *GWAPS*, vol. 2, pt. 1, 182.

27. Jermano and Springer, 78–79.

28. Ibid., 79.

29. Keaney and Eliot, 79.

30. *GWAPS*, vol. 2, pt. 2, 333.

31. *GWAPS*, vol. 1, pt. 1, 167.

32. *GWAPS*, vol. 2, pt. 2, 312.

33. Cordesman and Wagner, 405 (note 25).

34. Woodward, 201, 363.

35. Tim Ripley, "Destroying Iraq's Ballistic Missiles," *Jane's Intelligence Review* 4, no. 10 (October 1992): 460.

36. Keaney and Cohen, 83.

37. Rick Atkinson, *Crusade* (New York: Houghton Mifflin Company, 1993), 146–47.

38. *GWAPS*, vol. 5, 545.

39. Keaney and Cohen, 83–84.

40. Schwarzkopf with Petre, 418.

41. Ibid., 421.

42. Lawrence Freedman and Efraim Karsh, "How Kuwait was Won," *International Security* 16, no. 2 (Fall 1991): 27.

43. *GWAPS*, vol. 2, pt. 2, 100–101.

44. See map 7.

45. *GWAPS*, vol. 2, pt. 1, 184.

46. Ibid., 187 (note).

47. *GWAPS*, vol. 2, pt. 2, 335 (text, note).

48. Carus, "Missiles in the Third World: The 1991 Gulf War," 254.

49. Bermudez, "Iraqi Missile Operations During 'Desert Storm'," 132.

50. *GWAPS*, vol. 2, pt. 1, 189.

51. Keaney and Cohen, 88 (chart).
52. Ibid., 89.
53. Bermudez, "Iraqi Missile Operations During 'Desert Storm'," 134.
54. Ibid.
55. Keaney and Cohen, 87.
56. *GWAPS*, vol. 5, 543.
57. W. Andrew Terrill, "The Gulf War and Ballistic Missile Proliferation," *Comparative Strategy* 11, no. 2 (April–June 1992): 168.
58. Ibid., 169.
59. *GWAPS*, vol. 2, pt. 1, 190.
60. Terrill, 170.
61. *GWAPS*, vol. 2, pt. 2, 331–32.
62. Ibid., 333.
63. Ibid., 334.
64. Ibid., 330.
65. Ibid., 331.
66. Ibid., 336.
67. *GWAPS*, vol. 2, pt. 1, 189.
68. *GWAPS*, vol. 2, pt. 2, 331–32.
69. *GWAPS*, vol. 1, pt. 2, 246.
70. *GWAPS*, vol. 2, pt. 1, 189–90.
71. Dr Thomas A. Keaney, "Gulf War Airpower Survey," lecture, School of Advanced Airpower Studies, Maxwell AFB, Ala., 26 August 1993.
72. Keaney and Cohen, 83.
73. *GWAPS*, vol. 2, pt. 1, 191.
74. An Al-Abbas long-range missile apparently hit the barracks. "DSPs Detected Fatal Scud Attack," *Aviation Week & Space Technology* 140, no. 14 (4 April 1994): 32.
75. Ripley, 459–60.
76. *GWAPS*, vol. 2, pt. 2, 320 (note).
77. Keaney and Cohen, 87.
78. Terrill, 167.
79. Ibid.
80. Freedman and Karsh, 28–29.
81. Terrill, 166.
82. Ibid., 168.
83. Ibid., 167.
84. Robert M. Stein and Theodore A. Postol, "Correspondence: Patriot Experience in the Gulf War," *International Security* 17, no. 1 (Summer 1992): 199.
85. Andrew Hull, "The Role of Ballistic Missiles in Third World Defence Strategies," *Jane's Intelligence Review* 3, no. 10 (October 1991): 466.
86. Keaney and Cohen, 81.
87. Freedman and Karsh, 26 (note). See also Terrill, 170. The Iraqis possessed 30 chemical Scud warheads. See Gerald M. Steinberg, "Israeli Responses to the Threat of Chemical Warfare," *Armed Forces and Society* 20, no. 1 (Fall 1993): 86.
88. McGeorge Bundy, "Nuclear Weapons and the Gulf," *Foreign Affairs* 70, no. 4 (Fall 1991): 84. The letter, delivered by Secretary of State James Baker to Iraqi Foreign Minister Tariq Aziz, was rejected, but its contents were published in newspapers around the world. See also Richard H. Shultz, Jr., and Robert L. Pfaltzgraff, Jr., *The Future of Air Power in the Aftermath of the Gulf War* (Maxwell AFB, Ala.: Air University Press, 1992), 205.
89. Carus and Bermudez, "Iraq's *Al-Husayn* Missile Program," pt. 2, 242.
90. Freedman and Karsh, 15.
91. Janice Gross Stein, "Deterrence and Compellence in the Gulf, 1990–91," *International Security* 17, no. 2 (Fall 1992): 177 (note).
92. *GWAPS*, vol. 4, pt. 1, 35.
93. *GWAPS*, vol. 2, pt. 1, 180.

94. Carus, *Ballistic Missiles in the Third World*, 33; and Carus, "Missiles in the Third World: The 1991 Gulf War," 257.
95. *GWAPS*, vol. 2, pt. 1, 338.
96. Ibid., 182.
97. Carus, "Missiles in the Third World: The 1991 Gulf War," 255.
98. *GWAPS*, vol. 2, pt. 2, 15.
99. Hull, "The Role of Ballistic Missiles in Third World Defence Strategies," 466.

Chapter 4

Peripeteia

Changes to the Problem

The whole of the next war was there.

—Col Peter Beasley

Fifty years have passed since the Germans first used the V-1 and V-2 against the Allies. Three have passed since the Iraqis launched Scuds in the Persian Gulf War. The inaccuracies of these missiles did not detract from their strategic utility. Germany and Iraq both attacked strategic targets—cities—in the enemy's rear areas. In both cases, had less than cool heads prevailed, the Germans and Iraqis might have achieved their objectives. In the case of Germany, a second invasion at Pas de Calais was urged by Lord Morrison. In the case of Iraq, the Israeli government's restraint overcame a storm of criticism from within the government itself, the Israeli press, and a significant portion of the Israeli population.

The inaccurate V-1s, V-2s, and Scuds were much less effective in attacking military targets directly. Even so, the occasional "lucky" hit on the Air Ministry in London and the barracks in Dhahran demonstrated the possible effects of a well-placed missile. Airpower was used in both cases to destroy the missiles as part of a strategic air campaign, to satisfy governments and populations that something was being done. In both cases, airpower had limited effects on launch rates. On the other hand, the biggest threat these missiles posed to airpower was indirect—a diversion of effort from the main tasks. US air forces may not be as fortunate in the future. Third world countries are acquiring the cruise and ballistic missiles capable of directly assailing airfields that have previously been considered airpower sanctuaries.

Significant improvements in third world missile capabilities are evident in two areas: refinements to the missiles themselves and enhancements in the command structures' abilities to wield them effectively against enemy military forces. Third world cruise missiles and ballistic missiles will continue to be a problem for US airpower, and their capabilities are growing.

One need only consider the uses of tactical ballistic missiles (TBM) in the last 21 years to see how important they are becoming to third world countries and regional powers. Egypt launched several hundred Scud-B and Frog 7 ballistic missiles at Israeli command posts in the Sinai during the opening hours of the 1973 Yom Kippur War. The attacks aimed to disrupt Israeli command and control.[1] While few of the missiles struck their exact targets,

their effect was almost as good as destroying a command post. One commander could not fly to his command post by helicopter because of the intermittent Scud and Frog attacks. He remained out of his headquarters during the key hours when the Egyptians crossed the Suez Canal and the Israelis organized their defenses and prepared to retreat. (Of interest, this disruption was the exact effect the Nazis had hoped to achieve during the opening hours of the Allied invasion of the continent, if the V-1s and V-2s had been ready.) As discussed, Iran and Iraq fired over 500 Scuds apiece at one another. Libya fired two Scuds at a US Coast Guard base on the Italian island Lampedusa in 1986 after the El Dorado Canyon raid on Tripoli. Both missiles fell harmlessly into the Mediterranean Sea. Libyan president Muammar Qadhafi said if he had possessed a missile that could have reached New York he would have used it.[2] The Afghan government fired over 1,000 Scuds at the Mujahedin since the Soviets removed their troops in 1988. Iraq fired only 88 Scuds during Desert Storm, for whatever reasons, but they still caused tremendous concern for the coalition.

Alternate missions for ballistic missiles include: symbolic strikes, deterring enemy attacks, spoiling an enemy victory, wrecking his will, achieving surprise, deep-strike interdiction, and substituting for the lack of an air force. Probable targets might include cities, large military bases, fixed troop staging areas, surface-to-air missile (SAM) sites, industrial facilities, and oil refineries. One lucrative target mentioned in some literature is the Diego Garcia preposition area.[3] Since Desert Storm, Syria has acquired more Scuds from North Korea because of the missile's survivability and strategic effectiveness in disrupting coalition airpower strategy during the Gulf War. Syria's missiles tend to compensate for loss of its former superpower patron, the Soviet Union. Syria is acquiring cruise missiles also, both for conventional and unconventional warheads.[4] It would likely use recently acquired SS-21s to hit Israeli rear areas, and probably air bases.[5]

Cruise missiles have been used in fewer numbers than ballistic missiles, but three instances demonstrate their potential power. In the Falklands in 1982, Argentine navy pilots flying two Super Etendard aircraft fired four French-made AM-39 Exocet antiship missiles. They sank two British ships, the HMS *Sheffield* and the *Atlantic Conveyor*. Another Exocet, fired from a modified ship launcher installed on a flatbed truck, hit the HMS *Glamorgan* and put it out of action for the better part of two days. Iraqi Super Etendards attacked and hit the USS *Stark* in 1986, killing 32 sailors and seriously damaging the ship. While these Exocets were not land-attack cruise missiles, they could easily be modified into them, as the French are currently doing. The US Tomahawk cruise missiles in Desert Storm hit numerous targets with great accuracy after flying hundreds of miles. The powerful effects of cruise missiles are not lost on third world governments, and many are beginning to procure them in numbers. The result is an evolving dual threat—many third world countries may eventually have TBM *and* cruise missiles. The combination presents a unique—and serious—threat to airpower.

Third world nations are actively working to improve TBMs and cruise missile accuracies. First, they are obtaining newer, modern, more accurate missiles. The SS-21 Scarab is a prime example, and the Russians are aggressively marketing it in the Middle East. The missile carries a 1,000 pound warhead, has a normal range of 70-120 km (42–72 miles), an extended range of 150 km (90 miles) if the warhead is lightened, and a CEP of 160 meters.[6] The Russians have recently upgraded the SS-21, giving it an improved CEP of 15 meters (45 feet).[7] The missile uses mobile TELs that are slightly smaller than the Scud MAZ-543. Trained crews can stop, erect, and launch the SS-21 in 17 minutes. The crew can then reload the TEL and fire again in 40 minutes. Since the 9P129-1 TEL vehicle has a built-in geodetic survey system, no presurveyed launch sites are required.[8] The nose has a radar scene-matching terminally guided warhead (TGW), a preprogrammed inertial navigation platform, and a laser altimeter. Alternate guidance packages offered by the Russians include an antiradar—specifically, an anti-Patriot—seeker, and a variety of submunitions. Syria reportedly possesses six 9P129 TELs and 18 SS-21 missiles.[9] Solid rocket fuel will cut lengthy preparation times and thereby significantly reduce launch times of mobile missiles.[10] Warning cues and intercept times will correspondingly decrease, and as they do, the threat to air bases will substantially increase.

