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THE IMPACT OF FAULTY ENVIRONMENTAL DOCTRINE

by

Bruce F. Mc Connell
Lieutenant Colonel, USAF

A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

FULFILLMENT OF THE CURRICULUM

REQUIREMENT

Advisor: Dr. James A. Mowbray

MAXWELL AFB, ALABAMA

MARCH 1994

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EXECUTIVE SUMMARY

United States Army Air Forces' (USAAF) environmental doctrine, formulated during the interwar years and based on the "bomber will always get through" philosophy, produced faulty USAAF organizational doctrine and the resulting World War II USAAF strategy. As a direct result, airmen conducting strategic bombing had to use tactics and technology to overcome this flawed, doctrinally-based, strategy.

Early combat experience, heavy losses, and poor results, in both Europe and the Pacific, proved the strategy of daylight, high-altitude, precision strategic bombing was not workable.

In Europe, only the availability of the P-51 long-range fighter, made bomber mission escort possible and as a result made daylight precision strategic bombing viable. In the Pacific, invisibility using the cover of darkness and/or radar countermeasures reduced losses to acceptable levels. General LeMay's low-altitude, incendiary, area bombing was the solution to the destruction of Japan's industrial base.

Why should airmen study strategic bombing conducted fifty years ago? Consider the advice of Confucius--"Study the past, if you would divine the future." (29:413)

ABSTRACT

TITLE: The Impact of Faulty Environmental Doctrine

Author: Bruce F. Mc Connell, Lieutenant Colonel, USAF

United States Army Air Forces' (USAAF) environmental doctrine, formulated during the interwar years and based on the "bomber will always get through" philosophy, produced faulty USAAF organizational doctrine and the resulting World War II USAAF operational military strategy. As a direct result, airmen conducting strategic bombing missions in the European and Pacific theaters had to use tactics and technology to overcome this flawed, doctrinally-based, strategy. This operational strategy was the consequence of an untested, unofficial doctrine that took on a life of its own. It became the environmental doctrine for the use of USAAF aircraft.

BIOGRAPHICAL SKETCH

Lieutenant Colonel Bruce F. McConnell (M.S.B.A., Boston University) has been interested in the United States Army Air Corps and World War II since he took his first Civil Air Patrol aerospace education class in 1963. He has been stationed overseas for ten years, in four foreign countries, including South Vietnam. He has served as a U.S. Army engineer company commander, a USAF base civil engineer and civil engineering squadron commander, and a deputy Air Force installation commander. He is a graduate of the Air War College, class of 1994.

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CHAPTER I

INTRODUCTION

United States Army Air Forces' (USAAF) environmental doctrine, formulated during the interwar years and based on the "bomber will always get through" philosophy, produced faulty USAAF organizational doctrine and the resulting World War II USAAF operational military strategy. As a direct result, airmen conducting strategic bombing missions in the European and Pacific theaters had to use tactics and technology to overcome this flawed, doctrinally-based, strategy.

This operational strategy was the consequence of an untested, unofficial doctrine that took on a life of its own. It became the environmental doctrine for the use of USAAF aircraft. Using this philosophy, Air Staff planners created an aircraft procurement plan to defeat Germany. The plan was approved by the Secretary of War and dominated USAAF organizational doctrine by default.

If Air Force leaders of today fail to understand, how and why this occurred and the lesson's to be learned from the men who had to make the strategy work, they may be destined to repeat the mistakes of history. Consider the advice of Confucius--"Study the past, if you would divine the future." (29:413)

CHAPTER II

TYPES OF DOCTRINE

Since doctrine is a relatively intangible concept, it has been defined differently by both official and unofficial sources. As a frame of reference, this paper will use the definitions of doctrine rendered by Colonel (Col) Dennis Drew and Dr. Donald M. Snow in their 1988 article "Military Doctrine" published by the Air University. (7:288-291) Col Drew defines military doctrine as "what we believe about the best way to conduct military affairs." (7:288) He relates military doctrine to a "standard" or "guide for those who conduct military affairs." (7:288) He proposes the source of doctrine is "experience" based on the "repeated success or failure over time" and that doctrine is a "constantly maturing and evolving thing." (7:288) With only the limited experience of World War I, the USAAF developed their strategic-bombing military doctrine and did not properly test or exercise it, until they were under enemy fire.

"Fundamental doctrine defines the nature of war, the purpose of military forces" and the "relationships of military force to the other instruments of power" i.e. diplomatic, political, economic and military. (7:289) The American military, who generally support Clauswitzian theory, would include Clausewitz's assertion that "War is nothing else than the continuation of state policy by different means" in fundamental doctrine. (7:269, 15:44) Fundamental doctrine is ageless and highly resistant to change.

"Environmental doctrine," as related to air power, is "a compilation of beliefs about the employment of military forces within a particular medium"--in this case the aerospace medium. (7:290) Prior to World War II, USAAF unofficial environmental doctrine championed the theory that the bomber would always get through. This paper will trace the development of this environmental doctrine and illustrate the significant impact it had on USAAF organizational doctrine and operational strategy.

Finally, "organizational doctrine" is the "basic beliefs about the operation of a particular military organization" including "roles and missions" of the organization, "current objectives, administrative organization, and force employment principles" sometimes including "tactics" (7:290). "Organizational doctrine concerns the use of a particular force (e.g. US...) in a particular environment (e.g. US Air Force...)at a particular time--today." (7:290) Therefore, this review of

World War II organizational doctrine equates to a review of the USAAF doctrine of that period.

To clearly illustrate the relationships between these types of doctrine, Col Drew draws an analogy to a tree. Military history forms the roots, fundamental doctrine the trunk, environmental doctrine the branches, and organizational doctrine the leaves. (7:291) In this analysis, the leaves are USAAF organizational doctrine and the branches are the environmental doctrine that the bomber will always get through. To carry the analogy one step further, if any of the lower levels of doctrine are in error, or diseased, then the higher levels of the doctrine in the tree would also become diseased as nourishment, flowing up from the roots to the leaves, carries the taint with it.

CHAPTER III

HISTORY

During the interwar years, official United States Army Air Corps (USAAC) doctrine, found in Training Regulation 440-15 dated 26 Jan 1926, centered on close air support for Army ground forces. (17:29-30,40-43) However, advances in aircraft technology in the 1930s, led the Air Service and Air Corps Tactical Schools[1] (ACTS) to reevaluate their doctrine and develop an unofficial offensive environmental doctrine. Their concept of the Army Air Corps mission was to neutralize an enemy air force by "destroying it on the ground" and to nullify the "vital establishments" of his country through aerial bombardment. (17:30)

By 1935, under the influence of Brig Gen Billy Mitchell and Giulio Douhet, AAC unofficial environmental doctrine postulated that airpower should be used offensively, and the only practical means of defense against an air attack was an offensive, counter-air attack. (17:49) They even went so far as to indicate a

[1] The school was established on 30 Oct 1920 as the Air Service Field Officer's school at Langley Field, VA. In 1922, it was renamed the Air Service Tactical School and on 18 Aug 1926 was renamed the Air Corps Tactical School. In July 1931 it was moved to Maxwell Field, AL

ground offensive might not be required if the air offensive was successful. (17:57-59)

In the early 1930s, the final two components had been logically deduced, i.e., to maximize damage to the target and to protect the bombers from "random" pursuit attacks. (17:57-58) As a result, they added the concepts of high-altitude and formation-flying. Furthermore, analysis of target selection indicated certain industrial target destruction could have a disproportionate impact on an enemy's war-making capability. By 1935, with the resulting unofficial doctrine refinements, the unofficial AAC strategy had became formation, high-altitude, precision (requiring daylight), offensive, bombardment of selected industrial targets. (17:58)

