

Report Part Title: Targeting Electrical Power Systems

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Chapter 5

Targeting Electrical Power Systems

Despite the claims by air planners that electric power should always be attacked, the historical evidence suggests that there are specific conditions that must be evaluated before nominating this system as a strategic target. This chapter presents the conditions that define when an attack on the national power system will be successful. While electrical power systems are inherently vulnerable to attack, the application of air power against these systems, especially in a limited war, is usually ineffective in achieving strategic objectives, despite accomplishing the intermediate goals of diminishing electrical generating capacity, hindering war production, and causing civilian discomfort. Prior to discussing the strategies behind attacking this system it is important to note the recurring failures in understanding electric power as a target system that have plagued strategic air planners.

Failures

The two failures that stand out in the understanding of electric power as a target system are a lack of appropriate intelligence about the system and the repeated failure to assume a reactive foe.

Some problems in targeting electrical power are inherent in the nature of strategic air intelligence. The employment of air power demands more than just a knowledge of the number of enemy fighters, the types of missiles they fire, and how high they fly. Those facts are simply tactical or ground intelligence transferred to the air. In order to employ strategic air power it is necessary to have an understanding of the economic structure of a country. Attacking electrical systems demands information, not just on power production, but also on consumption, backup systems, and, most importantly, the projected effects of eliminating electricity. Unfortunately, this type of information is difficult to acquire and has rarely been available.¹

The planning for World War II offers a good illustration of the problems involved with gathering appropriate intelligence. Prior to the war there was a severe organizational deficiency. General Arnold commented after the war that "looking back on it, I think one of the most wasteful weaknesses in our whole setup was our lack of a proper Air Intelligence Organization." He continued, "Our target intelligence, the ultimate determinant, the compass on which all the priorities of our strategic bombardment campaign against Ger-

many would depend, was set up only after we were actually at war.”² Most of the information that was collected by the Air Intelligence section prior to the war was obtained through the New York banks, who had provided the capital for most of the equipment, and the British intelligence agencies.³ Much of this intelligence, however, was on the supply side of the problem: data such as the number of power plants, electrical capacity available versus the amount used, and the flexibility of the German grid system. What the air planners lacked was information on the effects of the bombing of electric power and an analytical approach that justified attacking this system.⁴ This created difficulties because, while the air planners shared common assumptions about how bombing electric power would lead to the capitulation of Germany, they were unable to either express or convince others of this vision.

Since World War II there has been little disagreement on bombing electrical power, especially within the Air Force, but not because of better information. In Korea the Air Force was forced to institute a “crash” program to look for strategic targets and naturally, electric power was an obvious choice.⁵ Against both North Vietnam and Iraq, the attacks were undertaken more out of knowledge about the supply of power than because of information about the effects.

In addition to the lack of intelligence about effects, there has also been a lack of awareness of how the enemy will react to this type of attack. In target analysis, just as in science, it has been necessary to assume a static or linear system. But, as scientists are discovering, in the “real” world systems are not static; they are dynamic. This crucial difference means that the calculations and predications made for static conditions are not valid for predicting actual, dynamic events.⁶ This dynamic quality is even more accurate when discussing war because, as Carl von Clausewitz noted, “War is not an exercise of the will directed at inanimate matter. . . . In war, the will is directed at an animate object that *reacts*.”⁷

There are several ways that a nation can react to attacks on electric power. Given enough prior preparation, it is possible to reduce the vulnerability of the electrical system. This can be done by creating many small generating plants and by interconnecting the generating facilities in the system. These two methods usually take long lead times and are expensive; therefore, most systems will have these programs in place prior to any conflict.

There are other methods for protecting electrical facilities that have been undertaken during war. One is to harden the facilities which house the generators⁸ or, as was done in both Germany and Japan during World War II, the use of blast walls around sensitive equipment.⁹ Other ways of protecting facilities would include using camouflage or creating underground facilities. The USSBS found one such underground plant in Germany after the war, and there were reportedly five built in North Vietnam.¹⁰ Operators can be trained to react to transfer power quickly; the purchase of spare equipment and a national means for allocating resources for the rebuilding of the system can speed recovery.¹¹