Equally ominous are improvements to current operational missiles. One obvious way to eliminate Scud inaccuracies is to change the type of warhead from conventional to chemical, biological, or nuclear. Iran is believed to have four nuclear warheads, acquired from the former Muslim republics of the Soviet Union.[11] Two of them are 40 kiloton (kt) Scud-C warheads. Secretary of Defense William Perry believes North Korea possesses two nuclear warheads and will attempt to build 12 per year.[12] Iran and North Korea are working together on the Nodong-1 Scud-D, which will have a range of 1,000 km (600 miles) and possess chemical or nuclear capability.[13] Iran has also obtained eight supersonic cruise missiles from Ukraine.[14]

The proliferation of cruise missiles allows third world countries a cheap, relatively accurate, powerful weapon to strike at an enemy target hundreds of miles away. There is currently a shift, or “crossover,” occurring place in the buying market, with cruise missiles replacing ballistic missiles because the cruise weapons are less complex, more accurate, and cheaper. Nonetheless, most third world countries buying cruise missiles are not reducing or eliminating ballistic missiles from their arsenals.[15] Instead, they are creating a dual missile capability in which cruise missiles have become a key component. Cruise missiles are less technologically complicated and demanding than tactical ballistic missiles. They are cheaper, too, and can cost less than $100,000 each, one-tenth of the typical $1 million ballistic missile.[16] The small, aircraft-like unpiloted vehicles are fairly simple, relying on unsophisticated technology.[17] They provide minimum radar cross section, no landing gear, no weapons pylons, no (or small) intake cavities, and they are easy to cover with materials that make them stealthy.[18]

French and Chinese cruise missile development exemplify the emerging threat they pose. The French are actively marketing their new Super Apache, an upgraded version of the Apache land attack cruise missile. The Super Apaches can fly in all weather conditions except heavy rain. Warheads and submunitions (several warheads packed onto a single missile) are optimized for moving, fixed, or hardened targets, and the wide variety of munitions can be adjusted to increase missile range. Current Super Apache maximum range is 500 km (300 miles). It may be used against the entire array of targets: cities, airfields, ports, barracks, troop concentrations, armor, ships, power plants, industry, buildings, and possibly even an enemy's ballistic missile infrastructure.[19] These cruise missiles use an inertial navigation system with global positioning system (GPS) updates, and a GPS or millimeter radar terminal guidance, which gives them a CEP accurate enough to hit buildings.[20] The Chinese have actively marketed cruise missiles as well, and expect to dominate the "low end" of the market with Russian technical assistance. Chinese cruise missiles are large, but they are accurate, and will have stealthy features by the year 2000, including a reduced infrared heat signature and radar absorbing materials.[21]

French, Russian, Swedish, and Chinese companies are converting deployed antiship missiles into land attack cruise missiles. Sweden, for example, is modifying its RBS-15 as an autonomous standoff missile (ASOW) to compete with the US standoff land attack missile (SLAM), which is derived from the antiship Harpoon. The French are modifying the AM-39 Exocet (30-mile range) into a ground attack missile.[22] At least 120 countries worldwide have the Exocet in their inventories and all could be candidates for such an upgrade.[23] The host of Exocet users includes such potentially volatile states as Egypt, Pakistan, Singapore, South Africa, Libya, India, Iraq, Argentina, and Peru. Similarly, the Russian's KH-35SE Harpoonski antiship cruise missile (so named because of its similar performance with the US Harpoon), with a 150-mile range, is being modified into a tactical land attack missile with a 300- to 360-mile range, and uses an inertial navigation system (INS), terrain correlation, and Glonass (the Russian GPS equivalent) to obtain a 20- to 30-yard CEP.[24] Pentagon officials expect Syria and China to have stealthy cruise missiles by 2000–2010, while other probable countries include France, Israel, Japan, South Africa, North Korea, Taiwan, Sweden, and Germany.[25] Most, if not all, of these nations will work with other countries to offset research and development costs, so the list may be considerably longer.

During Desert Storm, one Scud fired at Saudi port Jubail on 16 February 1991 hit only 300 meters from a large truck park and a pier where eight ships were offloading military supplies. The ships contained ammunition and all of the provisions for the US Marine Corps (USMC) air units, while the pier itself held 5,000 tons of artillery ammunition. Modest improvements in missile accuracies will almost assuredly mean these targets stand a much higher chance of being hit in the next war.[26] The INS on the Scud could be replaced or augmented by a GPS receiver with minimal reengineering, which could significantly increase accuracy.[27] Scuds could then be used against targets

that are more compatible with their warheads. The number of viable targets increases dramatically, forcing an enemy to deploy and disperse his forces, and reducing his operational flexibility. Fewer weapons would be required to destroy a given target or achieve the desired effect.[28] Precision accuracy to within 5 meters is available through commercial equipment. GPS guided bombs have hit within 15 meters of their targets without terminally guided warheads,[29] and GPS installed in ballistic and cruise missiles could exhibit similar accuracies. The US GPS and Russian Glonass are both being heavily exploited by friendly nations, neutrals, and regional enemies. GPS has become a valuable staple to the civilian and commercial sector, causing the Department of Transportation to take control of it from the Department of Defense (DOD). As the US and international business communities become more and more reliant on GPS, it will be less likely that the system will be denied to civilian users in a war not waged for national survival. Therefore, third world nations might reasonably expect to have at least a degraded GPS capability.

GPS is one reason cruise missiles are becoming the "weapon of choice" over the ballistic missile. In less than five years GPS guidance receivers will be integrated into cruise missiles for less than $2,000 each.[30] GPS can easily be tied directly into the INS of both cruise and ballistic missiles.[31] It is also simple and inexpensive to obtain, as purchasing it does not require a US government approved contract or coordination with America's foreign military sales office.[32] Thus, an entire spectrum of GPS equipment is available on the international commercial market. Some of the equipment is so precise it allows airliners to autoland, a capability that translates directly into an ability for cruise missiles to hit a small target.

The US military still controls GPS access. When the GPS satellites' "selective availability" feature is activated, it produces a degrading signal error that reduces positional accuracy for civilian users from 30 to 100 meters.[33] Only the military users have accuracy beyond 16 meters. The US military still retains control over selective availability, and has decided to leave it on since Desert Storm—meaning civilian and commercial users get the degraded information. As a result, a technique known as differential GPS (DGPS) is flourishing.

DGPS provides location information that is accurate to 5 meters or less.[34] The system calculates the GPS error from a known position, and then generates a correction signal. The Norwegian DGPS is typical of the ones being constructed in several countries, including the US, for civil purposes. It consists of a network of ground-based stations called a satellite-based reference system. This system determines the GPS error, and then transmits a correction signal on public AM and FM radio frequencies sidebands. It may eventually replace current maritime and aviation navigation aids.[35] Norway, Japan, and Sweden are developing DGPS systems that provide five-meter accuracy for mobile receivers and "centimeter" accuracy for stationary receivers.[36] National Aeronautics and Space Administration (NASA) and Federal Aviation Administration (FAA) have used the DGPS to demonstrate

autolanding capabilities with a Boeing 737. The accuracies they obtained to accomplish this amazing feat were 0.1 meters.[37] Despite their civilian uses, the military potential of DGPS signals is enormous. First, third world countries will ostensibly buy them for civil uses, but the military applications will be impossible to deny. Second, as the international community becomes more reliant on DGPS for safety and commercial use, the likelihood of the US DOD turning the signal completely off becomes remote. Yet, even if GPS is turned off, there remains Russia's Glonass.

Glonass is not as accurate as GPS, pinpointing latitude and longitude to within 100 meters and altitude to within 150 meters. Still, this precision represents a quantum leap for third world ballistic and cruise missile capabilities. While they would prefer GPS accuracy, third world countries using Glonass possess the capability to hit larger targets like the pier at Jubail. One company has integrated both GPS and Glonass receivers into a single system to improve accuracy, and assure reliability.[38]

The combination of GPS and commercial imaging satellites that depict target areas in a photographic-like display help solve targeting problems for third world countries. The ability to locate and identify targets and to assess battle damage are available for the asking. Photographic imagery is currently available from several countries. The Soviet Union (now Soyuzharta of Russia) has been selling five-meter resolution images since at least 1988. About 10-meter resolution—approximately 33 feet—is needed to distinguish buildings.[39] Soyuzharta's images may be as much as four months old, but they are useful for pinpointing locations of fixed targets.[40] Even if third world governments and militaries were denied such information in a crisis, they could assemble a substantial amount of target data in two ways: first, through commercially available images; and second, by using GPS handheld receivers from known locations.

Imaging satellites satisfy resolution requirements to differing degrees. Landsat originally launched in 1972 with 80-meter resolution, by 1990 it was down to 30 meters. Landsats are now controlled by the Earth Observation Satellite (EOSAT) Company which sells the images to commercial interests.[41] The French sell SPOT images with 10- to 20-meter resolution, and the Russians sell images down to five meters.[42] In October 1990, during the Desert Shield buildup, ABC news purchased five-meter resolution imagery that was detailed enough to show not only how many transport planes were parked on the ramp at Dhahran but also what type they were (they decided not to use them on public television broadcasts).[43]

Iraq relied heavily on satellite imagery in its war with Iran. The Iraqis attempted to obtain images of the Persian Gulf region from EOSAT after invading Kuwait, but the UN embargo effectively cut off this flow of information.[44] "The grand deception carried out by coalition forces in the recent Persian Gulf War would have been greatly complicated, if not made impossible, had Iraq possessed timely data from observation satellites."[45] Gen Merrill A. McPeak, Air Force chief of staff, said, "Any element of surprise would have been lost. Certainly, many more American casualties would have

resulted."[46] The same weather information that went to Turkey, Israel, India, and Egypt from the National Oceanic and Atmospheric Administration (NOAA) satellites went to Iraq, and was possibly used for planning Scud launches.[47]

Imaging satellites and their high resolution products are becoming easily available to any user. The French Helios satellite, a joint venture with Spain and Italy, will have a one- or two-meter resolution and is being offered to commercial users.[48] US congressmen and aerospace industry representatives are pressuring the Central Intelligence Agency (CIA) to ease the export and sale restrictions on high-resolution imaging satellites and data with resolutions of one meter or less.[49] Six US companies (TRW, Boeing, Martin Marietta, Litton, McDonnell Douglas, and GDE Systems, Inc.) want the US government to allow them to sell systems in the one-meter or "medium" resolution category, citing the French Helios military reconnaissance satellite offers for commercial users. Russia offers military reconnaissance systems and launch services for sale, while Germany is developing a one- to two-meter resolution system and the Chinese and Israelis are talking to potential customers.[50] Litton's Itek Optical believes it lost a sale to the United Arab Emirates (UAE) because of US government delays.[51] Itek attempted to sell a two-satellite system called Murakaba to the UAE that would provide 0.8 meters (2.6 ft.) resolution. The UAE, Spain, Saudi Arabia, South Korea, and Taiwan are all interested in purchasing US satellite systems or imaging capabilities. Lockheed wants to market a one-meter resolution system, while two other US companies are developing three-meter systems. Since one-meter resolution is no longer state-of-the-art, the US government will probably eventually yield to industry pressure.[52]

Although cruise and ballistic missiles can obtain great accuracy, to guarantee that they work as advertised requires reliable communications. Dependable communications are needed to get launch orders to the missile launch crews. To assure a secure link between the commanders and the TELs in the field, many third world militaries use commercially available communications satellites. Cellular telephones are also an easy and reliable means of communication. While vulnerable to jamming, the jamming signal might also interfere with the jammer's communications as well, or those of a neutral party. Many systems, however, are difficult to jam. A Russian company, Global Information Systems (GIS), wants to market "advanced" communications and data transmission satellites using technology previously available only to the military.[53] An example of the sophisticated technology, GIS is offering a steerable, phased array antenna that "steers" the satellite's focus to specific areas for data and communications transmission, making it more difficult to jam.[54] Third world countries can also use fiber optic cables as did the Iraqis in the 1991 war. They can further use motorcycle couriers. In short, stopping all communications between commanders and TELs in the field poses considerable problems.

Finally, many third world nations possess chemical or biological warheads that exponentially magnify the problems presented by conventional munitions.

While there are difficulties associated with delivering them by ballistic missile, cruise missile delivery is a more viable option. Having them hit airfield-size areas is not a problem with GPS and the other navigational systems available.

Implications

What may be the impact of the vast array of technological wizardry? Improved ballistic and cruise missiles, accurate position determination and navigation systems, adequate target images, weather data and communications combine to give third world nations a credible capability against land-based airpower. If airpower is based within range of a ballistic or cruise missile system, a third world country today has a good chance of hitting at least some of the larger targets on the airfield. The disrupting effects of such attacks on the tempo and timing of operations will be significant. In addition, some of the support facilities, buildings, and aircraft in the open will inevitably be destroyed and damaged. By putting airfields at risk, the missiles ultimately threaten air superiority. If they hit an F-15E or F-111 base, for example, they have limited the capability to attack the enemy's air force. The possibility of a third world air force surviving more than a few days may increase dramatically with accurate missiles. If the missile attacks are against F-15C bases, then the ability to defend against conventional air attacks will be degraded. Perhaps the most lucrative and tempting targets are the "force multipliers," the bases housing AWACS, J-STARS, airborne battle- field command and control centers (ABCCC), and tankers.[55] Without these aircraft—which cannot be placed in hardened shelters—the ability to conduct an air campaign becomes problematic. Additionally, the intended use of airpower may be radically altered—as was the case against the V-weapons and the Scuds—if the missiles have a strategic impact on the war. Given that missile accuracies are now vastly improved, even over those used in the Persian Gulf, the likelihood that airpower would again be diverted to Scud Hunt is high. Yet the significant cutbacks in the American military may diminish significantly the number of aircraft available to do the hunting. And even if the aircraft are available, the probability that they will find the missiles is remote.[56]

As the USAF shrinks and its numbers grow smaller, any of these scenarios does not portend well for the future. Some new capabilities—such as an improved Patriot antimissile system—are emerging to counter the ballistic missile threat, but the cruise missile threat may, in the long run, prove the more difficult challenge. Antimissile system command and control elements may themselves be vulnerable to missile attacks, as demonstrated in the anti-Patriot version of the SS-21 Scarab. One conclusion becomes more obvious as the missile threat grows and the US air forces dwindle—the excess

of airpower that could be siphoned off to chase V-1s and Scuds will not be there.