In addition, the delivery of the first electro-optical Norden bombsight in 1928 and the availability of a fast, four-engine bomber[2] in 1939 gave credence to the Air Corps Tactical School's unofficial doctrine. (11:51; 17:57; 34:148)

Basic guidelines for the strategic war plan were formed in the 1941 discussions at the first American-British Conversations[3]

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[2] Model 299, demonstration model of the B-17, was test flown in August 1935 and in Jan 1936. The AAC ordered 13 YB-17s, or Y1B 17s as they were later designated. The final pre-production Y1B-17 model was deleivered in late 1937. The Y1B-17A was the 14th airframe and the first turbo-supercharged engine type. The first production model of the B-17B was provided on 20 Oct 1939. (11:5)

3 References 16 and 17 indicate ABC-1 as American-British "Conversations" No. 1 and reference 19 indicates as American-British "Conference" No. 1. Since two sources said "Conversations" this term was used. (16:296; 17:127,141; 19:132)

No. 1 (ABC-1) and were used to create the "Rainbow 5" war plan. (16:296) From 1939-1941, the ACTS unofficial doctrine heavily influenced the formulation of Air War Plans Division 1 (AWPD-1). Finalized in September 1941, AWPD-1 was the plan that initially defined the USAAF[4]'s strategic aircraft requirements for the conduct of air operations in World War II. (16:297)

The first version of the plan specified the primary objectives as the German Air Force, including aircraft assembly, aluminum, and magnesium plants; electric power, including generating plants and switching centers; transportation, including both rail and river; and finally petroleum and synthetic oil. (19:132-133; 39:183) If this air offensive did not defeat the enemy, then a secondary strategic military objective would be to support an invasion of the European continent using ground troops. (15:44, 19:132-133) The final strategic military objective called for air operations to accomplish "hemisphere defense and a strategic defensive in the Far East." (15:44)

Using this basic strategy, the planners determined the need for 44 bomber groups (3,740 aircraft) with a 4,000-mile tactical

4 To answer AAC calls for more autonomy, Army Regulation 95-5 created the Army Air Forces on 20 June 1941, in part to bring the Chief of the Army Air Corps' relative standing in line with the British RAF where their chief headed a separate service. (17:127)

radius i.e., the future B-29 and B-32. (16:297) The total bomber force would require 239 bomber groups and 108 observation squadrons for a total of 63,497 aircraft. (15:44, 16:297)

The plan was briefed to Secretary of War, Henry Stimson, on 12 Sep 1941 (16:298). Concurrently, the Army-Navy Boa :viewed the plan and completed an "Estimate of United States Over-all Production Requirements." (16:298) The stage was set for the accelerated procurement of thousands bombers, without sufficient fighter escorts. Due to the lack of long-range fighter escorts, by default, USAAF environmental doctrine, organizational doctrine and operational strategy would become bomber-based.

CHAPTER IV

STRATEGIC BOMBING OPERATIONS IN EUROPE

To prove the concept of unescorted, formation, daylight, high-altitude, strategic bombing, USAAF B-17s[5] would have to successfully fight their way to the target and return with acceptable losses, i.e., the bomber must get through. The first 27 daylight strategic bomber raids over France, Holland, and one shallow raid into Germany, from 17 Aug 42 through 30 Dec 42 appeared to support the concept. Aircraft losses were only two percent and only 20 percent of the aircraft received damage. (13:5-129) These percentages are based on the aircraft actually launched. However, since the B-17s Norden bombsight was optically based, weather would often prevent entire formations from seeing, and therefore bombing, their targets.

During this same period, the number of effective[6] aircraft was only 760 versus 1377 launched for an effective rate of only 55 percent. Looking at losses compared to the effective rate tells a very different story, i.e., losses were four percent and damage was 35 percent. (13:5-129) To put this in perspective,

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[5] Because B-17s conducted the vast majority of raids from the United Kingdom and because they conducted most of the strategic missions, only the data related to B-17s was used. Data on UK-based B-24 heavy bombers was not used.

[6] "Effective" means the aircraft accomplished the mission it was assigned without diversion or mechanical return. (13:5)

remember, almost all of these raids had fighter escorts for the majority of the route both, in and out.

Providing direct support for the airborne attack strategy, "President Roosevelt and Prime Minister Churchill ordered a combined US-British bomber offensive against Germany" at Casablanca in January 1943, code-named POINTBLANK. (15:45; 3:210)

Within the next ten months, the USAAF daylight-bombing strategy was on the ropes. By the end of the second mission to Schweinfurt, the USAAF B-17s had been flying deep into Germany, without fighter cover for most of the mission. The losses were severe.

In mid-1943 in only four raids, two to Schweinfurt, one to Regensburg, and one to Stuttgart, accomplished beyond fighter cover capability, 16 percent of the aircraft launched were lost and 43 percent were damaged. If taken against the effective aircraft, it was 20 percent and 54 percent respectively. Therefore, you can look at it one of two ways. Of the 1,034 aircraft launched for the four missions, 59 percent were either lost or damaged; or, of the 825 aircraft effective enough to bomb the target, 74 percent were either lost or damaged[7]. (13:5-129) Daylight precision bombing, as a concept, was in trouble.

The major problem was attacks by German fighters. Lt Col Beirne Lay gave the following description of fighter attacks during the first Schweinfurt raid.

> Fighter tactics were running fairly true to form. Frontal attackers hit the low squadron and lead squadron, while rear attackers went for the high. The manner of their attacks showed that some were old-timers, some amateurs, and that all knew pretty definitely where we were going and were inspired with a fanatical determination to stop us before we got there. (13:93)

In *The Mighty Eighth War Diary*, historian Michael Freeman states "Luftwaffe fighters were chiefly responsible for the punishing assault on the Fortresses during the second Schweinfurt mission." (13:126)

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[7] The calculations for this analysis were accomplished using summaries from the "The Mighty Eighth War Diary" that were taken from 8th AF daily Narratives of Operations, USSTAF Daily and Weekly Intelligence Summaries, group and divisional records, and other European sources. The number of aircraft damaged beyond repair or just damaged were based on estimates made after the mission was completed. If an aircraft was listed as only damaged and was subsequently found to be nonrepairable, or was listed as nonrepairable and was subsequently found to be repairable, the records were "unlikely to be amended." (13:5-6)

CHAPTER V

STRATEGIC BOMBING OPERATIONS IN THE PACIFIC

As the secondary theater of operations, the Pacific did not get the bomber support the European theater enjoyed until late in the war. Furthermore, the extent of operations was far less i.e., by the end of the war 1,360,000 tons of bombs had been dropped on Germany, but only 160,800 tons were dropped on Japan. (1:84) However, the Pacific theater was supplied with the USAAF's newest and premier bomber, the B-29 Superfortress.