All of the above methods are useful in trying to restore power in the national electrical system. But one of the characteristics of a power system that makes it attractive for strategic attack is the fact that it has no storage. How do nations function when power is not available? Part of the solution lies in the fact that while it is not practical to store large amounts of generated power in the same manner as oil or aluminum, there are methods of ensuring that power is maintained to priority users, assuming that some parts of the system are functioning or can be repaired.¹²

The first way of ensuring that electricity is available is to reduce the amount of reserve capacity. Power plants do not normally run at their maximum capacity; therefore, there is a reserve of electrical power available for use. In the United States most power plants typically operate at 60 percent of capacity. Maximum efficiency, which compares costs for operation and maintenance to income, is usually 75 percent of capacity.¹³ As a result, there is at least 15 percent of reserve capacity available. Every country will vary as to the amount of reserve capacity available, but some reserve is normally available.

In addition to reserve capacity, power can also be “rationed.”¹⁴ One of the first steps a nation will take to ensure that power is available to the critical consumers is to centralize control of the system. For example, in 1939 both Germany and Japan created government ministries to prioritize power distribution and regulate use.¹⁵ In Germany the Central Office of Electric Supply considered measures for saving electricity such as forcing business to operate on off-peak hours and days by using three full shifts. They also sent power saving engineers to plants, curtailed power to low-priority industries, and switched off entire areas. They attempted to voluntarily reduce personal consumption, but later instituted involuntary measures.¹⁶

In Japan, the Ministry of Commerce and Industry had responsibility for power use and developed programs similar to those in Germany, but much more restrictive. The ministry prohibited the use of certain items that used electricity such as signs, decorative lighting, or the use of elevators in buildings under five floors. They also mandated “electric holidays” among certain industries. In addition, they prioritized the major users of power and fixed quotas for the lower-priority users; any use above the monthly quota was subject to a large surcharge.¹⁷

Besides conserving electric power, nations can make substitutions for electricity just as with any other resource. Germany compensated by importing power from Switzerland until 3 February 1945.¹⁸ The North Vietnamese, besides using numerous portable generators, also substituted by building hydrodynamic stations to power machinery directly from water flow.¹⁹ In addition, the whole problem of not having power for production can be bypassed by increasing imports to make up for the manufacturing deficit of needed material. The ability to substitute for the loss of power makes it difficult to predict exactly how the enemy will react. As Carl Kaysen wrote in an article about his experiences in intelligence during World War II, “Many substitution

possibilities are not discovered or known until necessity forces their discovery.”²⁰

There is nothing inherently new or different to how a nation will react to an attack on electric power, most of the methods have been done in the past. What is important to remember is that the enemy will react—possibly in the most unlikely way.²¹

When to Target Electric Power

Generation and transmission of electric power follow certain basic laws of physics that are the same the world over, yet systems are often constructed differently. Comparing Germany and Japan during World War II offers some idea of the disparity between national power systems (table 1).²² At the beginning of the war both countries used about 90 percent of the power for industry and somewhat less than 10 percent for individual household use. Other than this fact, however, the systems were very different. Germany’s generating capacity was almost evenly split between public and private facilities, 58 percent to 42 percent. By contrast, Japan had an overwhelming amount of public plants, 87 percent, as compared to 13 percent private. However, production of electricity was greater in Germany, 86-billion kilowatt-hours versus 38.4 billion in Japan.²³

Geography and national resources played a key role in the design of the two nations’ power systems. Germany’s greatest resource was coal, thus it is no surprise to find out that 80 percent of German power plants were fueled by coal. In contrast, Japan’s topography and lack of natural fossil fuels dictated a dependency on hydroelectric power. The Japanese used both traditional

Table 1
Comparison of German and Japanese Electric Systems

	Germany (1939)	Japan (1943)
Production in kilowatt-hours	86 billion	38.4 billion
Generating Capacity	57.9% public 42.1% private	87% public 13% private
Fuel source	80.2% coal 20% hydroelectric	18% coal 82% hydroelectric
Consumption	92% industry 6.4% households, buildings	92% industry 8% households, lighting

hydroelectric dams and stream-flow plants which harnessed the power of a river directly.

Although Japan did have most of the capacity in this hydroelectric capability during certain parts of the year, mainly the dry season of January, February, and March, the system was heavily dependent on the thermal plants to supplement the loss in power due to the reduced flow in the rivers. Thus, an attack on the thermal plants would have had a much greater impact on the Japanese economy in February than in August.