Fully one-third of the US tactical air forces went to Desert Storm, including 90 percent of the F-111s, F-117s, and F-15E strike aircraft. Over half of the tankers and command and control aircraft deployed, and almost all of the reconnaissance and electronic warfare aircraft.[57] None of those aircraft were more than casually exposed to an Iraqi missile threat. If even a portion of the airfields had been hit by a half a dozen well-placed Scuds, the land-based air operations for the rest of the war would have been tenuous. If an unconventional warhead was used, many of the operations would have ceased altogether. Today's widespread proliferation of ballistic and cruise missiles has perhaps redefined the notion of "command of the air" espoused over a half century ago by Giulio Douhet. The possibility now exists that a nation can obtain air control without possessing an air force.

Countering the Threat

The US is improving the capabilities of land-based airpower to deal with ballistic and cruise missile threats. Ballistic missiles have received a great deal of emphasis since Desert Storm, and important progress has been made in refining the intelligence, targeting, detection, discrimination, and surveillance techniques to negate them. The most desirable time to destroy TELs is before the enemy launches his missiles, and barring that, then immediately after the launch but before the TELs can leave the area. Accurate, timely intelligence and targeting information are vital.[58]

One promising system currently under development by MITRE Corporation will enable the USAF to provide intelligence and targeting information using "data fusion." The system, flown aboard J-STARS, fuses a wide variety of sensor information from radar, identification friend or foe (IFF) systems (systems that sort enemy from friendly aircraft on radar screens), electronic support measures (ESM), and Constant Source, which itself consolidates information from several intelligence sources. Additional information can come from fighter radars, unmanned aerial vehicles (UAVs) with various sensors, AWACS, and defense support program (DSP) satellites. J-STARS can help track and locate ground vehicle movements over time. This information in turn can help identify numbers of vehicles and patterns of deployment that are associated with TBM systems such as the Scud. ESM systems and Constant Source can further correlate any vehicle electronic emission patterns and their points of origin. All of this information can be consolidated—fused—and displayed on a single screen in "real time" or by replaying a tape to determine the likely positions of the TELs.[59] The J-STARS radar is sensitive enough to create an image of a stationary vehicle. Further refinements will allow identification of specific types of TELs and associated

support vehicles.[60] Once a TEL is located and identified, the information can be relayed to F-15Es or other aircraft for destruction.

The MITRE Corporation system should also help provide launch warning, determine the missile's impact point, and plot its trajectory to determine its launch area. AWACS would help detect and track ballistic missiles using an improved radar or infrared heat detection. Since ground vehicle movements and positions can be reviewed and transmitted to a fighter, there is a greater chance to destroy the TEL.[61] Live-fire exercises have validated such procedures.[62]

Other means for identifying missiles include the laser imaging detection and ranging (LIDAR) and constant surveillance. LIDAR is flown on an RC-135 or U-2, and helps determine if the enemy has chemical, biological, or nuclear weapons within a certain area. A laser fired into the area can detect even trace amounts of chemicals, radioactive isotopes associated with nuclear weapons, or biological weapons. The system could identify which areas were most likely to contain TELs with these weapons, assisting planners and commanders in assigning target priorities.[63]

Unmanned aerial vehicles can also assist in missile identification. A novel approach is being tested to guarantee constant surveillance of suspected ballistic missile TEL operating areas. The Raptor/Pathfinder is a 100-foot ultralight flying wing designed to carry several different sensors at 100,000 feet to survey an area continuously and to provide launch warning of ballistic missiles. It eventually will stay aloft for weeks or months at a time. The Raptor/Talon is a smaller, more conventional appearing UAV that will carry sensors at 65,000 feet for two days. Raptor/Talon will be paired with the Raptor/Pathfinder, and is projected to shoot kinetic kill hypervelocity missiles that travel one to two miles per second for a 60- to 120-mile range. Features of space-based detectors will be duplicated in the Pathfinder and Talon at a fraction of the cost, with a constant "long dwell time" in suspected TBM areas rather than fleeting presence of satellites. The advantage of the system is in targeting and in "boost-phase" interception of the missile's flight. Raptor/Talon's sensors will be sensitive enough by themselves to distinguish between SAMs, burning ground fires, and ballistic missile plumes.[64] Air Force generals Charles Horner and Merrill McPeak support the program. General Horner, the current commander in chief (CINC) US Space Command, has said that the best way to destroy TBMs is at the factory, then in storage, then at the launch site, and lastly in flight.[65] Maj Gen Kenneth Israel, director of the newly established Defense Airborne Reconnaissance Office (DARO), stated that the UAVs expendability in high-risk areas can provide key reconnais- sance data (including GPS coordinates) to direct aircraft airborne sensors. DARO is currently using Raptor UAVs for sensor testing, including synthetic aperture radar (SAR). SAR promises better penetration of inclement weather than electro-optical sensors limited by humidity, rain, fog, and clouds.[66] This capability is particularly valuable since TBMs and cruise missiles may be most useful in bad weather when current electro-optical sensors are useless. In the event of launch, DSP satellite data merged under Talon Shield will provide better detection, tracking, and location information.

Talon Shield merges and processes multiple signals from below-the-horizon and above-the-horizon views of multiple DSP satellites.[67]

Additional test results also appear promising. Operation Crossbolt 1 in January 1993 used current aircraft and sensors (U-2R with advanced SAR, RC-135S Cobra Ball with long-range infrared sensors, J-STARS, etc.) to locate a simulated SS-21 Scarab launch site (simulated by an Army Lance missile) and pass the information to an F-15E to destroy the TEL. The F-15E took 32 minutes to receive information, locate the target, and destroy the TEL. In Desert Storm, the Iraqis moved their Scud TELs in six minutes, so the 32 minute delay was far too long. Operation Crossbolt 2 will work to cut the time to less than 10 minutes from the time the TEL fires the missile until the time an aircraft destroys it. Air Combat Command officials do not believe even 80 percent efficiency will be required, because the TBM launch rate will decline—just as the SAM rate in Desert Storm did—for fear of attack. According to Col Patrick Garvey, chief of Air Combat Command's theater air defense division, "The idea is to make life miserable for the Scud crews."[68]

The short range attack missile (SRAM) lightweight exoatmospheric projectile (LEAP) concept being examined by the USAF and Boeing is designed to attack TBMs in flight. It replaces the AGM-69A SRAM nuclear warhead with a LEAP kinetic energy kill interceptor. The SRAM then essentially becomes a radar-guided missile fired from an F-15 to hit ballistic missiles in the boost phase.[69]

The Advanced Research Projects Agency's (ARPA) "War Breaker" automates the intelligence, planning, and targeting functions to reduce the time required to destroy time-critical targets (TCT) like Scud TELs. War Breaker combines many technologies and smart weapons, fuses their characteristics with intelligence details about enemy units, doctrine, geography, terrain, most recent position, and known capabilities to predict target location. The result is a "high probability area" for TCT search. War Breaker uses sensors on UAVs, airborne platforms, or satellites to verify the TCT, then assigns a "shooter" to attack it.[70] It can survey 100,000 square kilometers in 45 to 60 minutes, and its sensors will even "see" through trees and vegetation.[71]

Improved surveillance may result in third world nations using "stealth camouflage" to hide their TELs. Stealth structures were designed by US Army's Space and Strategic Defense Command to cover vehicles and bunkers, allowing them to deflect and absorb radar signals, and making it difficult for new high-resolution radars to pick them out.[72] Third world nations will probably emulate this technique over time, meaning they could use it to hide TELs. Even so, Larry B. Stotts, assistant for sensors and processing in ARPA's Advanced Systems Technology Office, has said the numerous War Breaker sensors operating in different bands would make it "very hard for an enemy to hide."[73] Overcoming decoys and stealth camouflage techniques is not likely to be easy.[74]

Patriots remain a primary defense against TBMs, and the Army is improving Patriot capabilities. The new Patriot advanced capability (PAC)-3 modification is undergoing testing. Older Hawk missile systems of the USMC

and Army National Guard (ANG) are also receiving antiballistic missile capabilities. The Hawk upgrades are specifically designed for short-range TBMs (Frog-7s) like those in Korea.[75]

Negating the cruise missile threat will likely prove much more difficult than thwarting TBMs. Cruise missiles in the short term will be dealt with similar to enemy aircraft, using airborne interceptors with look-down, shoot-down radars as well as ground defense systems. In the long term, stopping cruise missiles will require a new generation of passive infrared and active radar detection equipment. According to General Horner, the follow-on early warning system (FEWS) satellites will help solve the cruise missile problem. FEWS will have some capability to detect and track cruise missiles, but the capability is conditional, highly dependent on viewing angle and atmospheric conditions to track such a small heat source accurately.[76] Because current commercially available GPS receivers can be used in their manufacture, cruise missiles pose a tremendous problem. With available imagery and GPS coordinates, almost any structure can be targeted, according to Henry D. Sokolski, the DOD deputy for nonproliferation policy. "Anything that can be targeted will be vulnerable," he asserts, "and the accuracy will be relatively good."[77]

Outside the scope of this paper, but related to its focus, are the Non-Proliferation Treaty (NPT) and the Missile Technology Control Regime (MTCR). Both are legally undermined and circumvented.[78] Countries that build nuclear power and research facilities acquire the know-how to separate weapons-grade nuclear material, particularly plutonium. This is part of the ongoing verification and inspection problems with North Korea. Additionally, third world countries, like Iran and North Korea, have worked together to develop weapons of mass destruction and delivery systems like the Nodong missile. The NPT is up for review in 1995, and Japan may not support the "indefinite extension" of the NPT sought by the Clinton administration due to North Korea's nuclear and Nodong missile programs. In addition, several third world countries may tie their support of the NPT to a "no-use on us" pledge by the US.[79] The MTCR has become meaningless in some regions, such as the Korean peninsula. The range of SS-21 is sufficient to hit much of South Korea—including important air bases such as Osan and Kunsan—from positions well inside North Korea. But the SS-21 does not fall under the MTCR.[80] Finally, the MTCR is not a formal treaty, but an agreement between seven nations. There are no international bodies to enforce agreements with sanctions.

It remains to be seen if the improvements to airpower capabilities will offset the improvements to ballistic and cruise missiles. In the near term, further developments of existing systems seem to promise much better results than the Scud Hunt in Desert Storm—assuming similar conditions. The degree of success may differ substantially, however, if conditions vary—such as the enemy's number of TELs, his targeting strategy, decoys, overall ground forces dispositions, and how he chooses to employ his air force. Other factors include the number and location of US air bases, the types of aircraft employed, and their vulnerability to missile attack. Current situations worldwide offer

sobering scenarios. In the wars of the future, missiles may indeed become the dominant factor in the ability to achieve command of the air.