The B-29 was a significantly superior strategic bomber to the B-17. The B-29s service ceiling was 31,850 feet (ft)--an increase of 3,850 ft over the B-17. (28:6) Furthermore, the B-29s top speed was 365 miles per hour (mph) compared to only 302 mph for the B-17G. (28:6) The Superfortress' cruise speed was only 220 mph--only 5 mph more than the B-17--despite a gross weight twice the B-17s and a bomb load 250 percent larger. (28:6)

But the principal reason the B-29 was shipped directly to the Pacific was its superior range[*]. The B-29 had a range of 5,830 miles compared to only 3,400 miles for the B-17G. This superior range gave the B-29 an operating radius great enough,

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[*]Before Pearl Harbor, USAAC planners talked about the need for a Very Heavy Bomber or VHB. However, after the Pacific war was a reality, the long range need was paramount and the term Very Long Range bomber or VLR was more generally used. (32:106)

even at high altitude, to bomb Japan from bases in China or the Marianas island chain. (19:136)

Initial B-29 daylight, high-altitude, precision bombing missions against Japan, conducted from bases in China, experienced poor bombing results and were considered by the United States Strategic Bombing Survey (USSBS) to have "insufficient weight and accuracy to produce significant results." (1:84) In addition to breaking in new aircraft, six to seven 1000-mile B-29 round-trips from India, over the hump to China, were required to support a single combat mission[9]. (20:420, 27:190)

The name "Superfortress" was not given lightly to the B-29. In the context of USAAF environmental doctrine, the USAAF was still attempting to build a "fortress" that could fight its way to the target and successfully return. (6:586) Based on the lessons learned from the European experience, the B-29 was extremely well defended.

The B-29A was outfitted with a General Electric Central Station Fire Control System (CFC). This system controlled the

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[9]The China missions were completed under such severe conditions and General LeMay's position was "The overall logistical facts of life were insurmountable, topped by the fact that the B-29 just was not ready." Therefore, this paper used only data from the Saipan, Tinian, and Guam missions for the analysis and conclusions. (27:190)

four-gun (0.50 caliber (cal)) upper forward turret, the two-gun (0.50 cal) upper rear turret, the two-gun (0.50 cal) lower forward turret, and the two-gun (0.50 cal) lower aft turret[10]. The CFC system calculated and corrected the gun trajectory for the parameters of range, wind, altitude, temperature, and airspeed. (21:11) Therefore, the CFC gunner could bring, simultaneously, up to ten, accurate, 0.50 cal machine guns to bear on an attacking fighter. In addition, the tail gunner had two 0.50 cal machine guns and a 20mm cannon[11]. (28:20,57-60)

Despite heavier armament and a higher altitude capability, Japanese fighters took a heavy toll on the attacking B-29s. (6:574; 37:230) The Japanese actually created squadrons of fighters whose pilots were expected to ram the B-29s and then parachute to safety--if possible. In order to reach the B-29s bombing altitudes, the "ramming" aircraft were stripped of armament, armor, and radios. (4:126) These units were called "Shinten Seikutai" or "Heaven-shaking Air-Superiority Unit". (4:126)

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[10] **Initially, the upper forward turret had only two guns; however, the two-gun turret was found to be unreliable. With the vulnerability of the aircraft's nose and enemy tactics favoring a frontal attack, four guns were found to be safer. Only 90 aircraft were built with the two-gun turret. (28:20)**

[11] **The 20mm cannon was found to be ineffective as its ballistics did not match the 0.50 cal machineguns; therefore it was deleted after the first 125 were built. (28:20)**

Later in the conflict, as the Japanese became more desperate about night raids, they launched *Bakas,* manned, rocket-powered suicide planes, with over 2,000 pounds of explosive in the vehicle's nose. (4:232) The intent was for the suicide pilot to ram or fly as near possible to a B-29 and then detonate the explosive charge to damage or destroy it.

Strategic bombing's second major problem in the Pacific theater was the same old problem found in Europe--bombing accuracy. Describing early daylight, high-altitude, precision B-29 raids from the Marianas, the USSBS stated "The planes bombed from approximately 30,000 feet and the percentage of bombs dropped which hit the target areas averaged less than 10 percent." (1:84)

A significant contributor to the inaccurate bombing performance was another duplicate European problem--bad weather. Warm and moist trade' winds met cold Asian winds over the coast of Japan forming heavy, layered, persistent, and unpredictable cloud conditions that obstructed targets and confused bombardiers. (4:176) Furthermore, high altitude jet streams over Japan caused aircraft to have effective ground speeds of 400-500+ mph making accurate bomb release, using the optical

Norden bombsight, extremely difficult. Moreover, they made an upwind attack unrealistic. (6:576; 4:176) Extreme cloud cover repeatedly forced B-29s to bomb secondary targets, because the primary target was not visible, or to drop their bombs through the overcast. (20:441-450) Visual bombing capability steadily decreased as the winter progressed. The percentages of B-29s able to bomb visually decreased from 45 percent in December 1944 to 19 percent in February 1945. (6:576)

Lack of comprehensive and realistic training, prior to shipping aircrews overseas, was another contributor to poor bombing accuracy. In both theaters, as newly-arrived crews became seasoned, the visual and radar bombing accuracy eventually improved. In contrast, the intensive training provided the 313th Bombardment Wing (the atomic bomb wing) aircrews enabled them to visually drop single "practice" 5-ton conventional bombs extremely accurately. On their 24 July 1945 mission, eight of ten had excellent bombing results, two had direct hits, and all from 30,000 feet. (4:290)

Another contributor to aircraft losses was the distance to be flown (See appendix B). From Saipan to Tokyo was about 1450 miles, one-way, making a round trip of 2900 miles. The route was almost entirely over water and the few islands below were held by the Japanese. Initially, the B-29s carried 6,000 pounds of bombs, and 8,000 pounds of fuel. (20:443) Then, they flew for 3,000 miles through the severe weather described above. That kind of mission would generate a serious strain on any aircraft, but even more so on those damaged by fighters or flak over the target and returning with less than four operational engines. Mechanical aborts (>20%), unknown losses, and ditchings at sea were common in the early daylight high-altitude precision bombing raids. (20:442; 4:169,172; 21:35; 32:132)

Poor ground-crew training would also adversely impact strategic bombing operations. Inadequate maintenance, performed by newly-trained maintainers, caused 25 percent of the aborts in November and December 1944. Due to an intensive local training program in January and February 1945, the mechanical-failure abort rates dropped to 23 and 16 percent, respectively. (6:575)

Aircraft availaibility would be a constant problem. Industry and the ferrying system would never meet the promised B-29 delivery schedules. (6:575) The first Tokyo raid, on 24 Nov 1944, used 111 aircraft. However, aircraft losses and mechanical failures, without adequate replacements and spare parts, prevented another 100-bomber raid until 4 Feb 1945. (35:26)

The extremely long flights, the losses to Japanese fighters and flak (3.6%), the small tonnage of bombs delivered (7,140 tons), and the extremely poor bombing accuracy (<10%) combined to make the 24 November 1944 through 8 March 1945 missions from the Marianas extremely expensive in terms of aircraft and manpower--with a poor return. (1:84) Of the nine top numbered targets assigned to the B-29s, none had been destroyed. Target #357, the Musashino Aircraft Engine Factory, had been the primary target eight times and was still intact. Seventy five B-29s had been lost, 29--to enemy fighters, nine--to fighters and flak, one--to flak alone, 21--to operational causes, and 15--to unknown causes. (4:169; 6:574) Once again daylight, high-altitude, precision bombing as an operational strategy had failed. (6:573)

In the end, the US Marines would do the most to solve the distance problem. By invading the island of Iwo Jima on 19 February 1945, and securing it by 16 March 1945, the Marines gave the B-29s a half-way stop only 750 miles from Tokyo. (See appendix B)(21:258) Iwo Jima would enable B-29s to reach northern Japan, provide an air-sea rescue base at the half-way point and, most important of all, provide an emergency landing strip for the B-29s. By the end of the war 2,400 B-29s had made emergency landings on Iwo Jima and it had provided a haven for 25,000 American airmen. (6:598; 32:139)

CHAPTER VI

TACTICS CHANGES ATTEMPTED TO IMPROVE PERFORMANCE

To vindicate their doctrine of high-altitude, daylight, precision, strategic bombing, USAAF airmen made numerous changes to their tactics in order to make losses less likely.