Another difference in the Japanese system that surprised the USSBS inspectors was the amount of spare equipment available. The team members noted, "The entire Japanese utility system is over equipped by American standards, with spare generating, transforming, and instrument units" and there was a "much higher availability of replacement [parts] than would be expected on the basis of American or European practice."²⁴ Examining the differences in the German and Japanese power systems underlines the differences that can exist between power systems and the problem with assuming that because the physical characteristics are similar the cultural ones will be also.

In assessing a nation's vulnerability to losing power, the dispersion of the generating facilities and the interconnections within the country must be analyzed. Simply put, the more dispersed the generating facilities, the harder it is to attack the electrical power system. The greater the number of plants, the less power each one contributes to the system, and eliminating a few plants does little to affect the total output. The dispersion of the Japanese power system was a key reason why it was not attacked. Likewise, the EOU analysis, although mistaken, rejected the German power system in part because they thought it was very dispersed. Determining the dispersion of a nation's electric power grid is relatively simple and extremely important. Many nations have highly concentrated electrical systems—for instance, eliminating 25 plants might destroy 75 percent of the national power system, or in a large country, 50 of the biggest facilities may supply half of the national power. Other systems are more widely dispersed—for example, in China, an attack on 100 of the biggest plants would affect only one-quarter of the power capacity.²⁵ Determining how a country's system is interconnected is not so easy.

As mentioned earlier, power facilities are primarily interconnected for reliability—to allow power to be transferred from areas with a surplus to areas that are experiencing difficulties.²⁶ If only a portion of a country's generating capacity is eliminated, it would still be possible to get power to the affected area from undamaged facilities further afield, as long as the transmission system is working. Thus, interconnections of the national power grid allow each generating plant to serve as an emergency power center for every other area. The assumption by the Committee of Operations Analysts and the Enemy Objectives Unit during World War II that Germany had a very interconnected system was a key reason for their not recommending the German power system as a priority target.

More fundamental than deciding the vulnerability of the system, however, is knowing the strategy behind the attacks because this determines when striking these facilities is likely to be effective in achieving the goals of the air campaign. There have been four basic strategies used, either separately or in

combination, to justify attacks on electric power: to influence the will of the people; to raise the costs to the leaders; to produce direct military effects; and to impact war production (table 2). Highlighting each strategy provides insight into when it should be attacked in the future.

Table 2
Case Studies

Case	Amount Destroyed	Effects	Actual Impact
Air Corps Tactical School	100% (planned)	Morale—high Cost to leaders—low Forces—low Production—medium	Theory Only
WW II—Germany	Not attempted	Morale—high Costs to leaders—low Forces—low Production—medium	Not attempted
WW II—Japan	Not attempted	Morale—medium Costs to leaders—low Forces—low Production—high	Not attempted
Korea	90%	Morale—medium Costs to leaders—high Forces—low Production—medium	Little—support from outside countries, increase in imports. Did not pressure North Korea into peace.
Vietnam	85–90%	Morale—medium Costs to leaders—high Forces—low Production—medium	Little—increase in foreign aid; substitution efforts. Did not stop NVN support of Vietcong.
Iraq	Over 90%	Morale—medium Costs to leaders—medium Forces—high Production—low	Not known; perhaps temporary confusion, but no paralysis.

Legend:

HIGH: Primary effects sought by air planners in attacking electricity and its impact on ending the war.
MEDIUM: Other "bonus" effects anticipated by air planners.
LOW: Either not anticipated or inconsequential.

Attacks on Morale

One of the most persistent assumptions among air planners has been the belief that depriving civilians of electricity will lead to a change in a nation's policy. This notion drove the ACTS strategic targeting policy and has been an enduring thought in the justification for bombing electricity in every war since. The belief in electric power as the panacea target for affecting civilian

morale stems in part from the ubiquitous nature of electricity in American society. The United States accounts for 35 percent of the generating capacity in the world. In addition, our per-capita usage is among the highest in the world—double the consumption of other industrialized countries, such as Germany, Japan, and the United Kingdom.²⁷ Although daily life without electricity is almost unthinkable for an American, the problem is that in other areas of the world where electricity is not used as much, its loss would not be as catastrophic as in America. Oliver Todd, a journalist who visited Hanoi during the Vietnam War, summed it up best when he observed that “to a Western, so-called developed society, cutting our electricity means something. It doesn’t mean very much in Vietnam. The Vietnamese for years and years have been used to living by candlelight or oil lamps.”²⁸ Cutting electricity will not always have the same disastrous effect in other countries as in America.

