A HISTORY OF THE AIR FORCE ATOMIC ENERGY PROGRAM 1943-1953

INTRODUCTION & CHAPTER I

Project SILVERPLATE, 1943-1946

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A HISTORY OF THE AIR FORCE ATOMIC ENERGY PROGRAM

1943-1953

In Five Volumes

Volume I

Project SILVERPLATE, 1943-1946

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Lee Bowen
The United States Air Force Historical Division

Downgraded by ...

It was as though the earth had opened and the skies had split. One felt as though one were present at the moment of creation when God said: "Let there be light."

William L. Laurence, Dawn Over Zero, p. 11

FOREWORD

The advent of atomic weapons has brought a vast change in the military situation of our nation. Without immodesty it can be said that the bulk of the responsibility for adjusting to that change has fallen on the United States Air Force. During the ten year period following the end of World War II it was necessary virtually to reconstitute the nation's air arm in the light of this new form of energy. The remaking of the air defense and strategic capabilities of the Air Force to fully reflect the use of atomic weapons in warfare has probably received the greatest amount of attention, since here we literally engaged in a race for national survival. Less well known and appreciated have been the extensive programs in training, intelligence, logistics, planning, security, and development required to make our atomic striking power and atomic defense force effective instruments. Even less appreciated has been the long and continued effort at high levels to insure that the Air Force receive the opportunity to fully exploit atomic energy to the limit of its capability.

In order to preserve in usable form the early record of the Air Force Atomic Energy Program, the Assistant for Atomic Energy, DCS/O, requested the Air Force Historical Division to prepare an official atomic history of the decade 1943-1953. After several years of meticulous research and study, the historians have produced the five volumes that follow. In the course of their work the historians were given access to pertinent files in Headquarters, USAF; they were supported by excellent studies from some of the Air Force field commands; and they received assistance from the Atomic Energy

Commission, the Military Liaison Committee, and the Armed Forces Special Weapons Project.

In an effort to make their work as authentic as possible, the historians sought and received advice and information from some of the scientists and officers who participated in the work of MANHATTAN District. From time to time many of the Air Force officers most conversant with the program generously and voluntarily read and criticized portions of the text.

It is hoped that these five volumes will serve as a ready guide to one phase of a critical and transitional period in the over-all history of the United States Air Force.

Charles H. Anderson
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Major-General, USAF
Assistant for Atomic Energy, DCS/O

7 July 1959

INTRODUCTION: THE INTERNATIONAL BACKGROUND OF ATOMIC WEAPONS, 1939-1957*

In less than nineteen years, January 1939-October 1957, humanity experienced a momentous transition. The period began with the discovery of atomic fission, came to include the mastery of fusion, and reached a climax in the Russian announcement of the first man-made satellite hurled into orbit by a ballistic missile. All of these things -- nuclear and thermonuclear energy as well as missiles -- were developed primarily for military purposes. Naturally, therefore, the new weapons and their instruments of delivery can best be interpreted against their contemporaneous background of international affairs. The social significance of the military-scientific accomplishments is quite another thing -- too great, too profundly revolutionary to be seen without the long perspective of time.

* * * * * *

The United States undertook its atomic program from fear of Nazi Germany. The point is nicely put in Arthur Holly Compton's Atomic Quest:**

> It was a cool September evening (in 1941). My wife greeted Conant***and Lawrence****as they came into our home and gave us each a cup of coffee as we gathered around the fireplace. Then she busied herself upstairs so the three of us might talk freely.
>
> Lawrence began by telling briefly of new results from England and how this work was confirmed by experiments in the United States. This work had convinced him of the feasibility of making an atomic bomb using only a few kilograms of fissionable material. He described recent Berkeley experiments, indicating that the bomb could be made equally well either with uranium 235 or with a new chemical

*This chapter is based entirely on secondary source material. Consequently, there was no attempt made to make the study a scholarly treatise. Exact references, by asterisks, are for quotations and a few specific facts only. A bibliography of useful works has been appended.