In the European theater, the combat formations for the B-17 were designed to provide maximum defensive firepower by enabling mutually supporting fires from the Fortresses to concentrate defensive fire on attacking fighter aircraft. From their arrival through February 1943, Eighth Air Force (8AF) B-17 groups tried four different formation styles in attempts to tighten up the formations and improve mutual firepower. The failures over Germany, particularly from fighter frontal attacks[12], caused the airmen to develop the 54-aircraft "combat wing box" formation in early 1943 that provided increased mutual firepower to the front.

In response, the German's modified their tactics to attack the high squadron of the high group and the low squadron of the low group because of their exposure. (12:42) As a result, after the severe losses in mid-1943, USAAF airmen slightly modified the "combat wing box" formation to bring the exposed squadrons more

[12] **Numerous sources confirm German fighter opposition used overhead and frontal attacks to capitalize on the weak armor and armament of the B-17 series aircraft (9:55; 23:181; 24:167; 42:28)**

behind the lead squadron for better protection. (12:42; 42:28) To avoid the "combat wing box" firepower envelope, the Germans also experimented with "out-of-range" attacks. These assaults used air-launched rockets, time-fused fragmentation bombs dropped into the bomber formation from above, and aircraft trailing electrically-detonated bombs on the ends of cables. (13:39,93; 23:181; 40:39)

By 1944, a new 36-aircraft formation had been developed but the 54-aircraft "combat wing box" was still used if heavy fighter concentrations were expected over a particular target. (12:43) After long-range fighters became available, the formations were again changed in late 1944-45 to reduce the bomber losses from flak. (12:43)

In a vain attempt to find a solution and reintroduce the element of surprise lost to radar, two weeks before the first Schweinfurt raid, the USAAF conducted a low-level, heavy-bomber (B-24), raid on the Ploesti oil fields. Despite intensive training, the bomb groups clearly experienced the fog and friction of war. Cloud cover, the loss of two trained navigators from one of the groups, early spotting by a biplane, disorientation, incorrect targeting, poor decisions, and strong defenses at the target resulted in a 37 percent loss rate and only a 40 percent target success rate. (22:162-169,172; 25:62; 8:78-79) As a direct result, large, low-level, daylight, precision, strategic bombing attacks were not attempted again during World War II[13]. (25:60-62)

After the second raid on Schweinfurt, "deep penetrations without escort were suspended" and Schweinfurt was not attacked again for four months. (1:15; 9:55) Air superiority had become the key to making the strategic-bombing doctrine work.

In the Pacific theater, 21st Bomber Command (21BC), under the direction of Brigadier General Haywood Hansell, conducted three months of precision strategic bombing attacks. After reviewing the large number of ditchings due to mechanical trouble and lack of fuel, General Hansell trained this crews on the "critical art of cruise control." Furthermore, he allowed Col Robert "Pappy" Hayes, of the 497th Bomb Group, and his very competent engineer, Major C.C. Gibson, to try a different loading configuration on their B-29. They removed the large bomb-bay fuel tank, the rear 20mm cannon, and some of the tail armor. This arrangement eliminated over three tons from the aircraft's

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[13] Numerous sources were used for this evaluation, i.e., (4:14-35; 8:79-83; 22:157-172; 25:60-62; 26:129-135); however, General Leon W. Johnson (MOH winner) was the premier source as he was a participant and commander of the 44th Bomb Group during the Ploesti raid.

weight. On the first mission with the revised loading, Col Hayes' aircraft "Thumper" returned home with more fuel than a normally loaded aircraft. (4:172)

As a result, all of the 73rd Bomb Wing's aircraft were modified and in the next two missions only one aircraft had to ditch into the sea. During the previous two months, the wing had averaged 2.5 ditchings per mission and had peaked with eight on a single mission. (4:172)

On 20 January 1945, General Curtis LeMay took over 21BC in the Marianas. For six out of the next eight missions, General LeMay continued with bombing according to USAAF environmental doctrine i.e., daylight, high-altitude, and precision. (20:450-451) However, with pressure from Washington to try incendiary bombs, he tried two daylight, high-altitude incendiary raids that showed some promise.

In late January, General LeMay sent the on-site Wright Aeronautical representative back to the States for suggesting the short life of the B-29 engines was the result of the loading experienced during the climb to 20,000 feet while hauling the extremely heavy loads[14] of bombs and fuel. However, a new Boeing

[14] General LeMay's comment during the incident was reported to be "We aren't here to save engines!" or words to that effect. (4:176)

representative, Mr. Wellwood Beall, suggested the B-29s use the tactic of flying at low level until the fuel in the center wing tanks was burned off, thereby decreasing the fuel loading, and then climb to bombing altitude. (4:176) General LeMay, who was eminently flexible, gave the tactic a try and B-29 engine life was tripled. (4:176)

After analyzing Japanese defenses and sending scout aircraft in at low-altitudes on two different night raids, LeMay made a decision to put his career on the line and throw out current USAAF environmental doctrine and operational strategy. (4:179; 21:36; 32:143) He would send 21BC B-29s to conduct a night, low-level, area, incendiary raid over Tokyo.

On 9 March 1945, 334 aircraft took off and 285 actually dropped their M-47A2 and M-69 incendiary bombs on Tokyo from altitudes between 5,000 and 7,000 feet. The Japanese were caught completely by surprise. (4:188) The high winds, that had previously foiled the American's precision bombing, now became their ally and within 30 minutes the fire was completely out of control. (4:188; 20:453)

Almost 16[15] square miles of Tokyo went up in flames, including 11 square miles of the industrial area and 22[16] numbered 21BC targets. (6:616; 20:454) At least 78,660[17] Japanese were killed. (20:454) Numerous historians have commented on the effectiveness of this raid (underlining added):

> It was nearly a month before all the bodies had been removed from the ruins, and no other air attack in history had ever been so terrifyingly effective. (4:190)
> **Steve Birdsall**

> No other air attack of the war, either in Japan or Europe, was so destructive of life and property. (6:617)
> **Wesley Frank Craven and James Lea Cate**

> ...In the holocaust that followed almost sixteen square miles of the city were destroyed and some 83,800 persons perished, the most deadly attack in the whole of World War II. ...In terms of sheer physical destruction this conflagration outranked the great fire in Rome in A.D. 64; London in 1666; Moscow in 1812; Chicago in 1871; and San Francisco in 1906. (21:35)
> **Kevin Herbert**

> It remains the world's most devastating air attack of all time. (32:143) **David Mondey and Lewis Nalls**

> Never again--not even in the atomic bombings--was so much destruction to result from any single bombardment mission, nor was any other mission to lead so directly to revolutionary tactics in aerial bombardment. (20:452)
> **Vern Haugland**

[15] The actual destruction spread over 15.8 square miles and all four sources used stated either 15.8 or rounded up to 16. (4:190; 6:616; 20:454; 21:35; 32:143)

[16] USAF Historical Division lists 22 numbered targets destroyed and reference 20 indicates 23. The more conservative number was used. (6:616; 20:453)

[17] Various references list the deaths between 78,660, to 83,793 (the official Japanese death toll) to 83,800, and all the way up to 97,000. No one is really sure, the damage was too swift and too severe. (6:617; 4:190; 32:143; 20:454; 21:35)

The only detracting factor was the loss of 14[18] aircraft, 4.6 percent of the aircraft launched, or 4.9 percent of the effectives. However, 22 numbered targets were destroyed in this one raid. (6:616) In the four-months of daylight high-altitude precision raids prior to the 9 Mar 1945, 75 aircraft were lost with no numbered targets being destroyed. (6:573; 4:169) As the night incendiary raids continued, losses declined as the crews learned to handle the severe updrafts and thermals caused by the burning cities.