Notes

1. Joseph S. Bermudez, Jr., "Ballistic Missiles in the Third World—Egypt and the 1973 Arab-Israeli War," *Jane's Intelligence Review* 3, no. 12 (December 1991): 537.
2. Andrew Hull, "The Role of Ballistic Missiles in Third World Defense Strategies," *Jane's Intelligence Review* 3, no. 10 (October 1991): 467.
3. Ibid., 469–70. Diego Garcia is a small island in the Indian Ocean used as an airfield and preposition area for US equipment.
4. Michael Eisenstadt, "Syria's Strategic Weapons," *Jane's Intelligence Review* 5, no. 4 (April 1993): 169–72.
5. Joseph S. Bermudez, "Syria's Acquisition of North Korean 'Scuds'," *Jane's Intelligence Review* 3, no. 6 (June 1991): 249.
6. Steven Zaloga, "The Tochka Tactical Ballistic Missile System," *Jane's Intelligence Review* 6, no. 1 (January 1994): 6–10.
7. Christopher Foss, "Russia Puts Pinpoint Missile on Market," *Jane's Defense Weekly* 8, no. 20 (21 August 1993): 9.
8. Zaloga, 8.
9. Ibid., 8–10.
10. W. Seth Carus, "Missiles in the Third World: The 1991 Gulf War," *Orbis* 35, no. 2 (Spring 1991): 256.
11. James Wyllie, "Iran—Quest for Security and Influence," *Jane's Intelligence Review* 5, no. 7 (July 1993): 311.
12. "Nuclear Arms in Korea Call for Tough Diplomacy," *USA Today* 12, no. 127 (4 April 1994): 14.
13. Gen Charles Horner, CINC US Space Command, believes that for the next five years the USAF is vulnerable to tactical ballistic missile attacks, particularly the Nodong-1. See John D. Morrocco, "Airlift, Intelligence Continue to Pose Problems," *Aviation Week & Space Technology* 140, no. 3 (17 January 1994): 44.
14. Wyllie, 312.
15. David A. Fulghum, "Cheap Cruise Missiles a Potent New Threat," *Aviation Week & Space Technology* 139, no. 10 (6 September 1993): 54.
16. According to Reid Goldstein and Anthony Robinson, *Forecast International/DMS Market Intelligence Report: Missiles* (Alexandria, Va.: Jane's Information Group, 1994), Tab D, "Nodong-1" (Scud-Mod Series), 1, the North Koreans' Scud-C costs $890,000 to produce, and the Nodong-1 costs $1.4 million each. North Korea currently has 835 Scuds and Nodong 1 missiles in its inventories, and is producing slightly over 100 total missiles per year. (Ibid., 4)
17. Fulghum, 54.
18. Ibid., 55.
19. "Cruise into the Future," *Jane's Defense Weekly* 17, no. 25 (20 June 1992): 1079.
20. Ibid.
21. Fulghum, 54.
22. Ibid., 54–55.
23. David A. Fulghum, "Mideast Nations Seek to Counter Air Power," *Aviation Week & Space Technology* 138, no. 23 (7 June 1993): 79.
24. Fulghum, "Cheap Cruise Missiles a Potent New Threat," 55.
25. Ibid.
26. Raffi Gregorian, "Global Positioning Systems: A Military Revolution for the Third World?," *SAIS Review* 13, no. 1 (Winter/Spring 1993): 133.
27. Ibid., 139.
28. Ibid., 144.
29. Ibid., 136.

30. Fulghum, 79.
31. Gregorian, 139.
32. Ibid., 144.
33. Andrew Wilson, ed., *Jane's Space Directory 1993–94* (Coulson, UK: Jane's Information Group, Ltd., 1993), 197.
34. Gregorian, 137.
35. Bruce D. Nordwall, "Norway's Broadcasters to Carry D-GPS Signal," *Aviation Week & Space Technology* 139, no. 5 (2 August 1993): 59.
36. Ibid., 59.
37. Edward H. Phillips, "D-GPS Systems Demonstrate Precision Autoland Capability," *Aviation Week & Space Technology* 139, no. 12 (20 September 1993): 86.
38. Bruce D. Nordwall, "Filter Center," *Aviation Week & Space Technology* 139, no. 22 (29 November 1993): 59. The combined accuracy of GPS and Glonass is better than either one, at least in preliminary tests. See Bruce D. Nordwall, "Navsat Users Want Civilian Control," *Aviation Week & Space Technology* 139, no. 16 (18 October 1993): 59.
39. Richard Davis, "Spying on the Government: The Media, Remote-Sensing Satellites, and U.S. National Security Policy," *Political Communication* 9, no. 3 (July–September 1992): 192.
40. Ann M. Florini, "The Opening Skies," *International Security* 13, no. 2 (Fall 1988): 105.
41. Davis, 193.
42. Ibid.
43. Ibid., 196.
44. Thomas G. Mahnken, "Why Third World Space Systems Matter," *Orbis* 35, no. 4 (Fall 1991): 568.
45. Ibid., 577.
46. James D. Asker, "Space Key to U.S. Defense," *Aviation Week & Space Technology* 138, no. 18 (3 May 1993): 57.
47. Davis, 202.
48. Dr Bhupendra Jasani, "The Value of Civilian Satellite Imagery," *Jane's Intelligence Review* 5, no. 5 (May 1993): 235. This article demonstrates how commercially available images, in this case photos of the Golan Heights from the SPOT satellite, can be used to monitor cease-fire agreements. The photos also clearly demonstrate the need for trained interpretation, and the limits of verifying underground facilities. See also John D. Morrocco, "Lawmakers Warn Clinton on Satellite Imagery Sales," *Aviation Week & Space Technology* 139, no. 21 (22 November 1993): 38.
49. Jeffrey M. Lenorovitz, "Industry Presses CIA to Ease Curbs on Imaging Satellites," *Aviation Week & Space Technology* 138, no. 25 (21 June 1993): 80.
50. Ibid.
51. Ibid., 80–81.
52. James R. Asker, "Pressure Builds to Free Satellite Imaging Sales," *Aviation Week & Space Technology* 139, no. 20 (15 November 1993): 26–27.
53. "Russians Adapt Military Technology for Comsats," *Aviation Week & Space Technology* 139, no. 9 (30 August 1993): 58.
54. Ibid., 59.
55. For example, during Desert Storm, all attack aircraft, except A-10s and AV-8s, required aerial refueling to accomplish their missions. "Gulf War Not as Revolutionary as Previously Thought, Survey Finds," *Aerospace Daily* 166, no. 31 (13 May 1993): 277.
56. Of note, third world nations may request images of their own countries to evaluate how well they can hide TELs, and how well their deployed decoys will work. Multi-spectral analysis may be available.
57. "Gulf War Survey: Specialized Aircraft more Important than Multi-role Types," *Aerospace Daily* 166, no. 31 (13 May 1993): 267.
58. William B. Scott, "War Breaker I & P Project Aims to Cut Cycle Times," *Aviation Week & Space Technology* 138, no. 23 (7 June 1993): 151–53. Timely intelligence is critical because the TELs can move quickly after launch. During Desert Storm, Iraqi Scud TELs "could be reconfigured and moving within a few minutes after a launch. Within 10 minutes after launch, a mobile Scud launcher could be anywhere within five miles of the launch site. If the Iraqi Scud

crew were given five more minutes, it could be anywhere within nine miles of the launch point—12 miles if it traveled by road. Destruction of mobile Scud launchers depended on time—the faster strike aircraft could get to the target the better the chance of destroying the launcher." *Conduct of the Persian Gulf War: Final Report to Congress* (Washington, D.C.: Department of Defense, 1992), 167.

59. David Hughes, "Mitre, Air Force Explore Data Fusion for Joint-STARS," *Aviation Week & Space Technology* 140, no. 10 (7 March 1994): 47–48.

60. Ibid., 48.

61. Ibid.

62. Ibid.

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66. David A. Fulghum, "DARO Pushes Endurance UAVs," *Aviation Week & Space Technology* 140, no. 15 (11 April 1994): 23.

67. "Talon Shield Readied for DSP Operations," *Aviation Week & Space Technology* 140, no. 14 (4 April 1994): 31.

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69. "Boeing, AF in Talks to Modify SRAM with LEAP for Missile Defense," *Aerospace Daily* 168, no. 56 (23 December 1993): 476.

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72. David A. Fulghum, "Stealth Structures Hide Critical Targets," *Aviation Week & Space Technology* 140, no. 8 (21 February 1994): 94.

73. Scott, "War Breaker Program Explores New Sensor, Targeting Systems," 38.

74. Frank Kendall, Director for Tactical Warfare Acquisition Programs in the Pentagon's Acquisition Office, believes decoys will cause tremendous problems in future operations against missile launchers, because the TELs resemble other military vehicles and because decoys would be relatively easy to make. See John D. Morrocco, "Airlift, Intelligence Continue to Pose Problems," *Aviation Week & Space Technology* 140, no. 3 (17 January 1994): 44.

75. David Hughes, "Active Army Disbands Last Hawk Battalion," *Aviation Week & Space Technology* 140, no. 14 (4 April 1994): 33.

76. David A. Fulghum, "Half-Size FEWS to Detect Aircraft, Small Missiles," *Aviation Week & Space Technology* 139, no. 6 (9 August 1993): 24.

77. "Mideast Threats of the 1990s: Cruise Missiles, UAVs, Submarines," *Aerospace Daily* 161, no. 54 (18 March 1992): 447–48.

78. In a country like North Korea, the MTCR and NPT may be meaningless, because the country has a nuclear program that can extract weapons-grade plutonium through its civil nuclear energy program, and it already builds and exports ballistic missiles. For examples, see four articles by Joseph S. Bermudez: "New Developments in North Korean Missile Programme," *Jane's Soviet Intelligence Review* 2, no. 8 (August 1990): 343–45; "Syria's Acquisition of North Korean 'Scuds',"

Jane's Intelligence Review 3, no. 6 (June 1991): 249–51; "North Korea's Nuclear Programme," *Jane's Intelligence Review* 3, no. 9 (September 1991): 404–11; and "North Korea's Nuclear Infrastructure," *Jane's Intelligence Review* 6, no. 2 (February 1994): 74–79. For Secretary of Defense William Perry's comments concerning the probability that North Korea has two or more nuclear weapons, see "Nuclear Arms in Korea Call for Tough Diplomacy," *USA Today* 12, no. 127 (4 April 1994): 14; and Don Phillips, "Sanctions a First Step, U.S. Warns North Korea," *Washington Post* 117, no. 120 (4 April 1994): 1.

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80. The MTCR cannot stop countries like North Korea and Iran from producing missiles with ranges exceeding the MTCR limit of 180 miles and 1,100 pounds of payload. See Janne E. Nolan, "The Politics of Proliferation," *Issues in Science & Technology* 8, no. 1 (Fall 1991): 64.

Chapter 5

Nemesis

Conclusion: Theater Offensive Missiles and the Next War

In future, the possession of superiority in long-distance rocket artillery may well count for as much as superiority in naval or airpower.

—Duncan Sandys

Hybris—*Global Reach, Global Power*
Anagnorisis—*Ballistic and cruise missiles*
Peripeteia—*Downsizing*
Nemesis—*North Korea*

The V-1s and V-2s in World War II, and the Scuds in Desert Storm, diverted the opposition's land-based airpower from other tasks. In both wars the diversion was statistically significant in total numbers and percentages, but other required missions were still accomplished. Airpower was not seriously hampered or overwhelmed by the missile threat. Allied bombers still flew against targets in Germany and prepared France for the Normandy invasion despite bombing ski sites. Coalition aircraft still bombed strategic targets in Iraq and battlefield targets in Kuwait during Desert Storm, and the Scud Hunt only slowed the conduct of the air campaign by several days.

In World War II and Desert Storm, the missiles and their infrastructures were brought under attack *before* they fired at US, Allied, or coalition targets. Duplicating these early attacks may prove difficult in America's next war against an enemy possessing ballistic or cruise missiles. In the next conflict, an astute enemy may use missiles to negate America's airpower potential by attacking aircraft on the ground, and the emphasis American air leaders devote to subduing the missile threat would in turn limit airpower's ability to achieve policy goals. US airpower may be attacked *first* rather than dealing the first blow. Hostile nations with particularly rough terrain and extended periods of harsh weather would probably be the best suited to thwart American airpower with missiles.[1]

Former secretary of defense Dick Cheney has pointed out that by the year 2000, 24 developing countries will have operational ballistic or cruise missiles. Fifteen will produce them indigenously.[2] Six countries will deploy

missiles with ranges of 3,000 km (1,800 miles), and three will have missiles with ranges of 5,500 km (3,300 miles).[3] In regions such as Northeast Asia and the Middle East, the US will face potential adversaries with better missiles—and more of them—than those possessed by Saddam Hussein in the 1991 Gulf War. With 24 third world nations acquiring cruise missiles or ballistic missiles, the US can count on facing this type of threat in almost any conflict for the foreseeable future. Third world governments certainly noticed the impact 88 Scuds had on coalition operations in the Persian Gulf, and may devise strategies that aim to duplicate American consternation.