**Arthur Holly Compton, Atomic Quest (New York, 1956), p. 7. This meeting with Conant and Lawrence did not constitute Compton's initiation into the atomic program. He was already actively engaged in the work as member of the Special Reviewing Committee of the National Academy of Sciences. See p. 52.

Incidentally, Arthur Holly Compton should not be confused with his brother, Karl T. Compton who was also working in the atomic program. See p. 50.

***James B. Conant, President of Harvard University.

****Ernest O. Lawrence, professor at the University of California.

> element discovered in his laboratory which was soon afterwards named "plutonium." He outlined the proposed method of making this element. By using an atomic chain reaction the uranium of mass 238 would be converted into plutonium of mass 239, and by chemical methods the plutonium would be extracted from the uranium. He also told of the progress that John R. Dunning and Harold C. Urey were making at Columbia University toward separating uranium 235 from the much more abundant uranium 238. Here at least was a process that could be pushed through if enough effort were put behind it. Finally he pressed the point that we knew the Nazis were working with a large group of able men on the problem of separating the forms of uranium and had already made substantial progress. There was every reason to believe that the Nazis saw in the atomic bomb the possibility of a new weapon of decisive importance. If they succeeded first they would have in their hands the control of the world.

Compton's comments provide an excellent summary of the purpose and state of the atomic energy program as it existed in the autumn of 1941. But history is erratic in its ways. The Germans surrendered before the first atomic bomb was ready even for testing, and it will probably always be disputable whether the Hiroshima-Nagasaki blasts were a cause or an excuse for the Japanese surrender in September 1945. What no one foresaw in the course of World War II or at the moment of Allied victory was that the real international significance of atomic weapons lay in their influence, for good or bad, on Russo-American relations.

The Basic Problem of Russo-American Relations

The true nature of the Russo-American rivalry was recognized in 1835, more than a hundred years before Pearl Harbor, when the French historian Alexis de Tocqueville wrote:

> There are, at the present time, two great nations in the world which seem to tend toward the same end, although they started from different points; I allude to the Russians and the Americans. All other nations seem to have attained the limits that nature traced for them. These two giants alone go forward in a race the end of which cannot now be foreseen.... The Anglo-American relies upon the personal interest of the individual to accomplish his ends, and gives free scope to the unguided exertions and common sense of the citizen; the Russian centers all the authority in a single arm; the principal instrument of the former is freedom, of the latter servitude. Their starting points are different and their courses are not the same; yet each of them seems chosen by fate to hold the destinies of half the globe.

For many years, however, the Russians and Americans were too preoccupied with domestic problems to be disturbed by basic differences in their national character. Relations remained friendly until the social and political world of the nineteenth century was shattered by World War I and its aftermath revolutions.

In 1917-1918 the balance of power that previously gave stability to Europe was seriously weakened. England and France were exhausted by the war they won; Germany for the time being was helpless; the Austro-Hungarian Empire had vanished; central Europe was largely chaotic; and in Russia the Romanovs died at the command of Bolshevik Communists. These latter—violent, bitter, bigoted and ambitious—were destined to succeed in a political venture beyond the imagination of ancient emperors.* It was then that the long passive Russo-American rivalry became active. Two ways of life, two systems of economy, two hemispheric hegemonies were in conflict for world leadership.

The Soviet Union established in November 1917 was based on the four classical doctrines of Karl Marx,** and on a fifth dogma contributed by his Slavic apostles—the absolute dictatorship of the "Party" head.***

*Clement R. Atlee develops the same point in his book, As It Happened, p. 205.

**The four major doctrines of Marx were:

1. The central factor in the life of man is the system by which material goods are produced and exchanged.
2. Capitalism is incapable of developing adequately the economic resources of society or of distributing fairly the products of human labor.
3. By its inability to adjust to economic change, capitalism contains the seeds of its own destruction by revolution.
4. Imperialism is the final phase of capitalism and leads directly to war and revolution.