There is still a more basic problem with attacking morale—it rarely succeeds in achieving the overall objective. While bombing attacks can lower morale in terms of attitude, causing populations to become apathetic, these changes do not influence behavior. For example, bombing in World War II did lower morale. Moreover, this decline was in direct proportion to the amount of civilian deprivation, caused in large part by the loss of electricity.²⁹

Despite the decrease in civilian morale, studies after World War II showed that active opposition to the current government policy was infrequent and that bombing electrical power to produce a change in civilian morale did not bring about a change in government policy.³⁰ Ultimately then, air planners must decide if eliminating electricity will have any impact on lowering civilian morale, and if so, if it will actually influence the political leadership toward the desired objectives.

Attacks to Influence Leaders

Attempts to influence the political leaders of a country by depriving the civilians of electricity or by destroying the costly equipment in a power plant is usually associated with a strategy of increasing costs on the leadership to force a change in policy. This was the justification for attacking electric power in Vietnam and Korea, and in neither case was it successful, nor is it likely to be successful in the future.

There are several reasons why this strategy fails. The first is nationalism and the high resolve most nations have in any conflict, which tends to undermine the usual calculus of cost versus benefits that may seem applicable to nations outside of the conflict. If the area or issue in question is of high national interest, then the damage inflicted on electric power will not likely exceed the costs that the leaders of a country are willing to pay.³¹ In addition, once national leaders become committed to a course of action, they are reluctant to change. Such a change could mean the loss of prestige and political power, which they may fear more than “losing” the war. Rather than admit certain defeat in domestic politics, they would rather continue the present course of action despite the bombing.³²

A more practical consideration is that political leaders are generally well insulated from the loss of the national power system. As the official USAF bombing survey from Linebacker II noted, "An air campaign against the electrical power system of a country should not have as an objective the total cutoff of power. All critical elements of military and government agencies have alternate means of generating electric power."³³

The loss of electric power is not likely to exceed the cost the political leadership is willing to pay. Coupled with government and military insulation from the loss, it seems unlikely that national political leaders will be convinced to change their policy because of an attack on electric power.

Attacks for Military Effects

An attack on electricity to directly affect the military forces of a country is a new phenomenon, having been used for the first time in the war against Iraq. This is primarily a reflection of how much more dependent the military is on electricity to perform activities, such as powering air defense radars and communications, than in the past. In contrast, during World War II attacks on electric power for military effects were specifically rejected because of the length of time between an attack and the impact on military operations.

While striking electrical power plants might be useful as a tactical measure to create temporary confusion, such attacks will have only a minimal long-term impact, because the military, as a priority user, will have access to whatever power is available in the national grid and will also likely have emergency power systems. Even in Baghdad, where the lights went out minutes after H-hour, it is not clear if that was a direct result of the attacks on the electric system or an Iraqi defensive reaction, and what, if any, long-term impact it had on military operations. No doubt the attacks against the Iraqi power system did cause some confusion in the Iraqi military, but exactly how well that advanced the goal of strategic paralysis on the Iraqi leadership is still not clearly known.³⁴

William C. Arkin of Greenpeace International investigated the bomb damage in Iraq after the war and believes that the strategic bombing of Iraq made little difference to the outcome.³⁵ According to Arkin, "The air war was clean on a strategic level, but irrelevant to the defeat of the Iraqi army."³⁶ The attack on electric power and the indirect collateral damage inflicted has caused others to question the target selection plan of the Gulf War as well. In *The Gulf Conflict and the New World Order*, Lawrence Freedman and Efraim Karsh state, "The aspects of its [USAF] campaign most directed against Iraq's economic and political structure (i.e., electric power) seems to have been the least relevant to the ultimate victory."³⁷

Attacks on Production

The strongest argument for attacking electrical power is to stop or slow down war production. The industries that make war goods are usually very dependent on electric power, and many processes are simply not possible

without this resource. In most countries, the majority of the electricity generated is used in the manufacturing process.