In the next 10 days, Gen Lemay would dispatch four more, maximum-effort, low-altitude, area, incendiary missions, of 1600 sorties, to three other cities in Japan. The raids destroyed 32 square miles of Japan's major industrial cities and would deliver three times the weight of the bombs dropped in the previous three months[19]. (4:194) On the 11 Mar 45 Nagoya raid, where the overall damage was the least, 18 more 21BC numbered targets were damaged or destroyed. (6:618) Only seven aircraft

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[18] **Four references indicate 14 aircraft lost and one indicates only five aircraft lost. However the four references that indicate 14 lost also state five aircraft ditched and the crews were recovered. The single author may have seen this statistic and made a mistake. Furthermore, the USAF Historical Division account stated 14 lost. One of the authors quoting 14 lost gave aircraft nicknames that exceeded the five figure. (6:616; 4:190; 20:453; 21:35; 32:143)**

[19] **The flight at low altitude required far less fuel to get to altitude and ammo was not loaded for the gun turrets. On the 9 March 1945 mission, two squadrons even took the machine guns out of the turrets. (4:182) In later raids only the rear turrets, and later the lower turrets, were provided ammo to shoot out searchlights. (4:191) This significant decrease in weight enabled bomb loads to be increased from 6,000 lbs to 13,600 lbs per aircraft; thereby effectively more than doubling the size of the attacking force with the same number of planes. (20:456) Flying at lower altitudes also caused less wear and tear on the engines and the cloud cover was not as bad. Therefore, in the first five incendiary raids, 90 percent of the bombing force was able to bomb the primary target versus 36 percent for the previous three months of high-altitude daylight attacks. (4:179,191,194; 6:612; 20:456; 32:142,144)**

were lost in all four of these raids (0.58 percent of the aircraft launched and 0.6 percent of the effectives). (20:450-456)

At this point, logistics would start to control strategy. When Gen LeMay changed tactics, the logistical system could not react fast enough. After the first five mass incendiary raids, the system was out of incendiary bombs. Gen LeMay stated:

> We made those five big raids and then had to quit, not because it was our plan but because we ran out of bombs. We never did get caught up on incendiary bombs. We still had on hand a sufficient supply of HE bombs, but not always the types we wanted. (20:455)

The first phase of Gen LeMay's plan, using urban area incendiary bombing tactics, would destroy 105.6 square miles[20] of Japan's six most important industrial cities. During the 17 maximum efforts of this phase, from 9 Mar 45 to 15 Jun 45, 6,960 B-29s were dispatched, 6,387 bombed the primary target, and 136 were lost. By the end of the war, 21BC would incinerate a total of over 150 square miles in 65 of Japan's cities[21]. (4:318)

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[20] This was 93.7 percent of the planned industrial target area (112.7 sq mi) and 41 percent total urban area of these six cities. (6:643) This figure includes the destruction in the city of Tokyo previously described.

[21] This figure includes the destruction in the city of Tokyo previously described.

Some experiments with night precision bombing, using flare pathfinders and mixing flares with the high-explosive bombs, were tried but abandoned when the results were poor. (4:216; 6:646-647)

The first operational strategy, that worked against Japan, was night, low-altitude, area, incendiary bombing. Local air superiority, gained using the invisibility of darkness, was the key.

As the Japanese reoriented their ground defenses, more searchlights were used to highlight the bombers so they could be visually attacked by flak guns at night. In July 1945, to camouflage the B-29s on their low-level night raids, 21BC started to paint the undersides of the B-29s black. This tactic proved to be very effective but the war ended before all of the B-29s could be painted. (4:274)

CHAPTER VII

TECHNOLOGY CHANGES IN AN ATTEMPT TO IMPROVE PERFORMANCE

During this same period and throughout the war, USAAF airmen were using technology to improve their performance, to reduce losses, and to validate the viability of their doctrine of daylight, high-altitude, precision, strategic bombing.

In the European theater, the USAAF and Boeing began to get an inkling of the B-17's vulnerability from the British, who were given 20 of the early-produced B-17Cs and complained loudly. As a result, self-sealing fuel tanks, dorsal and ventral power turrets, and a tail gun position were added to the B-17 D&E models. In addition, six of the seven machine guns were upgraded from 0.30 to 0.50 caliber.

By the time B-17F started production, the ventral turret had been abandoned in favor of the Sperry Ball turret, self-sealing oil tanks had been added, and the number of guns had risen to eleven, all 0.50 caliber. (42:24-30,62) The B-17F was the primary production model initially sent to Europe for service with the 8AF. However, continued combat experience and lessons learned demanded further improvements to reduce the aircraft's and crew's vulnerability.

Freeman writes "By May of 1943, the standard modification list for B-17s joining 8th Air Force had 59 items, 19 pertaining to armament, nine to armour plate and bullet-proof glass fitment, three concerning electrical accessories and two the engines." (12:151) Furthermore, numerous local modifications to the B-17s nose tried to address the German frontal attacks. Twenty millimeter-cannon and twin 0.50 caliber nose guns were tested but were found to cause structural damage or interfered with the bombardier's vision. (13:87; 12:148-149) By the time the later versions of the B-17F and B-17G were being produced, in recognition of the frontal attack losses, a twin-gun chin turret had been added and the number of guns had risen to 13, all 0.50 caliber. (42:28,62; 11:53)

Continued losses over Germany prompted USAAF airmen to attempt to give the fighters enough "legs" to escort the bombers all the way to the deep-penetration targets in Germany and back. External, "jettisonable" fuel tanks were designed and built by both American and British firms in large quantities. Initially, the premier American fighter was the American P-47 "Thunderbolt," and it had a 200-gallon steel ferry tank; but, it had serious fuel-flow problems above 22,000 feet. (12:218) However, by mid

July 1943, the British were producing a 200-gallon, heavy-paper composition ferry tank for the USAAF "at a rate of 1,000 per month." (12:218) Unfortunately, this tank was used with only 100 gallons of fuel; and since the P-47 was a gas guzzler it only increased its range to 550 miles. Also by July of 1943, 4,000, new, US-made, 75-gallon, steel P-39 tanks arrived in England; but, these only increased the P-47's range to 560 miles. (12:218-221) However, this fuel tank concept would form part of the final technological solution when the P-51 arrived on the scene; two of these 75-gallon wing-mounted, tanks, would increase its 450-mile range to 1,300 miles and were used until they ran out in the spring of 1944. (12:221)

Later, in May 1944, airmen modified the P-47 108-gallon paper composition belly-tank to be used as wing tanks on the P-51; thereby, increasing the P-51's range by an additional 200 miles to a total of 1500 miles. (12:221) In addition, some P-51 units modified the 110-gallon P-47 steel belly-tanks for use as P-51 wing tanks; however, these were not as popular with the pilots as the paper composition tanks. (12:221; 14:104)

By December of 1944, redesigned versions of the 108-gallon paper-composition tanks were available for the P-51s that eliminated the jury-rigged external plumbing and increased the aircraft's performance by five mph[22]. (12:221) These range increases would enable the P-51 to escort the bombers to any target in Germany and gave them the capability to fly support missions for the B-29s from Iwo Jima to Tokyo.

According to General Curtis LeMay, "From the end of 1943 to the Big Week in February, 1944, strategic daylight bombing perforce ground to an abrupt halt, while the Eighth Air Force waited on delivery of satisfactory long range fuel tanks to give our fighter escorts full range to the target and back." (27:189) Ultimately, technology would even give the P-47 "legs." Although too late for the European theater, the new P-47N with improved engines, strengthened and extended wings[23], and two newly-designed 300-gallon wing drop tanks would have a combat range that exceeded 2,000 miles. (6:587) Early models were sent to the Pacific in late spring 1945.