This political philosophy was no innovation. It was part of the Byzantine tradition, cherished by centuries of glittering czars, and taken from the hands of Nicholas II by Lenin for himself and his successors.*

The new caesars, the new czars, came to power and exercised their authority in much the same way that Justinian and Ivan and Peter had done in earlier years. Like some of the Romonovs, the Communists attempted to westernise and industrialize Russia. They succeeded where their predecessors failed by eliminating the mannerisms of Byzantium without sacrificing the concepts. The ritual and the incense were discarded, but the body politic remained the same. The golden carriage turned into a shiny black limousine; the Little White Father replaced ermine with business suits; and Holy Mother Russia put away Pan-Slavism in favor of the Communist World State. As the symbols changed so did the efficiency of administration, but not the dream of empire.

The technique of the Communist foreign policy was geared especially to serve the imperialism of an industrialized and mechanized nation. The Kremlin's diplomacy after the Red Revolution followed the morality of war. Treaties were no more than cover plans for the strategy of a conflict that would be long and costly but, from Moscow's viewpoint, was sure to end in complete victory.** From time to time there might be reverses in the struggle, and limited concessions would have to be made to the enemy. But temporary setbacks were not important. Moscow could wait, for Moscow had all time. Only patience, steadfast purpose, and unquestioning obedience were necessary to achieve final triumph. This was the Russia--powerful, zealous, evangelical, and unscrupulous--that came to fulfill the prophecy of de Tocqueville.

*This point was made by George Kennan (pseudonym X) "Sources of Soviet Conduct", Foreign Affairs, July 1947.

**Stalin is reputed to have said that a "sincere diplomacy" is as much of a contradiction--and presumably as much of an impossibility--as dry water.

In the years that followed 1918 France and England did not recover the strength they had sacrificed. The United States, in the bitter election of 1920, repudiated its international responsibilities and rejoiced in the false security of isolation. Although Germany had been defeated, her magnificent vitality had not been destroyed, and the nation, along with Russia, made an amazing industrial and military recovery. In their renaissance of power, Germany and Russia were joined by Japan, the latter endowed with a vast empire in Manchuria and China. The three of them became the dominant military nations of the earth. Their totalitarian philosophy and plans for conquest--in which they were joined by Italy as a camp follower--made them natural allies. If they had combined their economic and military strength in an effective alliance, they might have become invincible. Fortunately for the western democracies, the alliance never materialized, but for two years at least, 1939-1941, it seemed to have been achieved.

Meanwhile, shortly after the end of World War I, Russo-American rivalry began to influence the foreign policy of the United States. In 1920 Bainbridge Colby, Secretary of State during the last months of the Wilson administration, declared in an official paper that:

> We cannot recognize, hold official relations with or give friendly reception to the agents of a government which is determined and bound to conspire against our institutions; whose diplomats will be the agents of dangerous revolt; whose spokesman say they sign agreements with no intention of keeping them.

The American suspicion of Russian intentions was in no way allayed for the next ten or twelve years.

Then in 1933 President Franklin Roosevelt, hoping to increase trade, decided to establish normal diplomatic relations with the Kremlin. The offer was tempting, and in return the Soviet Government agreed not to support any movement seeking to overthrow the Government of the United

States. But, in keeping with its philosophy of wartime morality, the Government of Russia did not feel bound by the promises made to Washington. In 1934, at a Comintern Congress held in Moscow, representatives of the American Communist Party boasted of their revolutionary activities at home. Secretary of State Cordell Hull protested vainly, and there was some talk of withdrawing the American Ambassador. By that time the embassy was regarded as a valuable observation post, and diplomatic relations were maintained despite the Kremlin's refusal to observe agreements. The situation remained unchanged and full of suspicion for another four years.