The USSBS analysis after World War II recommended attacks on electric power, but only in the context of affecting war production, which can be an important factor in winning a war, over the long term, against a country that cannot import.³⁸ Therefore, bombing electrical power to affect war production is most effective in a total war of attrition against a major power. Likewise, in a war of short duration, where the enemy has stockpiled war material, stopping war production will have minimal impact on winning the war. In a limited war, against a small nation with outside support, attacking electrical power to halt war production will not have much impact because of the ability of the nation to substitute for the loss of power by increasing imports and dispersing manufacturing, as North Korea and North Vietnam demonstrated when their power systems were eliminated.

Conclusions and Implications

Strategic attacks on national electrical power systems can be useful in fulfilling national security aims, but only under specific conditions. First, the target country's power system should be vulnerable to destruction by being very concentrated with very few interconnections. Second, the strategy behind the attacks should be focused on stopping war production over the long term. To strike electric power to affect civilian morale, increase costs to the leadership, or impact the military will waste missions and could prove counterproductive to the political aims of the war.

The problem with attacks on electric power is the potential negative political impact of causing indirect collateral damage to the civilian population. There are some actions in attacking electrical power such as breaching a hydroelectric dam or bombing a nuclear generator that would be successful at interrupting power, but would not be considered because of the negative political impact generated. Although dams have been attacked in the past, in the current political climate and with the limited nature of modern war, it seems unlikely that these attacks would be considered as a means of eliminating electrical power.

Similarly, the indirect effects to civilians in Iraq as a result of the bombing of electric power have raised questions at home and abroad. The official response is that although the attacks were more thorough than planned, they were nonetheless necessary and the postwar suffering of the Iraqi people is the fault of Saddam Hussein.³⁹ Certainly this is true from the legalistic point of view, for the defender and the attacker both bear an equal responsibility for the protection of civilians; but the practical fact is that the negative impact of these attacks on world opinion far outweighed the military benefits accrued by bombing electrical power in Iraq.⁴⁰ The implication is clear—national electrical systems are not a viable target. If the wars of the near future

will be limited wars and not total wars of attrition, then attacks on electric power should not be considered. Although national power systems are vulnerable to air attack, the military is largely insulated from a loss of power, and civilian discomfort has not been shown to influence government policy. If the true aim of eliminating electricity is to affect other systems, such as communications or computers, then the time and effort would be better spent concentrating on the intelligence and methods for attacking these systems. In future strategic air operations, the targeting of national power systems has little utility.

Notes

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1. H. H. Arnold, *Global Mission* (New York: Harper & Brothers, 1949), 168–69.
3. Wesley Frank Craven and James L. Cate, *The Army Air Forces in World War II*, 7 vols. (Chicago: University of Chicago Press, 1948–1958), 1:624 and 2:214. As one example, three out of four of the sources used to derive the air estimate to analyze electric power in the Rhine-Ruhr area were British.
4. Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military* (Ithaca, N. Y.: Cornell University Press, 1991), 157.
5. Robert F. Futrell, *The United States Air Force in Korea, 1950–1953*, rev. ed. (Washington, D.C.: Office of Air Force History, 1983), 183.
6. This is part of the new science of chaos, see James Gleick, *Chaos: Making a New Science* (New York: Viking, 1987).
7. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 149, emphasis in the original. Also see Alan Beyerchen, “Clausewitz, Nonlinearity, and the Unpredictability of War,” *International Security* 17, no. 3 (Winter 1992–93): 72–75.
8. US Congress, Office of Technology Assessment, *Physical Vulnerability of Electric Systems to Natural Disasters and Sabotage*, OTA-E-453 (Washington, D.C.: GPO, June 1990), 5, 47–49 (hereafter cited as OTA Report).
9. United States Strategic Bombing Survey (USSBS), *German Electric Utilities Industry Report* (Washington, D.C.: GPO, January 1947), 31–33 (hereafter cited as USSBS); and USSBS, *Electric Power Industry of Japan*, 28–29.
10. USSBS, *German Electric Utilities*, 33; *The Pentagon Papers: The Defense Department History of United States Decision-making in Vietnam*, Senator Gravel edition, 5 vols. (Boston: Beacon Press, 1971), 4:153; and Headquarters USAF, Intelligence Study, “Targeting Concept for North Vietnam,” 28 July 1967, 65, in HRA file, K142.6323-1.
11. OTA Report, 5–6, 51–52, 54–55.
11. David J. Rose, *Learning about Energy* (New York: Plenum Press, 1986), 445–46.
13. OTA Report, 34; and Leyson, 58.
14. Rose, 446.
15. USSBS, *German Electric Utilities*, 118; and USSBS, *Electric Power Industry of Japan*, 26–27.
16. USSBS, *German Electric Utilities*, 16–17.
17. USSBS, *Electric Power Industry of Japan*, 26–27.
18. USSBS, *German Electric Utilities*, 9.
19. Jon M. Van Dyke, *North Vietnam's Strategy for Survival* (Palo Alto, Calif.: Pacific Books Publishers, 1972), 210–11.
20. Kaysen, 15.