The next major problem plaguing the strategic bombers was inaccurate bombing. The USSBS concluded "only about 20 percent" of the bombs dropped "hit within one thousand feet of their

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[22] The absolute range of the P-51 to a dry tank , with two 75-gallon drop tanks, was 2,084 miles. With the additional 100-mile range provided by the 108- or 100-gallon drop tanks, the absolute range would be about 2,184 miles to a dry tank. (18:248) Operating out of Iwo Jima was at the maximum safe limit of the P-51s capability with tw 110-gallon wing tanks (14:148)

[23] Inside the new P-47N wings were four additional 50-gallon fuel ...ls.

aiming points." (1:13; 30:39; 2:546) The USSBS also indicated bombing improved as the war progressed, thereby, confirming the indictment of poor initial aircrew training. (1:13) The optically-based Norden bombsight required the bombardier to see the target in order the execute a bomb run and have any hope of hitting and destroying the target. Unforgiving European weather often obscured the target with clouds, fog, or rain. Furthermore, by October 1943, the Germans had smoke-screen facilities at 22 of their port facilities to hide them from the bombers. (13:122) In addition, industrial haze, lack of freedom of maneuver because of the large formations, and enemy attacks made it much harder to drop the bombs in the "pickle barrel." (1:13) Once again, USAAF airmen would attempt to use technology to overcome this deficiency.

Late in 1942, 8AF experimented with Gee[24] to determine the viability of specially-equipped bombers to lead bomber formations, over cloud cover, to conduct "blind" bombing. But they were unable to find enough cloud cover to test the theory. Meanwhile, the British agreed to provide H2S[25] and Oboe[26] equipment

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[24] Gee was a secret British receiver equipment that permitted triangulation position fixing using three beacons located in the United Kingdom. It had a range of about 350 miles. (12:47)
[25] H2S was the RAF's 10-centimeter airborne terrain scanning radar. (12:48)
[26] Oboe was the RAF's beam, aural-positioning system that used two ground stations located in the UK. It enabled the pilot to fly a course over the target and let him know if he strayed off course and when to release his bombs. (12:48-49)

to 8AF. As a consequence, in April 1943, the USAAF created the American pathfinder force. (12:47) Unfortunately, according to the agreement, Oboe could not be used over Germany, in daylight, without RAF approval. RAF approval was not received until October 1943. Subsequently, after six 8AF unsuccessful or marginal attempts Oboe was found to be unusable at high-altitudes because of distance and atmospheric conditions. (12:48-49)

The radar bombing approach was determined to be a better possibility. However, the H2S radars were plagued by problems and were abandoned. In their place, the American-made version of the H2S, the H2X or "Mickey," equipped aircraft were received by the pathfinder force in January 1944. This approach was found to be successful, and by the end of the war every squadron in 8AF groups had one or two H2X-equipped pathfinder aircraft. (23:183) The system worked so well it was even used on partially-bad days as a navigational aid with the optical sight being used if the target was visible. Since it was not as accurate as a visually-directed attack, it was only used for city areas or large isolated industrial targets. (12:50)

To attack smaller targets, 8AF acquired eight Gee-H beam radars, that worked on the same principal as Oboe, except the aircraft beamed the signal and the UK ground stations responded. It was used successfully until June 1944 when most of the targets were beyond its maximum range. However, an improved version was used after September 1944 by synchronizing it with the Norden bombsight at various checkpoints. (12:51) Finally, the microwave-based, American-made, Mico-H was setup and used in the spring of 1944. It employed two microwave radar transmitting stations located in Belgium and France. It provided a visual display to synchronize the bombsight at a checkpoint on the final bomb run. With these technological advancements, the 8AF was able to put more "bombs on target."

To reduce the effectiveness of German radar detection and radar-controlled flak guns, B-17s would drop strips of metal-coated paper called "window." Later in the war, the allies would develop "carpet," a radar-jamming transmitter. Carpet, carried in some of the bombers, would be used to jam German radar receivers. The resulting interference would provide limited radar invisibility for the bombers. (22:183-184)

In the Pacific, the radar upgrade came in the form of a totally modified B-29 designated the B-29B. Only 311 were produced and when they were sent to the Pacific, starting in

April 1945, they were all put into the 315th Bomb Group. (28:24, 4:269) A number of new modifications were incorporated into the B-29B, but the most important technological improvement was the addition of the AN/APQ-7 Eagle radar. This radar reduced the beam from the original 360 degree scope scan to a narrow 60 degrees. (28:25) This reduction significantly improved the definition of the radar signal. (28:25) The 315th flew 15 night, medium-altitude[27] radar, precision missions, against 10 major Japanese oil industry targets, and destroyed 6,055,000 barrels of storage capacity. (4:270,276-277; 20:467-468)

With the Eagle radar, the 315th was able to attack their primary target every mission and, despite cloud cover, they could guarantee destruction in a maximum of three missions. On their best single mission, a raid on 5 August 1945, they destroyed the Ube Coal Liquification Company refining units and half of the Ube Iron Works Company. (4:276) The Eagle radar made precision bombing realistic; however, as the B-29Bs were stripped and almost unarmed, they had to use the invisibility provided by night or overcast skies.

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[27] **True to USAAF doctrine, the Eagle radar was expected to revive the high altitude precision attack, even if it was conducted at night. However, the Eagle radar was found to be worthless above 20,000 ft; therefore, medium altitudes of 15,000 to 20,000 ft were used. (4:269)**

As an invisibility radar countermeasure, "rope," a very large version of "window," was dropped on most B-29 raids. In an improvement over "carpet," four radar-jamming "Angel" versions of the B-29s were delivered in July 1945 to counteract the Japanese radar-controlled searchlights and flak guns. On 1 July 1945, the "Angels" orbited the city of Kure for 90 minutes to cover the attacking B-29 formations. (4:263) "Opposition was surprisingly light" and no aircraft were damaged, (4:263) The "Angels" were only used one more time before Japan surrendered and no B-29s were damaged on that mission either. (4:263)

One final technological advancement was required to make daylight high-altitude strategic bombing possible--the development of a long-range escort fighter. The original contender was the P-38 but because of serious engine, altitude, and diving problems it wasn't the solution. However, the P-51 Mustang, a fast, gas-efficient aircraft came to the rescue. (14:66-67) The P-51B was an American-British creation with an American-designed airframe and a British-designed Rolls Royce Merlin engine. (18:248; 41:80; 10:104) With two 108-gallon paper composite or two 110-gallon steel wing tanks, the P-51 was able to provide escort for the bombers over any target in Germany and gave them the capability to fly support missions for the B-29s from Iwo Jima to Tokyo (14:145, 20:442)

On 11 December 1943, the 354th Fighter Group, Ninth Air Force, sent 44 P-51s on their first B-17 bombing escort mission to Emden, Germany. In the next few months, the USAAF would relearn the lesson the German's should have learned over Britain, i.e., if you tie the escort fighters to the bomber streams you lose their inherent flexibility. By authorizing fighter sweeps ahead of the bombers, the fighters could attack the airfields, destroy fighters on the ground, and attack targets of opportunity from vehicles to trains. (38:69; 24:169; 10:104) Attrition, using fighter-escorts, was the method finally used to eliminate the Luftwaffe. (31:9A; 33:173)

In the Pacific theater, because of the switch to night attacks, P-51s would only escort 10 missions to Japan from Iwo Jima but would significantly reduce daylight losses when they were used. Major John P. Carroll, a B-29 commander, commented on the first-ever Iwo-based P-51 support mission for a 7 April 1945 daylight B-29 bombing raid:

> The P-51s did a better job of protecting our squadron than I ever saw when flying with the Eighth Air Force in Europe. Thirty Mustangs swept the area ahead of us, and only two Jap fighters got in to us. Both of them went down smoking. (20:457)

The crowning technological achievement displayed in the Pacific theater was the atomic bomb. On 6 Aug 1945, a single aircraft dropped a single bomb on the city of Hiroshima. In an instant, 4.5 square miles of the city was obliterated and at least 70,000 Japanese died. (4:297-298; 20:483) On 9 Aug 1945, a second atomic bomb was dropped on the city of Nagasaki. In another "great flash" 23,753 Japanese died and 1.5 square miles of the city was devastated. Strategic bombing had brought Japan to its knees. However, with the advent of the atomic bomb, the ultimate area weapon, precision bombing would take a back seat until the late 1960s.