On 21 August 1939, when Hitler was building up toward the final crisis, the Nazis signed a pact with the Soviets which could only be interpreted as Moscow's blessing on the impending war. A few weeks later the partition of broken Poland revealed the full extent of the Nazi-Soviet alliance, and anti-Russian feeling in the United States was intensified. The nature of Russian imperialism was further indicated shortly afterwards by the Soviet attack on Finland. On 30 November President Roosevelt declared in a public address that:

> The Soviet Union is run by a dictatorship as absolute as any dictatorship in the world. It has allied itself with another dictatorship, and it has invaded a neighbor so infinitesimally small that it could do no conceivable harm to the Soviet Union.

As the Russo-Finish war progressed, feeling againt the Soviet Union reached a crescendo. When, after approximately four months of heroic resistance, the Finns surrendered to the Russians, the relations between the Soviet Union and the United States sank to a nadir for the 1917-1941 period.* These twenty-four years showed clearly the nature of the basic problem--it was the difficulty of preserving peace between the two greatest nations of the world, separated by the philosophies of democracy and absolutism. Freedom of mind was in conflict with thought control. Free competition in the economic field was struggling with a totally regimented economy. A belief in the political equality of sovereign states was challenged by a fanatical devotion to world revolution that was intended to centralize in the Kremlin final authority for all men.

The Russo-Anglo-American Wartime Alliance

There can be no doubt that by the end of 1939 the Russo-German alliance made most people in the United States think of Berlin and Moscow as equally responsible for the horrors being visited upon Europe. The differences between Naziism and Communism were superficial, and their similarities were significant of the gangster thought and aims which bound the two aggressors together. Once the "winter war" against Finland was concluded, however, Russia followed a more passive policy,** and gradually Germany stood forth as the assassin of minorities at home and the conquering tyrant of the weak.

*The New York Times, on 16 March 1940, conservatively expressed American sentiment as follows: "There is no war in Finland. There are only cities and towns burned and shattered from the air, an experiment in destruction which is of interest to the German and Russian flight commands. There are only women and children and old people, some driven from their homes by the Russian "proletariat," some hounded out, some left in poverty because their men folk are wounded or dead. There is only a shattered, impoverished nation, whose offense in the eyes of the bullies of Europe was that it struggled to remain free."

**This statement is made without overlooking the fact that in the summer of 1940 Russia took the Baltic States of Lithuania, Estonia, and Latvia. It was done without war and in the midst of violent German aggression in the west.

In the spring of 1940 Nazi forces occupied Denmark overnight and began an invasion of Norway which could not be halted. Shortly afterwards the Nazis crashed through the frontiers of Holland and Belgium and repeated in Rotterdam the hideous pattern of destruction first wrought in Warsaw. With a strength and force never before known in warfare, the Germans outflanked the Maginot Line in the north and the Italians invaded France from the south. In a matter of days Paris agreed to surrender, and, of all the anti-German Allies, the United Kingdom alone remained to fight the Nazis in Europe. The Battle of Britain brought destruction to the cities of England. It was feared that the Germans at any time would stage an invasion of the British Isles and it seemed at least problematical whether the English could do more than offer a token resistance.

These were the days when the United States received the dividends of isolation. Indignation and fear spurred the nation toward some form of intervention in the European conflict as a move of self defense. At first, in 1940, there was the "sixty destroyer deal" and the sale of surplus rifles to Britain. A few months later, on 6 January 1941, the President presented to Congress his plan of Lend-Lease as a means of supplying the British with sufficient strength to continue the fight. The project was soon approved by Congress, and by the nation too, though the pro-Nazi "America First" organization continued to wield some influence. For instance, it was said that "we are in danger today because we American people have attempted to interfere with the internal affairs of Europe." Again, it was contended that the German armies were invincible and that nothing could or should be done to halt their progress. But the pro-Nazi propaganda was not effective and the United States prepared for what was accepted as an inevitable war with Germany.

By the summer of 1941 Hitler had won many staggering victories and his only failure had been the Battle of Britain. He held a position that, for the time at least, was impregnable. But he could not afford to remain inactive. On 22 June, without warning, he sent his troops across the Russo-Polish frontier in what he hoped would be a march to Moscow. The move did much to nullify his previous brilliant success. The Russians did not collapse; Britain gained a powerful ally; and the way was prepared for an alliance of the Soviet Union, the British Empire and the United States.