21. Beyerchen, 72–75.
22. These statistics are drawn from two USSBS reports, *The Effects of Strategic Bombing on the German War Economy* and *The Electric Power Industry of Japan*, Electric Power Division.
23. The German figures for power production are from 1944 while the Japanese figures are 1943 statistics. The main difference is that Germany produced a much greater amount of electricity than Japan.
24. USSBS, *Electric Power Industry of Japan*, 29.
25. Richard I. Brody, *Regional Conventional Deterrence and TLAM* (Unpublished paper, Strategic Policy Analysis Group, Center for Naval Analysis, 31 July 1992).
26. Eugene Gorzelnik, North American Electric Reliability Council, telephone interview with author, 14 April 1993; and *Electricity Transfers and Reliability* (Princeton, N.J.: North American Electric Reliability Council, October 1989).
27. Donald G. Fink and H. Wayne Beaty, eds., *Standard Handbook for Electrical Engineers*, 12th ed. (New York: McGraw-Hill, Inc., 1987), 16-2, 16-3. The only two nations with a higher per-capita number of kilowatt-hours are Canada and Sweden. In the case of Canada, at least, much of the power that is produced there is exported to the United States.
28. Mark Clodfelter, *The Limits of Air Power: The American Bombing of North Vietnam* (New York: Free Press, 1989), 136.
29. Irving L. Janis, *Air War and Emotional Stress*, Rand series, reprint ed. (Westport, Conn.: Greenwood Press, Publishers, 1976), 145–46.
30. *Ibid.*, 147–49, 151–52.
31. Robert A. Pape, Jr., “Coercion and Military Strategy: Why Denial Works and Punishment Doesn’t,” *The Journal of Strategic Studies* 15, no. 4 (December 1992): 432–33.
31. Ernest May, *Lessons of the Past* (Oxford, England: Oxford University Press, 1976), 125–42.
33. Herman L. Gilster and Robert E. M. Frady, *Linebacker II USAF Bombing Survey* (Headquarters Pacific Air Forces: April 1973), 12.
34. Gosline interview; and Col John A. Warden interview with author, Air Command and Staff College, 7 December 1992.
35. “Tactical Bombing of Iraqi Forces Outstripped Value of Strategic Hits, Analyst Concludes,” *Aviation Week & Space Technology* 136, no. 4 (27 January 1992): 62–63.
36. *Ibid.*
37. Lawrence Freedman and Efraim Karsh, *The Gulf Conflict and the New World Order* (Princeton, N.J.: Princeton University Press, 1993), 437.
38. USSBS, *Summary*, 14; and USSBS, *German Electric Industry*, 3, 46–51.
39. “Strategic Campaign Focused on Targets and Cut Casualties, Pentagon Maintains,” *Aviation Week & Space Technology* 136, no. 4 (27 January 1992): 64–65.
40. I am not arguing that the number of postwar casualties is correct; in fact, I believe they are well above the number actually caused by the loss of electricity. These numbers are based on a survey of 9,034 households and not the actual number of cases in hospitals. This methodology is in International Study Team, *Health and Welfare in Iraq*. This study also did not take into account the restoration of electricity, which—according to the *Gulf War Airpower Survey*—occurred despite the UN sanctions by the summer of 1991. The numbers also seem exaggerated in comparison with the figures from World War II. For example, in Japan during 1944 approximately 4,600 people died of dysentery and typhoid (based on a population of 13 million, and death rates per 100,000 per year, of 14.3 and 20.8), in the same year there were a total of 33,000 cases of dysentery and typhoid, see USSBS, *Health and Medical Services in Japan*, 159–64. Based on an Iraqi population of 18 million, 70,000 deaths would equal a death rate of 388 per 100,000—almost 20 times that of Japan in 1944. Regardless of the accuracy of the figures from the Gulf War, the fact remains that the perception among many people is that these deaths were preventable.