CHAPTER VIII

CONCLUSIONS

Under the influence of Douhet and Mitchell, the Air Corps Tactical School developed an unofficial, untested, offensive, environmental doctrine for the USAAF. They would correctly identify the need for air superiority but would incorrectly assume fortress-style bombers would gain it by themselves. This unofficial environmental doctrine, and its adherents, would formulate AWPD-1 and prepare industry to produce thousands of bombers. However, they would fail, despite the admonitions of General Claire Chennault and the pursuit believers, to identify the need for fast, maneuverable, fighters. (17:55-56) The final impact would be the de facto creation of an offensive, formation, daylight, high-altitude, precision, bombardment of selected industrial target organizational doctrine and operational strategy.

Because the ACTS unofficial environmental doctrine was not fully tested, fog and friction would intervene making the resulting operational strategy extremely difficult to implement. Furthermore, the invention of radar in 1935 would seriously degrade the capability of fast, fortress-style, bombers to attack industrial targets and withdraw before the pursuit (fighter) aircraft could be directed against the bomber streams.

Since USAAF bombardment doctrine had not been thoroughly tested, in all possible weather scenarios, European and Japanese winter weather would severely degrade the visual bombing accuracy of the Norden-bombsight-equipped B-17s and B-29s. Moreover, the higher the bombing altitude used, the more accuracy suffered.

Faced with mounting bomber losses using a flawed strategy, the airmen of the USAAF, 8AF, and 20AF[28] used every tactic and technology they could devise to implement the flawed USAAF operational military strategy of daylight, high-altitude, precision, strategic bombing.

In Europe, only the availability of the P-51 long-range fighter, and the drop tanks to increase its operating radius over the skies of Germany, made bomber mission escort possible and as a result made daylight precision strategic bombing viable. (30:38) Consequently, by the spring of 1944, the German Air Force had lost air superiority. (1:18-19) Validation of this premise can be clearly seen by analyzing the third and fourth

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[28] Twentieth Air Force included 21st Bomber Command in the Marianas, and 20th Bomber Command in India. Twentieth Bomber Command moved to Okinawa to setup operations on 7 July 1945. Twentieth Air Force was originally headquartered in Washington commanded by General Arnold but moved to Guam on 16 July 1945. It was commanded by General LeMay for a short time who was replaced by General Twining on 2 August 1945. However, the war ended for the B-29s on 15 August 1945. (4:324)

B-17 raids to Schweinfurt on 21 July 1944 and 9 October 1944. With strong fighter escorts, the losses were 0.9 and zero percent and 24 and 4.3 percent damaged, respectively. (13:301,362) Fighter escort worked.

In the Pacific, 20 daylight high-altitude precision bombing missions were conducted from 24 Nov 1944 to 4 Mar 1945. During these three months, no 21BC numbered targets were destroyed, only 51 percent of the aircraft bombed the primary target, and 4.3 percent of the effective aircraft were lost. In contrast, during the three month period, 9 March 1945 to 15 Jun 1945, Gen LeMay would accomplish only 17 day and night[29] incendiary attacks. However, during these missions, the B-29s would destroy 40 numbered targets in only two missions, would torch 106 square miles of Japan's six largest industrial cities, would bomb the primary target 91.8 percent of the time, and lose only 2.1 percent of the effective aircraft.

Of these attacks, seven missions were conducted in daylight and three were escorted by P-51 fighters. In the first phase,[30]

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[29] Ten night attacks and seven day attacks. Altitudes for night bombing were generally 5,000 to 12,000 ft and for daylight 12,500 to 20,500 ft. Gen LeMay varied the altitudes to to keep the Japanese off-balance. Three of the day attacks were escorted by P-51 fighters and three were not, the remaining mission's escort status was not available.

[30] Only the first phase of the incendiary plan was considered because the majority of Japan's defenses were on the larger cities. Furthermore, as time passed, the Japanese stared to hold back aircraft to support an expected allied invasion. Therefore, using later raids would skew the results.

the loss rate for day missions was only 1.7 percent versus 2.5 percent for the night missions. The only variables that apparently changed were the altitudes and the fighter escorts. Therefore, it is likely the daylight losses were reduced when fighter escorts were provided. The night losses were still less than the daylight precision raids and this appears to be the result of the invisibility provided by darkness and radar countermeasures. Once again, air superiority was the answer.

A number of future needs and lesson's learned were clearly delineated in this study of World War II strategic bombing. Significantly lower loss rates when *escort fighters* were provided, or when invisibility using the cover of darkness and/or radar countermeasures was used, clearly reinforced the necessity for air superiority.

The successful combined bomber campaign, the night missions of the Pacific B-29s, and the severe weather impacts in both Europe and the Pacific validated the need for an all-weather, day or night, air attack capability.

Poor bombing accuracy, and large number of return trips to destroy a single industrial target, certified the need for vastly improved precision bombing capability. However, to the Air

Force's detriment, this would take a back seat to the atomic weapons delivery platforms designed after the war.