The combination of technology and geography will likely assist potential aggressors who rely on missiles to overcome American airpower, as can be seen from a brief look at the situation in Korea.[4] North Korea has Scud-Bs and modified Scud-Bs in its inventory, and is preparing to field the Nodong-1 long-range ballistic missile.[5] Given the range of 180 miles for the Scud-B, all airfields as far south as Kunsan and Taegu air bases are potential targets. With the improved Scud-B's 360-mile range and the Nodong-1's 600-mile range, *all* airfields in South Korea come within missile range from North Korea. Given the importance of Osan and Kunsan air bases, the two major US air bases in South Korea, it is not difficult to imagine that if the North Koreans initiate hostilities, they would want to strike quickly and disrupt operations at both bases. And though North Korea currently has no Exocets, should it acquire them or other cruise missiles with a land attack modification, then the threat of a missile hitting a specific target on the airfields becomes very real. Should the North Koreans alternately acquire SS-21s from Syria or Ukraine, they would have a 75-mile-range weapon that could accurately hit individual targets as far south as Osan Air Base if fired from just north of the 38th parallel. Should they focus on the flight line area boundaries as aim points, half of the missiles fired with a 1,000 meter CEP would easily fall within the flight line area. If they aimed at the center coordinates of the air bases, almost all of the missiles would likely hit the airfield.

Yet, Scud Hunting in Korea might prove incapable of eliminating the missile threat. Finding Scuds, SS-21s, and cruise missile launchers could prove extremely demanding in the hills and mountains of Korea. One need only glance at a map to understand that even a system like J-STARS, with an improved high-fidelity synthetic aperture radar, is going to have problems scanning into every valley. In contrast to the relatively flat and featureless terrain in Iraq, radar "shadows" caused by mountainous terrain in North Korea afford some protection for the mobile launchers.[6] North Korean tunnels are numerous, and information concerning their locations is sketchy at best. If tunnels in mountainous terrain shelter mobile TELs, they would be very difficult to find and destroy. Add to the terrain and tunnels a large number of decoys and modified launch vehicles, and the problem looms large indeed. North Korea's SAMs and interceptors will contribute to the challenge, and the Korean weather, if the North Koreans choose to use it to their advantage, will do much to negate Scud Hunting operations.[7]

Besides attacking key South Korean airfields, the North Koreans will likely submit Seoul to an assault. The city is now defended by Patriots, but these systems are not perfect. As mentioned, an anti-Patriot version of the SS-21 is available, and may pose a very real threat to the Patriot system in a concentrated missile attack. A combined SS-21 antiradar missile and Scud attack could overwhelm the small number of Patriot batteries. Political and strategic considerations—stopping Scuds from hitting Seoul—will make Scud Hunting by land-based airpower an urgent priority once again.

Considering the importance of the Osan air operations center (AOC) to directing US-Republic of Korea (ROK) air defenses, Osan would probably receive a good deal of North Korean attention. The North Koreans cannot be expected to make the same mistakes that Saddam Hussein did—they will probably concentrate on just a few key air bases and Seoul. Pentagon planners realize the lengthy period of time to build up coalition forces unmolested during Desert Shield was a luxury that can't be counted on in the future.[8] A North Korean missile attack might not render Osan and Kunsan unusable, but certainly the tempo and types of operations conducted there would suffer.[9] Aerial resupply by C-5s, C-141s, or C-17s might be deemed too risky, and without airlift, base survivability becomes problematic.

Relatively impervious to allied countermeasures, the North Koreans could extend their attack outside of the Korean peninsula. North Korean missiles potentially put staging bases in Japan at risk, and this risk could affect how the Japanese support such a war. Similar situations could occur elsewhere. Countries such as Spain, France, and Italy, which might be used as American staging bases in an Eastern European or Mideast crisis, could be threatened by a missile-equipped Muammar Qadhafi. The mere rhetoric of such technologically proficient tyrants may compel the deployment of Patriot batteries and aircraft vitally needed elsewhere. Missiles might prevent the USAF from guaranteeing theater air superiority, and certainly total "command of the air" if that means controlling the air medium exclusively. The USAF may in fact be incapable of achieving air superiority, because land-based airpower cannot negate all cruise and ballistic missile launchers.

In future regional conflicts, the TBMs and cruise missile threats could determine deployment locations. As missiles gain in range and increase in accuracy, key aircraft like AWACS, J-STARS, and EF-111s may have to deploy at the far edge of the theater, or possibly even *out* of the theater. Basing these aircraft in the rearmost areas of the theater in turn reduces the time they can perform their assigned missions, increases tanker requirements, and limits the number of sorties that a given aircraft can fly. As the USAF shrinks to fewer numbers of combat aircraft, the force multipliers like AWACS and J-STARS become more critical. Any reduction in their operations could be especially damaging to the air superiority effort.

The requirement to hunt and attack TELs will leave fewer aircraft available for other missions, such as strategic attack, offensive counterair (attacks on enemy airfields, air defense networks, and command and control facilities) and battlefield preparation. With the large air forces available in

1944 and in Desert Storm, the diversion presented a problem, but never forced a dramatic change in the overall campaign plans for the invasion of Normandy or for the liberation of Kuwait. With a large air force, such a diversion was tolerable; in the era of an austere budget with few combat aircraft, the need to hunt for enemy TELs while undergoing Scud attacks on air bases could wreck an air campaign. There may not be enough aircraft to hunt for missiles and conduct the other required air missions.

Only certain aircraft and weapons can be used to attack TELs, which will further limit a shrinking air force. Precision guided munitions (PGM) and all-weather, night-capable aircraft like the F-15E, low-altitude navigation and targeting infrared for night (LANTIRN)-equipped F-16s and night-capable F-111Fs are necessary to find and target the TELs. Currently, these aircraft are also the best suited to destroy precision hardened targets. The enemy potentially can use his missile TELs as decoys to protect key resources.[10] Like aircraft, the numbers of American PGMs will probably be limited, and each must count in a place like North Korea with so many hardened targets and tunnels. Hunting for TELs is also an expensive proposition. Not only does it require specific PGMs and night-capable aircraft, but also J-STARS, AWACS, and tankers.

The missiles' impact on air operations will increase significantly if bases are located within TBM or cruise missile range. The tarmacs, runways, taxiways, revetment, and support facilities such as petroleum, oil, and lubricants (POL) are all legitimate targets for today's more accurate missiles. Even the less accurate Scud, if concentrated on a single air base, can wreak havoc. Recovering from attacks will not be easy, and the attacks themselves will significantly disrupt the tempo of operations. Gas masks and protective garments will cause reduced worker efficiency. Should the air base attacked house F-15Cs, America's primary air interceptor, the impact on air superiority could be grave. A Scud attack could leave the base (or some other target the F-15s were tasked to protect) vulnerable to a follow-up attack by air-launched land-attack Exocets. A reduced number of aircraft, flying at a reduced tempo, with less than perfect AWACS, leaves theater air superiority in doubt.

General Horner pointed out the morning after a night of heavy Scud activity in Desert Storm, "Last night could have been the turning point of the war. If [Hussein] had hit Riyadh Air Base and destroyed six AWACS or put chemicals on the F-15s at Dhahran, think of how the attitude and support of the American people might have changed."[11] Without AWACS or F-15Cs, the Iraqi Air Force could have challenged coalition airpower and raised the number of losses. Some Iraqi aircraft might have conducted limited strikes against coalition ground forces or air bases, contributing to higher coalition casualties.

Cruise and ballistic missiles give third world countries many of the capabilities of an air force without much of the cost. Missiles offer prelaunch survivability, defense penetration, tactical surprise, and relative accuracy (which is steadily improving).[12] Missiles solve some of the greatest challenges faced by third world air forces. Range and payload considerations are

comparable to those of third world aircraft, especially when considered with such factors as enroute survivability and force reliability. For third world nations, missiles offer a deterrence value against major or minor powers.[13] They threaten a higher price for war than some countries are willing to pay.

In short, missiles potentially eliminate America's ability to achieve political goals through the application of land-based airpower. Cruise and ballistic missiles with GPS accuracies allow developing countries to deny the USAF air superiority, which may in turn allow an enemy to conduct ground operations without fear of air attack. If the United States cannot bring the trump card of airpower into play, its ability to apply military force becomes exceedingly limited.

Excess airpower in World War II and Desert Storm did not stop the enemy from launching missiles. There was no correlation between sortie rates or tonnages dropped and any reduction in V-1 or V-2 firings. With the Scuds, there was a sharp drop in launches the first week, but the increase during the war's last week meant that even this apparent effectiveness was deceptive. However, in both World War II and Desert Storm, there were no documented cases of the enemy using his fixed sites. There is still cause to attack these, if only to keep the launch rates lower than they otherwise might be. Yet airpower cannot completely stop mobile missile launches. Achieving that objective may well require ground force employment, perhaps by special forces. On the other hand, the commitment of ground troops may undermine American political goals. The solution is unlikely to be simple, and an enemy possessing TBMs and cruise missiles may drag both ground and airpower into an operational abyss.

The essence of Greek tragedy is the reversal of fortune, the peripeteia. Achilles, strong and bold, in the end succumbs to a wound in his heel, a tragic end to a seemingly invulnerable warrior. TBMs and cruise missiles represent the possible reversal of US airpower, its undoing, as it were; so strong and potent, yet vulnerable. In Greek tragedy, the plot climaxes once the main characters discover that fortunes have reversed—and the hero suffers inevitable punishment in a bitter defeat that was the consequence of much of his own doing.

Notes

1. For example, "North Korean planners must certainly recognise that bad weather and terrain will combine to severely reduce the effectiveness of US airpower." Robert Hall and Ian Kemp, eds., "North Korea: A Potential Time Bomb," Supplement—Special Report No. 2, *Jane's Intelligence Review* 6, no. 4 (April 1994): 23.

2. John J. Kohout III, "The What, Who, How and Why of GPALS Command and Control," *Comparative Strategy* 11, no. 2 (April–June 1992): 149–61.

3. Keith B. Payne, "Defense Against Proliferation," *Jane's Intelligence Review* 4, no. 5 (May 1992): 235.

4. Edward L. Warner, the assistant secretary of defense for Strategy, Requirements, and Resources, and one of the key civilian officials involved in the Bottom-Up Review, believes the principal regional threat is North Korea. Furthermore, Warner supports the Clinton

administrations two-war strategy, and asserts that airpower will stop the threat in one theater and then deploy, or "swing," to the other theater thousands of miles away.

> "It is clear that this is an era where airpower . . . is an inextricable component of American military capability and one we can rely on to answer almost any challenge," Mr. Warner said. "We are putting a tremendous amount of emphasis on early arriving combat power. Nothing is more important to that than airpower. Sealift can't get you there."
>
> Preliminary Air Force analyses have shown that precision guided munitions aboard F-111, F-15E, and F-117A aircraft, plus long-range B-52, B-1B, and conventionally armed B-2 bombers, will be the leading edge of the airborne response. The Air Force mission, Mr. Warner said, will be to establish air superiority in rear areas as well as local air superiority above attacking enemy forces. At the same time, commanders will likely execute "selective attacks against critical targets" in the enemy's rear areas. Once US forces switch to offensive operations, "sustained air and missile attacks" will be launched to weaken the enemys ability to make war. Ultimately, Mr. Warner said, a combined-arms attack will expel enemy forces and achieve an American victory with minimal casualties.
>
> The two-war strategy is ambitious, and some senior commanders are already expressing reservations.

Quoted from David L. Lynch, "This Isn't the Bottom Yet," *Air Force Magazine* 77, no. 2 (February 1994): 25.

5. In addition to the Nodong-1, North Korea is planning to field two other missiles—the Taepo Dong 1 and 2—both with a range greater than 1,000 km/600 miles. See Jeffrey M. Lenorovitz, "Mobile DSP Station to Improve Detection of Korean Missiles," *Aviation Week & Space Technology* 140, no. 14 (4 April 1994): 31–32; Barbara Starr, "N Korea Casts a Longer Shadow With TD-2," *Jane's Defense Weekly* 21, no. 10 (12 March 1994): 1; and Barbara Starr, "North Korea Grasps at Stage Beyond Nodong 1," *Jane's Defense Weekly* 21, no. 11 (19 March 1994): 18.

6. See maps 7 and 8 for comparative maps of Desert Storm Scud Hunt areas and possible Scud deployment areas in North Korea.

7. Richard H. Schultz, Jr. and Robert L. Pfaltzgraff, Jr., *The Future of Air Power in the Aftermath of the Gulf War* (Maxwell AFB, Ala.: Air University Press, 1992), 23.

8. John D. Morrocco, "U.S. Uses Gulf War to Frame New Strategy," *Aviation Week & Space Technology* 140, no. 3 (17 January 1994): 40.