As soon as Churchill was informed of the German attack on Russia he declared that the British had but one aim, one single irrevocable purpose--the destruction of Hitler. The Prime Minister promised Moscow whatever aid Britain could give. In Washington Senator Harry S. Truman suggested that Lend-Lease be given equally to Germany and Russia in order that the war between the two might be fought to a point of exhaustion on both sides. The administration was more conventional. On 23 June Sumner Welles, Acting Secretary of State, said that for Americans there was no choice between the Communist and Nazi dictatorships, but that Hitlerism was the more pressing danger. The next day, 24 June, the President pledged all possible aid to Russia.* Thus a Russo-Anglo-American alliance was created and within six months it was sealed by the deed of Pearl Harbor.

*The dependence of Russia upon American Lend-Lease has been excellently explained as follows: "The weapons which the western powers supplied were a useful and in some cases a vital addition. But the lorries which carried the Russian divisions into Germany were mostly American, Canadian and British make--more than 400,000 lorries were supplied Russia under Lend-Lease. So were most of the boots in which the infantry proper slogged its way to Berlin, through the mud and snow and sand of the Eastern European plain. Much of the Army's clothing and of its tinned food were supplied under Lend-Lease. One might sum up broadly that the fire-power of the Red Army was home produced, whereas the element of its mobility was largely imported." Isaac Deutscher, Stalin, A Political Biography, p. 512, Note 1.

The Failure of America's Early Peace Plans

Long before the United States was involved in World War II, Washington foresaw that democratic civilization could survive only if a just peace followed upon the shambles of the Axis defeat. On 6 January 1941 the President announced his plans for a world founded on freedom of thought and worship, and freedom from want and fear. In August, less than two months after the Germans began their invasion of Russia, the formula of the four freedoms was made the basis of the joint Anglo-American Atlantic Charter. The declaration enunciated the political ideals upon which the American Republic and the British Empire would seek peace. The Roosevelt administration, keenly aware of the mistakes made by Woodrow Wilson in 1917-1918, hoped to bind the Allied Powers to "certain principles (of peace before the end of hostilities), leaving the details of boundary adjustments and the like to be settled later."*

Immediately after Pearl Harbor, Cordell Hull, Secretary of State, inquired of those nations already at war with Germany and Japan whether there existed any secret agreements among them concerning a possible division of spoils. Upon being assured that no such agreements existed, the Department of State drafted a United Nations Declaration which embodied the principles of the Atlantic Charter and constituted an official promulgation of the peace aims of the Allies. On 1 January 1942 the Declaration was signed by the President, the Prime Minister--who was then in Washington--the Russian Ambassador and T. V. Soong, who was the Personal Representative of Chiang Kai-Shek. The next day the document was signed by the representatives of twenty-two other allied states. The signatory nations automatically became a coalition for prosecuting the war and for making the peace.

The United Nations Declaration set forth great ideals which, could

*Cordell Hull, _Memoirs_, II, p. 1116.

they have been uncompromisingly pursued, might have led humanity to a much happier life. Unfortunately there was the more pressing objective of winning the war. Where there was conflict between the pursuit of victory and a just peace, the interests of military requirements prevailed. The solution of the dilemma was beyond the genius of foresight. As mentioned by Sumner Welles, Britain and the United States had two alternatives in 1942. They could have created an official international group to plan continuously for future peace while all the Allies, especially Russia, were dependent upon American aid. In contrast, they could have refused resolutely to discuss any political or territorial questions until the meeting of a peace conference. Continuing, Welles added:*

> Each course had its advantages and disadvantages....My own judgement now (in 1950) as it was then (in 1942), is that the advantage of the former far outweighed its disadvantages. By sticking neither to one course nor the other we fell, as so often happens in such cases, between two stools. The immense influence that we possessed immediately after Pearl Harbor was not exercised. When we did attempt to negotiate political settlements (late in 1943) our influence was no longer decisive.