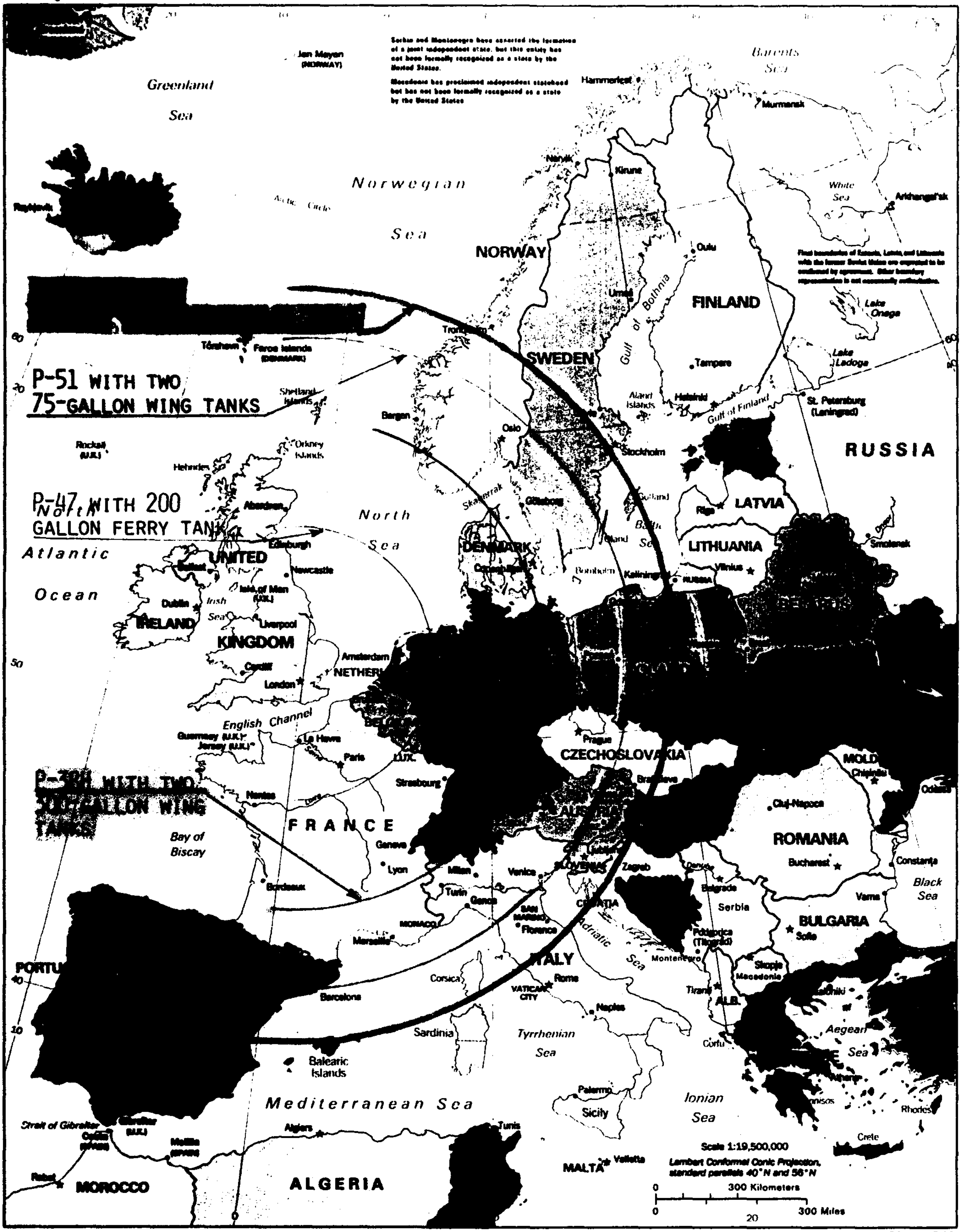
Clues to watch for were also highlighted, the quality and realism of training and the capabilities of the logistics system to impact and/or meet the needs of the war fighter. In a prolonged conflict, the side with technological edge has the advantage--only as long as his technology stays on top. The corollary is that technology will be constantly changing.

Despite faulty environmental doctrine, and significant obstacles to overcome, airmen made the strategy work. If airmen have the perseverance, drive, resources, and innovation--they can overcome even faulty doctrine and strategy.

Why should airmen study strategic bombing conducted fifty years ago? Santayana said it best; "Those who cannot remember the past are condemned to repeat it." (29:499) The lessons are clearly available--only the interpretation is more difficult.

APPENIDIX A

Europe



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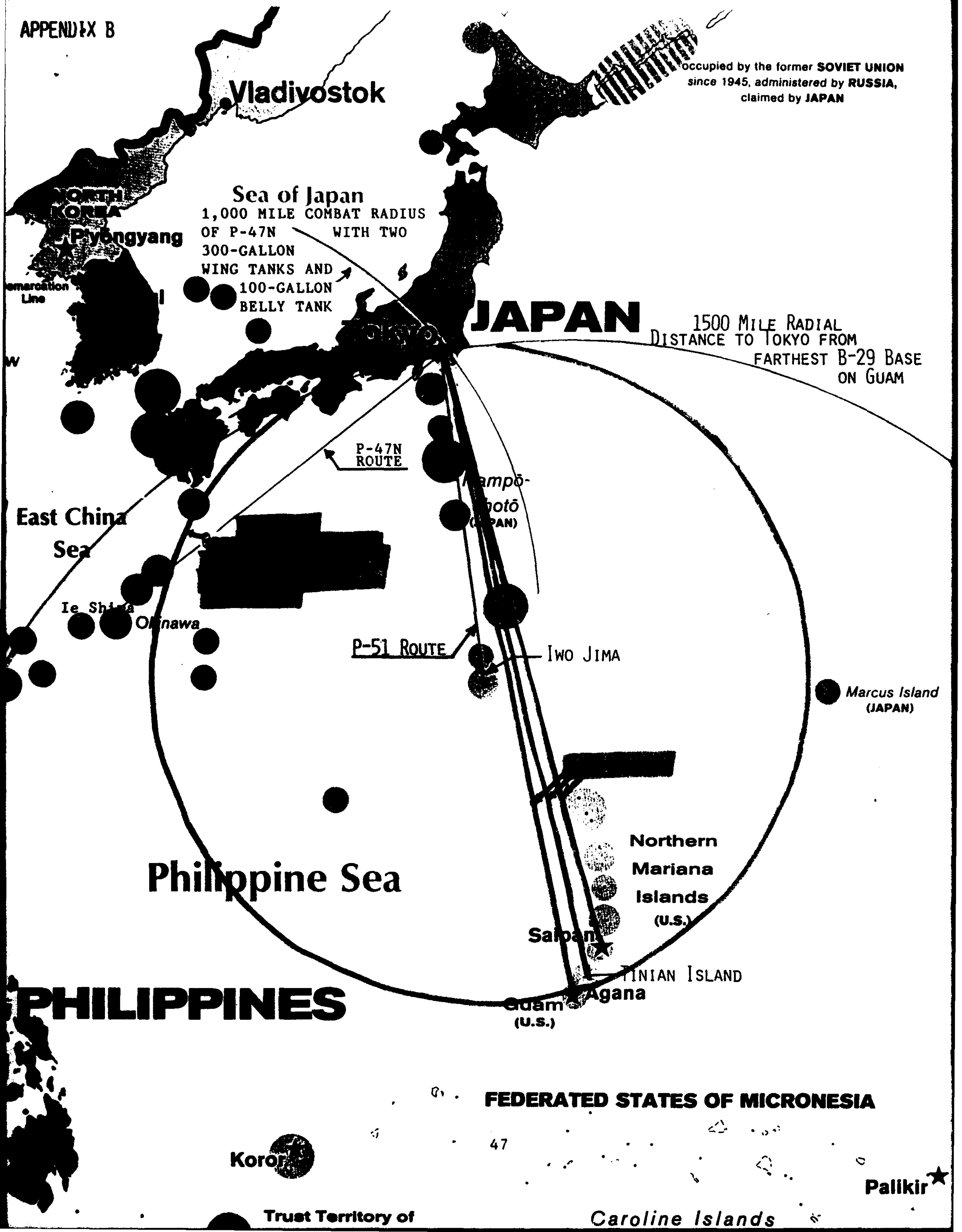
APPENDIX B



Vladivostok
occupied by the former SOVIET UNION
since 1945, administered by RUSSIA,
claimed by JAPAN
NORTH KOREA
Pyongyang
Sea of Japan
1,000 MILE COMBAT RADIUS OF P-47N WITH TWO 300-GALLON WING TANKS AND 100-GALLON BELLY TANK
JAPAN
Tokyo
1500 MILE RADIAL DISTANCE TO TOKYO FROM FARTHEST B-29 BASE ON GUAM
P-47N ROUTE
East China Sea
[redacted]
Ie Shima
Okinawa
P-51 ROUTE
IWO JIMA
Marcus Island
(JAPAN)
[redacted]
Northern
Mariana
Islands
(U.S.)
Philippine Sea
Saipan
TINIAN ISLAND
Agana
Guam
(U.S.)
PHILIPPINES
FEDERATED STATES OF MICRONESIA
Koror
Palikir
Trust Territory of
Caroline Islands

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