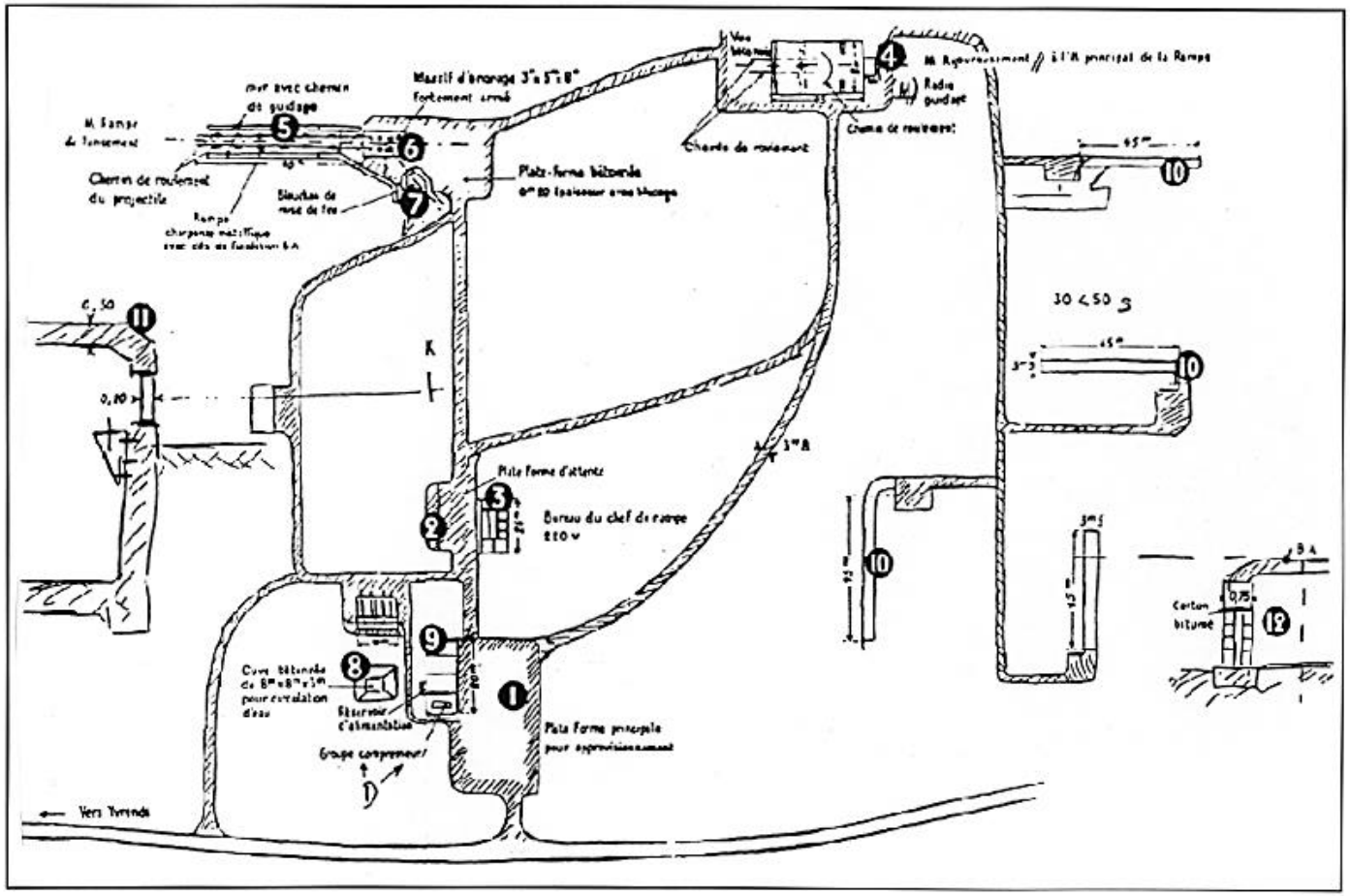
9. See figures 3 and 4 for example airfield diagrams with Scud-B CEP circles.

10. W. Andrew Terrill, "The Gulf War and Ballistic Missile Proliferation," *Comparative Strategy* 11, no. 2 (April–June 1992): 170.

11. Robert M. Stein, and Theodore A. Postol, "Correspondence," *International Security* 17, no. 1 (Summer 1992): 215.

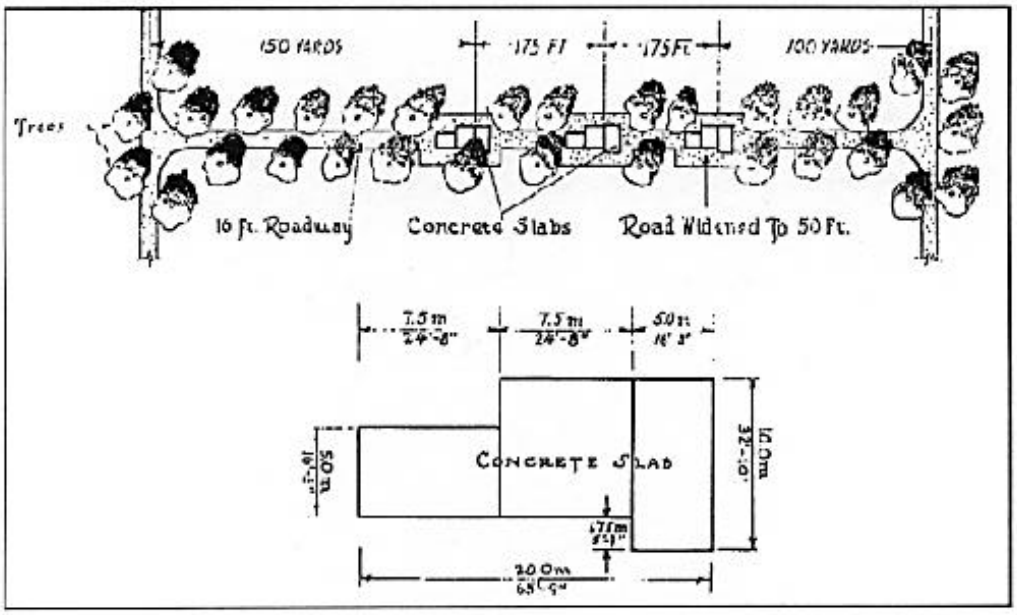
12. John R. Harvey, "Regional Ballistic Missiles and Advanced Strike Aircraft," *International Security* 17, no. 2 (Fall 1992): 74 (chart).

13. Andrew Hull, "The Role of Ballistic Missiles in Third World Defense Strategies," *Jane's Intelligence Review* 3, no. 10 (October 1991): 464–66.



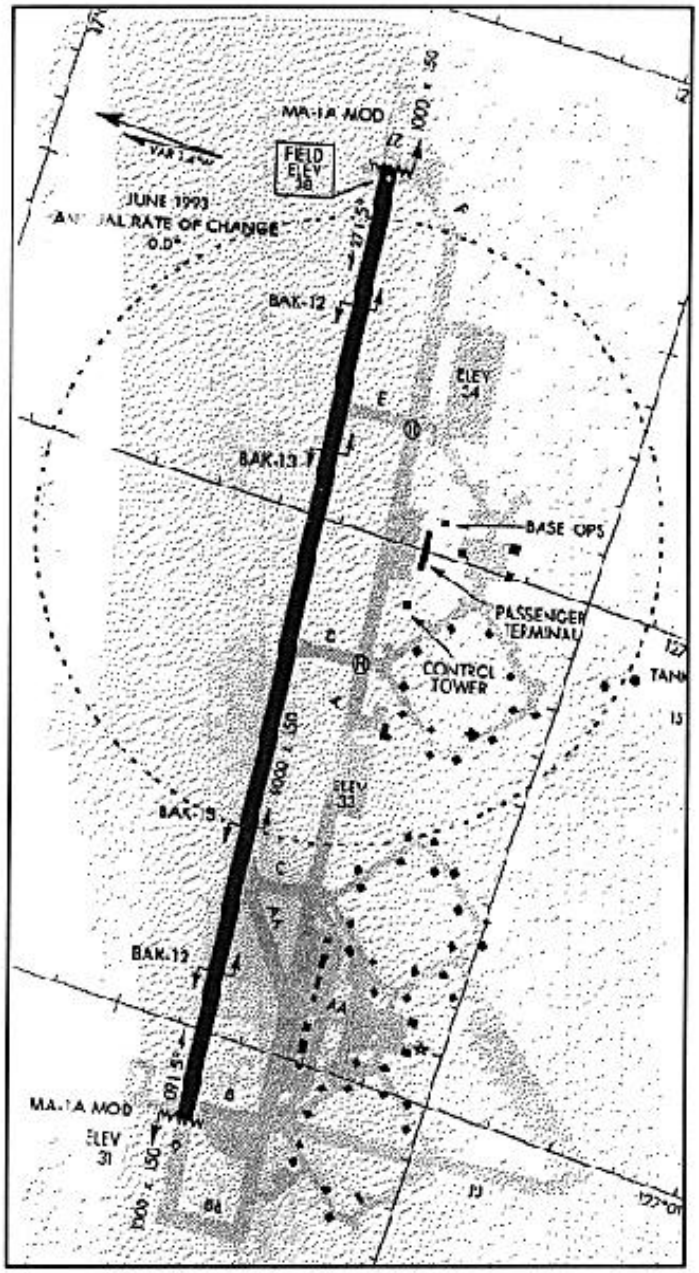
Source: Jozef Garlinski, *Hitler's Last Weapons* (New York: Time Books, 1978), 100-1. Sketch made by a member of the French underground intelligence.

Figure 1. Typical V-1Fixed Site Plan



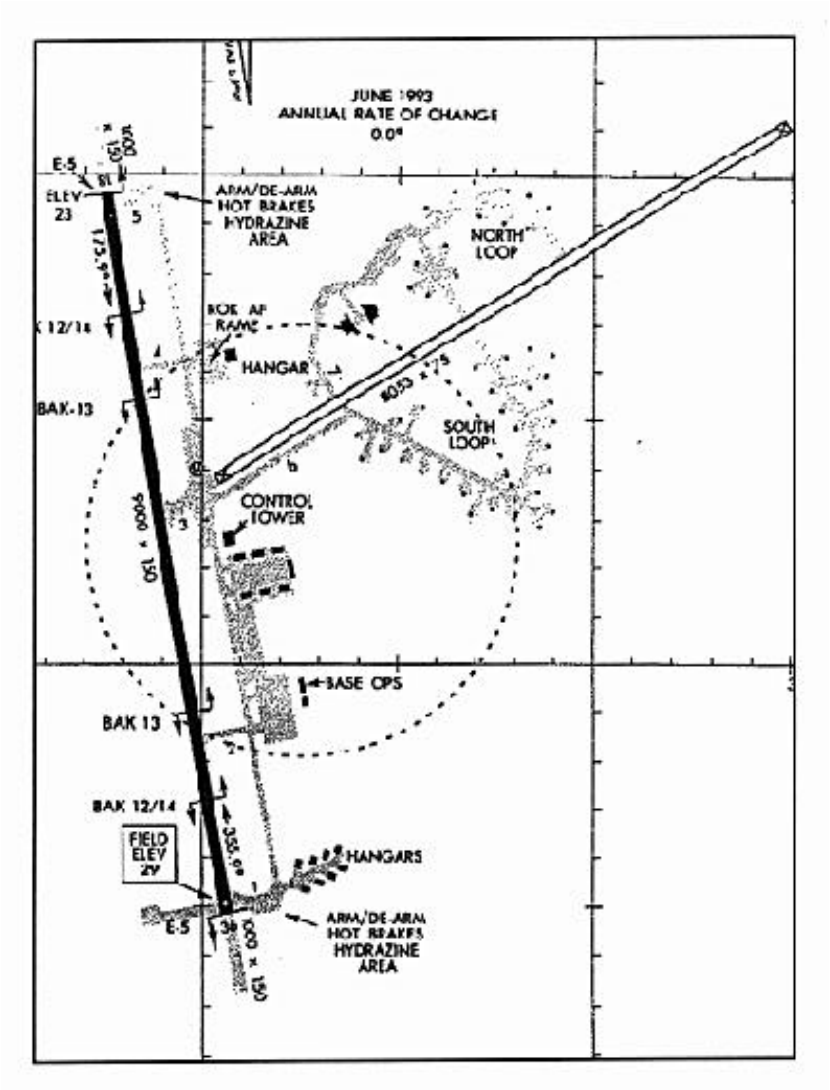
Source: Air Defense Review, Supreme Headquarters Allied Expeditionary Force, Issue Number 5, 22 December 1944, Air Defense Division, figure VIII (USAF/HRA 506.66A-5, 22 December 1944).