To some extent it was the desire of Roosevelt and Hull to avoid the pitfalls of the 1918-1919 Paris Conference plus their inability to act independently of strategy, that gave Russia the great advantages enjoyed by the Kremlin after the defeat of Germany and Japan.**

*Sumner Welles, Seven Decisions that Shaped History, p. 138-139.

**It was awareness of Wilson's mistakes, 1917-1919, that accounts for many of the major diplomatic decisions made by the White House between 1941-1945. For instance, it was with the intention of getting around the disadvantages of a formal armistice, such as that of 11 Nov 1918, that the President persuaded the Prime Minister, at the Casablanca Conference, to insist upon "Unconditional Surrender." Again, it was the Wilson failure to get the League of Nations through the Senate that led the Roosevelt administration to insist that the United Nations should be organized while the war was still in progress rather than to wait for the strain of conflicting interests to disrupt

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The Failure of the Russo-Anglo-American Alliance to Solidify

The Anglo-American alliance with Russia never worked smoothly even during the darkest days of 1941-1943. Moscow was unalterably distrustful of Washington and London. Stalin and his colleagues believed that, despite fine words, the Anglo-American friendship with Russia was nothing more than a concession to circumstances. There was always the dark fear that, if possible, the democracies would thwart a complete Russian victory. Washington and London, on the other hand, saw that when Germany and Japan were defeated there would be a vacuum in Europe and Asia into which Russia might move with little effective opposition from the west. There was also the fear that when Russia reconqured her own occupied provinces she might make peace with the Nazis and leave her allies in the lurch. The United Kingdom and the United States could not agree on methods of meeting the danger. Roosevelt advocated

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the unity of the Allies after the war. On 15 Jun 1944 Roosevelt said: "The maintenance of peace and security must be the joint task of all peace-loving nations. We have, therefore, sought to develop plans for an international organization comprising all such nations." The Dumbarton Oaks talks were held 21 Aug-28 Sep 1944 and there was then drawn up the "Proposals for the Establishment of Peace and Security." This document served as the basis for the discussions of the San Francisco conference, Apr-Jun 1945, which drafted the Charter of the United Nations. It was also decided, as a means of avoiding another mistake of the World War I settlement, that, instead of attempting a single comprehensive peace conference, there should be a "cooling off" period after World War II, to permit the wartime hatreds to dissipate somewhat and then to achieve peace by a series of conferences which would consider specific points of issue.

and followed appeasement;* Churchill opposed the White House policy.

Stalin conducted his diplomacy with greater skill than either of the western leaders.

Perhaps his wisest decision was to avoid meeting the President and the Prime Minister until the fortune of war was in his favor. For nearly two years he claimed that the military situation did not permit him to leave Russia for a single day, and he did not invite the American and the Englishman to sit with him in Moscow. By November 1943 all that was changed. The Germans had been crushed at Stalingrad; it was evident that the Russians would soon begin an extensive reoccupation of their lost provinces; and most important of all, Russian industries had appreciably decreased the dependence of the Kremlin on Lend-Lease. Stalin could then meet his "opposite numbers" without subservience, and he did not treat them gently.

In November 1943 Roosevelt, Churchill and Stalin went to Teheran. Churchill met the issues, and there was tension between him and Stalin.

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*Roosevelt was strongly influenced in his thinking by

1. The decision made in January 1942 to defeat Germany first and to conduct only holding operations in Asia against Japan. This strategy annoyed the Chinese and gave the Japanese an opportunity to "dig in," which meant that the Americans very much wanted Russian aid to Asia.

2. The exaggerated claim that Japan had an "inhuman will to resist" which might result in the Kwangtung Army continuing an endless resistance even after the occupation of the Japanese islands. As John R. Deane, head of the American Military Mission to Moscow, wrote in his book, Strange Alliance: "Even though the Japanese islands would be conquered, we could be certain that the Kwangtung Army (close to a million men), a powerful and almost completely self-sustained force, would not continue to fight, perhaps joining with Japanese forces in China in attempting to set up a new Japanese state (in Manchuria)." William R. Donovan, former head of OSS, made the same point in an address quoted in The New York Times, 1 Mar 1946, and so did Clement R. Attlee, in his book, As It Happened, p. 210.