Figure 2. Typical V-2 Launch Site



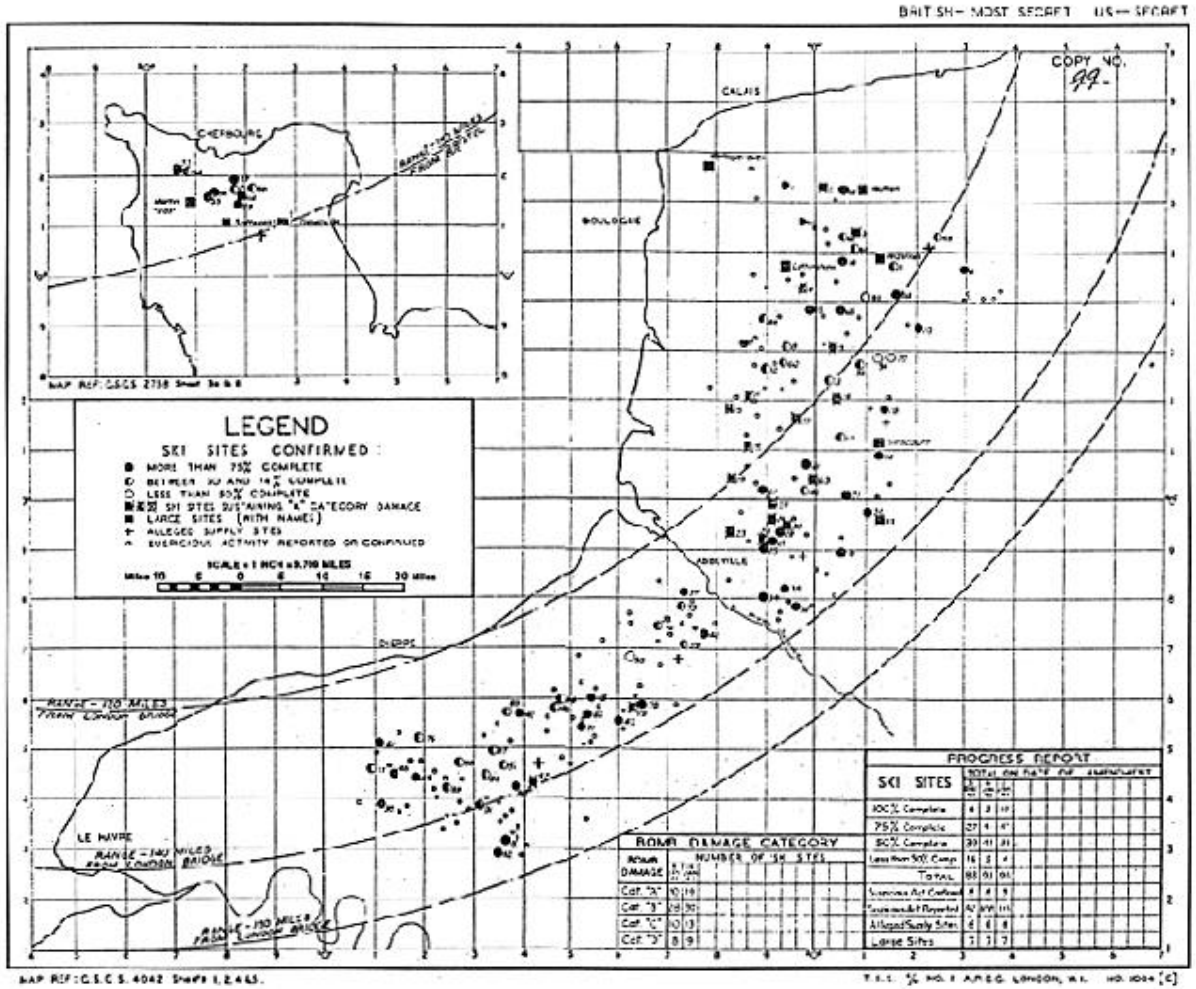
Source: *DOD Flight Information Publication (Terminal),* vol. 2, *High and Low Altitude Pacific, Australasia and Antarctica,* 9 December 1993 (St. Louis, Mo.: Defense Mapping Agency Aerospace Center, 1993), 185.

Figure 3. Osan Air Base and Representative Scud CEP Ring (1,000 meters)



Source: *DOD Flight Information Publication (Terminal),* vol. 2, *High and Low Altitude Pacific, Australasia and Antarctica,* 9 December 1993 (St. Louis, Mo.: Defense Mapping Agency Aerospace Center, 1993), 115.

Figure 4. Kunsan Air Base and Representative Scud CEP Ring (1,000 meters)

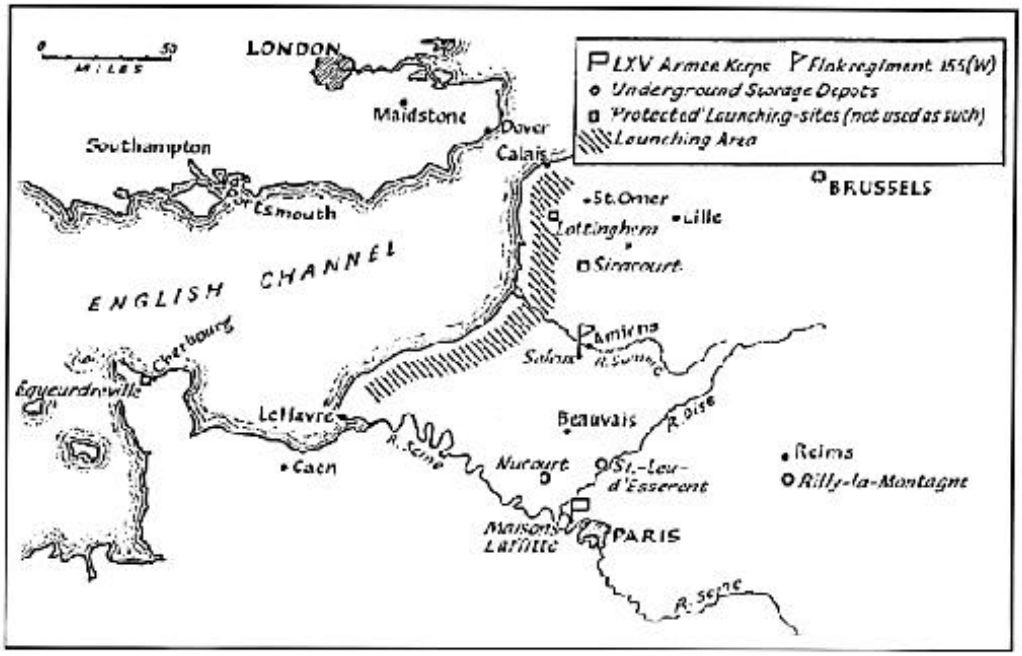


Source: "Crossbow" Summary of Information, 16 March 1944, Combined Operational Planning Committee (USAF/HRA 508.4311-1 December 1943—October 1944).

Map 1

Locations of V-1 Ski-Sites in France and Ranges to London

Based on the ski-site locations inside the 150 mile ring, the Joint Intelligence Committee concluded the range of the V-1 to be approximately 150 miles.



Source: Basil Collier, *The Battle of the V-Weapons 1944–1945* (New York: William Morrow and Co., 1965), 96.

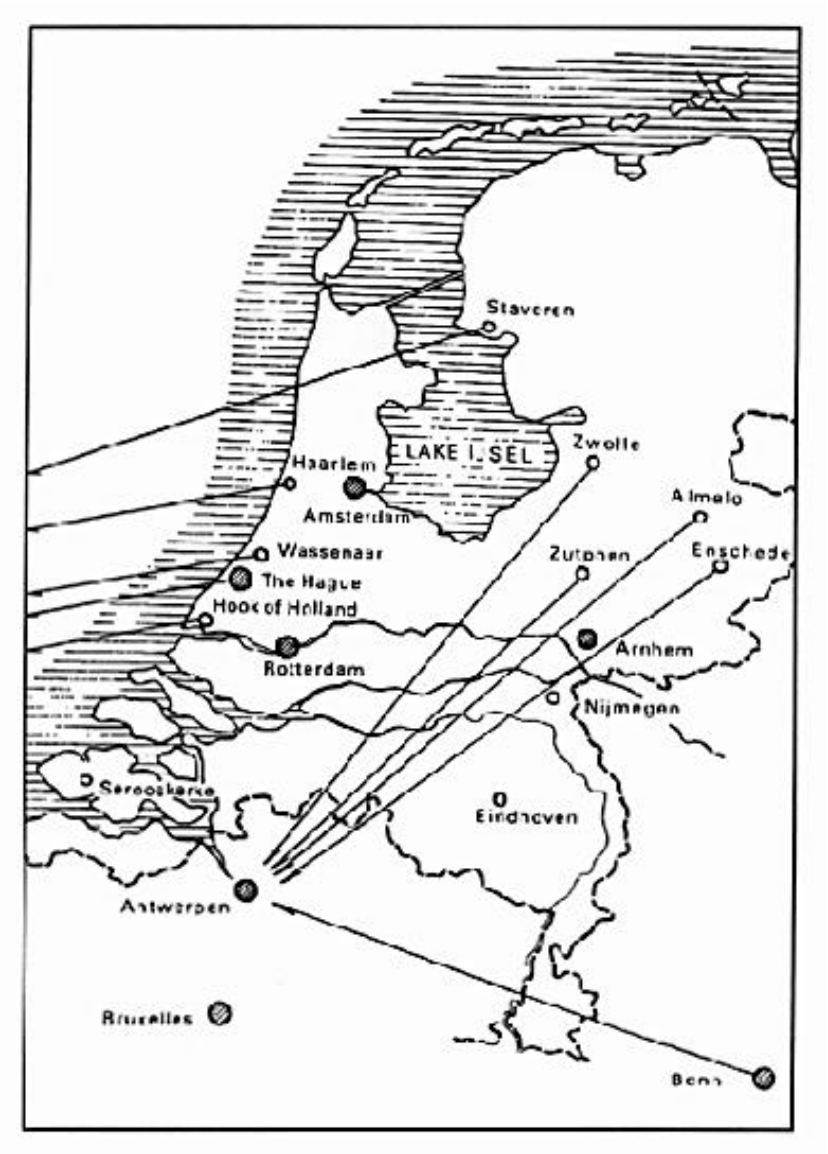
Map 2

V-1 Launch Areas in France

Source: Collier, 110.

Map 3

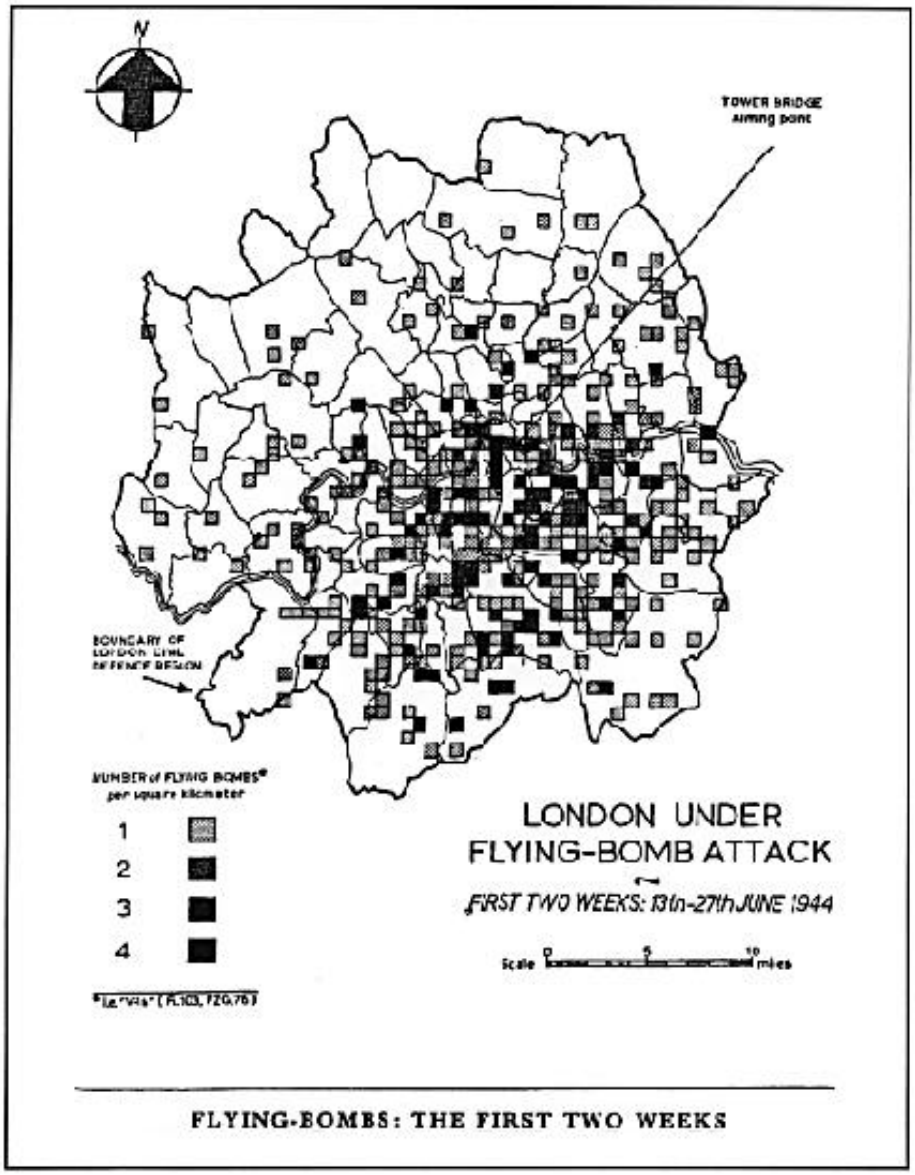
V-2 Launch Areas in Holland



Source: Garlinski, 148–49.