3. The delay of two and a half years in mounting OVERLORD which gave the Russians a chance to take much of eastern Europe.

Roosevelt's role was to take the middle road and "reconcile" the two antagonists.* The resultant compromises did scant justice to Chiang Kai-Shek,**obtained a promise from Stalin to enter the war against Japan without naming the time,***and opened the way for Russia's invasion of the Balkans.****

The three men did not meet again until they went to Yalta in February 1945. The situation then was far more favorable to Russia than it had been fifteen months before, and it raised Stalin to a

*Roosevelt's desire to placate the Russians is well brought out by a single incident. One morning between the Plenary Sessions of the Conference, Churchill sent over a message suggesting that he and the President have lunch together preparatory to the next Plenary Session that afternoon. But Roosevelt was very conscious of the presence of the NKVD men and did not want to give them the impression that he and the Prime Minister were hatching their own schemes. Harriman conveyed Roosevelt's regrets to Churchill who was not pleased. He remarked that he could accept rebuffs as well as the next one. Robert E. Sherwood, Roosevelt and Hopkins, p. 784.

**Both Churchill and Roosevelt expressed sympathy for Russia's desire for a warm port. The President even suggested that Dairen might be placed under international control as a free city for Russian shipping. This statement was dangerously close to giving away Chinese territory without so much as consulting the Chinese Government. Neither Churchill nor Roosevelt protested against Stalin's flat statement that Poland would have to be compensated with territory taken from Germany for the provinces surrendered to Russia in 1939 as a result of the Molotov-Ribbentrop agreement. Yet the President left Teheran with the feeling that Stalin was "get-at-able" because of his lip service to the United Nations Organization. Robert E. Sherwood, Roosevelt and Hopkins, pp. 798-799.

***In October 1943 Cordell Hull went to Moscow for a pre-Teheran Conference at a sub-summit level. It was then that Stalin first said Russia would attack Japan after the defeat of Germany. But this committment was considered more binding after Stalin's agreement with Roosevelt and Churchill at Teheran.

****"Perhaps only he and Churchill were aware of its implications. Europe had now been militarily divided in two; and behind the military division there loomed the social and political cleavage. Against a vastly different social background, an old dream of Russian diplomacy--the dream about bringing the Balkans under Russian influence--was coming true." Isaac Deutscher, Stalin: A Political Biography, p. 508.

position that was at least first among equals. In the Far East the Japanese were sweeping southward through China, and General Douglas MacArthur was no where near the Japanese home islands. There were few indeed who believed that Tokyo would surrender in less than two years.* On the continent of Europe the American and British troops were 300 miles west of Berlin, while in the east the Russians were but thirty miles from the German capital. There was talk that the Soviet armies might occupy the city before the end of the conference.

Only atomic bombs in being could have overcome Roosevelt's disadvantage, and they were lacking. On 30 December 1944 Brigadier General Leslie R. Groves, head of the atomic energy program, wrote General Marshall, Chief of Staff, USA, that:**

> It is now reasonably certain that our operation plan should be based on the gun-type bomb, which, it is estimated, will produce the equivalent of a ten thousand-ton TNT explosion.—The first bomb, without previous full scale test which we do not believe will be necessary, should be ready about 1 August 1945. The second one should be ready by the end of the year and succeeding ones at...intervals thereafter.
>
> Our previous hope that an implosion (compression) type of bomb might be developed in the late spring have now been dissipated by scientific difficulties which we have not as yet been able to solve. The present effects of these difficulties are that more material will be required and the material will be less efficiently used. We should have sufficient material for the first implosion type bomb sometime in the latter part of July. This bomb would have an effect which would be the equivalent of about 500 tons of TNT.