Map 4

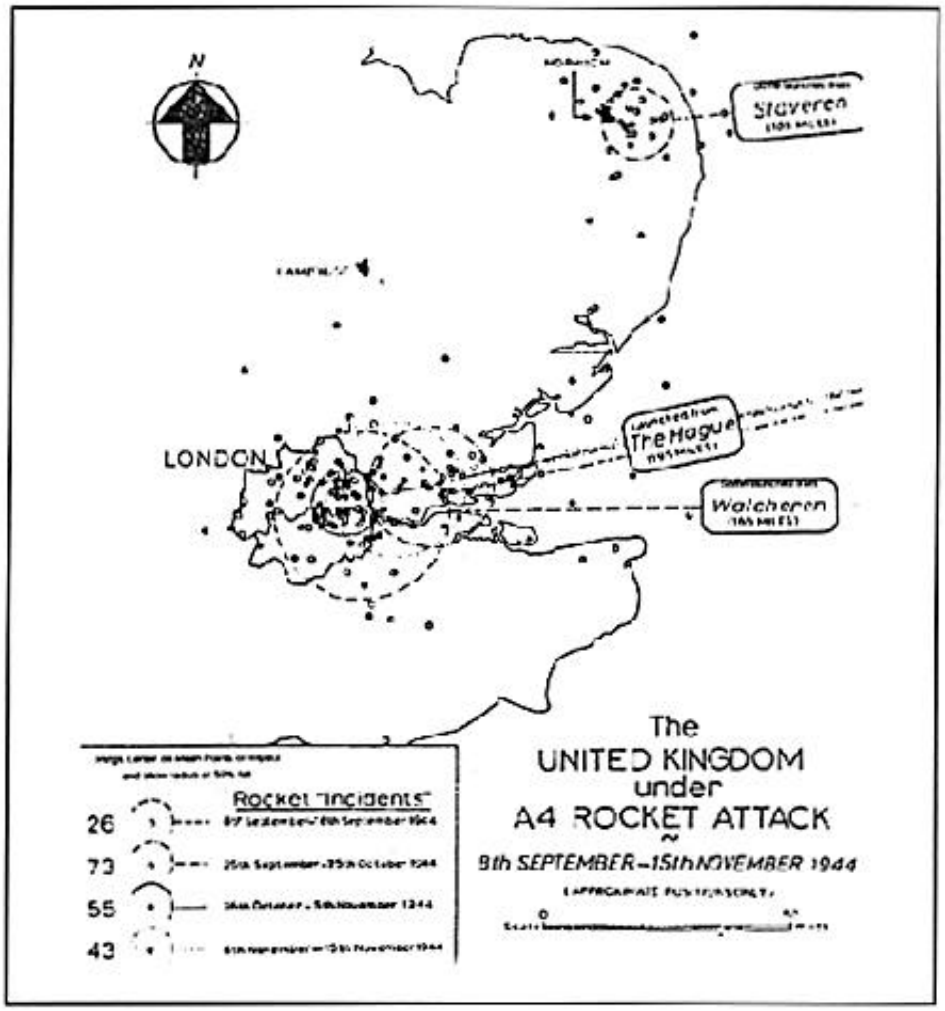
V-2 Launch Areas Against London and Antwerp



Source: David Irving, T*he Mare's Nest* (Boston: Little, Brown and Co., 1965), 228.

Map 5

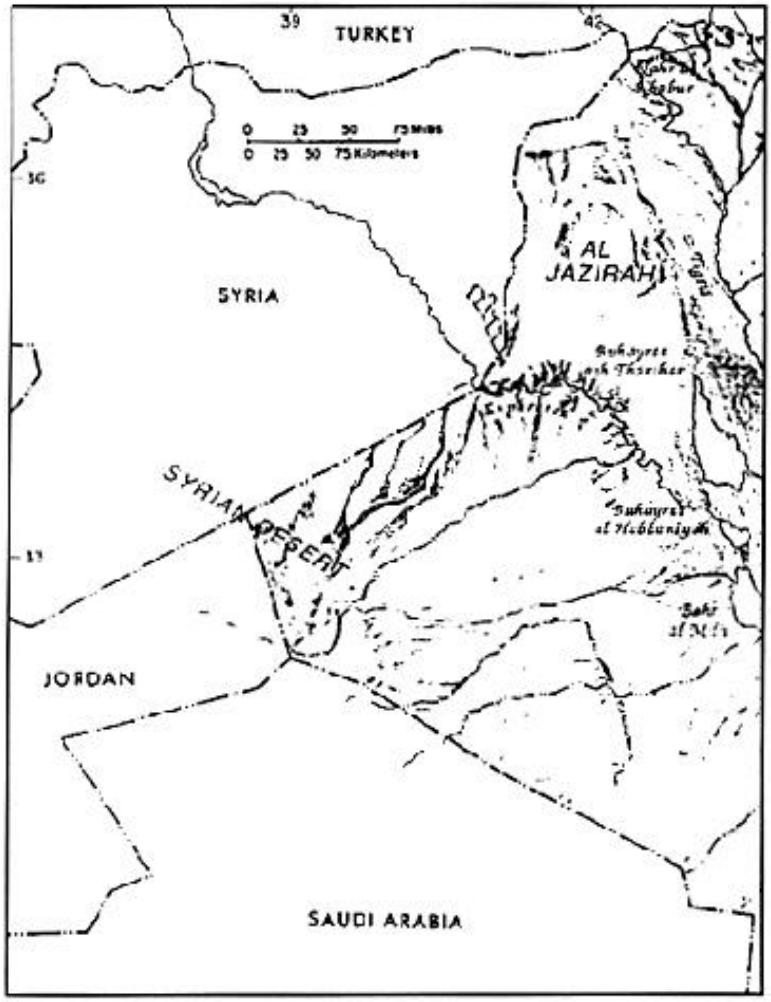
V-1 Representative Accuracy



Source: Irving, 262.

Map 6

V-2 Representative Accuracy

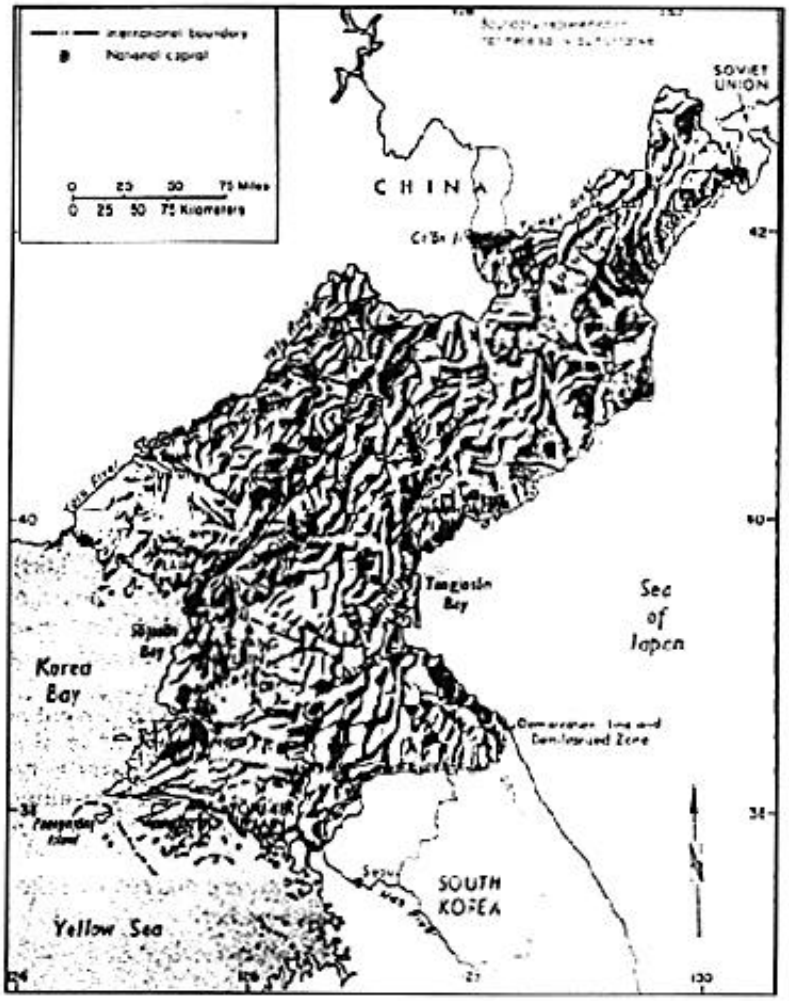


Source: Helen Chapin Metz, ed., *Iraq: A Country Study* (Washington, D.C.: Government Printing Office, 1990), 72.

Map 7

Western Iraq

Most Scud launches took place in western Iraq, and most of the Scud Hunt sorties were flown in this region. Compare with the terrain of North Korea in Map 8. Both maps are to the same scale.



Source: Frederica M. Bunge, ed., *North Korea: A Country Study* (Washington, D.C.: Government Printing Office, 1987), 53.

Map 8

North Korea

Scud hunting in North Korea will involve much more difficult terrain than Iraq, terrain that favors hiding Scud TELs.

Glossary

ABCCC	airborne battlefield command and control center
AF	Air Force
ALCM	air-launched cruise missile
AOC	air operations center
ARPA	Advanced Research Projects Agency
ASOW	autonomous standoff missile
AU	Air University
AWACS	airborne warning and control system
CAP	Combat Air Patrol
CEP	circular error of probability
CIA	Central Intelligence Agency
CINC	commander in chief
CM	cruise missile
CNN	Cable News Network
DARO	Defense Airborne Reconnaissance Office
DGPS	differential global positioning system
DOD	Department of Defense
DSP	Defense Support Program
EOSAT	Earth Observation Satellite
ESM	electronic support measures
FAA	Federal Aviation Administration
FEWS	follow-on early warning system
GPO	Government Printing Office
GPS	global positioning system
GWAPS	*Gulf War Air Power Survey*
HMS	Her Majesty's ship
HRA	Historical Research Agency
IFF	identification friend or foe
INS	inertial navigation system
JFACC	Joint Forces Air Component Commander
J-STARS	joint surveillance target attack radar system
km	kilometer
LANTIRN	low-altitude navigation and targeting infrared for night
LEAP	lightweight exoatmospheric projectile
LIDAR	laser imaging detection and ranging
MEL	mobile-erector-launcher
MTCR	Missile Technology Control Regime
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NPT	Non-Proliferation Treaty

PAC	Patriot advanced capability
PGM	precision guided munitions
POL	petroleum, oil, and lubricants
RAF	Royal Air Force
ROK	Republic of Korea
SAM	surface-to-air missile
SAR	synthetic aperture radar
SLAM	standoff land attack missile
SOF	Special Operations Forces
SRAM	short range attack missile
TBM	tactical ballistic missiles
TCT	time-critical targets
TEL	transporter-erector-launcher
TGW	terminally guided warhead
UAE	United Arab Emirates
UAV	unmanned aerial vehicle
UN	United Nations
USAAF	United States Army Air Forces
US	United States
USAF	United States Air Force
USMC	United States Marine Corps
USS	United States ship
USSBS	*United States Strategic Bombing Survey*

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