*"Before I left Saipan, a B-29 pilot who had just flown over Tokyo asked me to throw some snowballs on Fifth Avenue for him. I did it last week and thought of him and all the others who are fighting and sweating and hating the war out in the Pacific. They are hating it but they are also fighting it hard and well. They have no illusions about the job ahead. They know it will be at least two or three years more before Japan can be crushed completely and that the job will become progressively more difficult. We have cracked the outer shell but the core is still hard and tough." William Hillpe, "New Year's Report on the Pacific", Newsweek, 1 Jan 1945.

**This document was included by the Department of State in The Conference at Malta and Yalta, Part I Galley 357. However, twelve years later, speaking from memory Gen Groves said that "just before Yalta" he informed the President that only two bombs were needed to end the war. AEC, In the Matter of J. Robert Oppenheimer, p. 163.

Moreover there were some highly placed military persons who, convinced that the weapons would never detonate,* were deeply concerned about the cost in life of a long war against Japan. They exerted constant pressure on the President to make any practical concession necessary to insure Russian intervention.** Roosevelt's chief aim at Yalta, therefore, was to see that Stalin entered the war against Japan. The President won his point but the price was high.

*Admiral Leahy, who prided himself on his knowledge of explosives, frequently expressed his skepticism of atomic weapons. At the end of 1944, just before Yalta, he still said the bomb would not work. Even after the news of the successful TRINITY Shot, 16 Jul 1945, reached Potsdam, Leahy continued to disbelieve. On the return trip from Potsdam, the President and his party stopped at Portsmouth, England, to meet King George VI. In a conversation with the King, Admiral Leahy said: "I do not think...(the atomic bomb) will be as effective as expected. It sounds like a professor's dream to me." Later on, in justifying his comments, Leahy wrote: "I knew of no explosive that would develop the power claimed for the new bomb." The Admiral was not alone in his misunderstanding of atomic energy. William D. Leahy, I Was There, p. 265, 269, and 431.

**"I knew at Yalta...of the immense pressure put on the President by our military leaders to bring Russia into the Far Eastern War. At this time the atomic bomb was still an unknown quantity, and our setback in the Battle of the Bulge was fresh in the minds of all. We had not as yet crossed the Rhine. No one knew how long the European War would last nor how great the casualties would be. The Joint Chiefs of Staff, just before our departure for Yalta, had sent to the State Department copies of documents relating to Russian participation in the war against Japan. These documents stated: We desire Russian entry at the earliest possible date consistent with her ability to engage in offensive operations and are prepared to offer the maximum support possible without prejudice to our main effort against Japan....

"At...Yalta...the military staffs were particularly concerned with the Japanese troops in Manchuria. Described as the cream of the Japanese Army, this self-contained force, with its own autonomous commands and industrial base, was believed capable of prolonging the war even after the islands of Japan had been subdued, unless Russia should enter the war and engage this army. With this belief, the President's military advisors urgently desired Russian entry into the war. Our casualties would be far smaller if the Japanese had to divert forces to meet the Russians in the north." Edward R. Stettinius, Jr., Roosevelt and the Russians, pp. 90-91 and 98.

The most important matter dealt with at Yalta was the occupation of Hitler's realm. Previous agreements were discarded and, in view of the success of the Russian armies, the President and Prime Minister recognized the claims of Moscow to occupy East Prussia, Mecklenburg-Pomerania, Brandenburg, Saxony-Anhalt, Saxony and Thuringia. The remaining western part of Germany was to be divided into American and British zones. Berlin, within the Russian Zone, was to be split into three sections -- Russian, British and American. The western statesmen recognized the Communist puppet government in Warsaw, but on condition that after the war Moscow would permit free Polish elections. In the Far East Stalin gained Outer Mongolia, Dairen, Port Arthur and the Chinese railways. These were crippling blows to Eastern Europe and to Chiang Kai-Shek, but in February 1945 few criticized the decisions.*

Meanwhile, there were two other misfortunes that boded ill for the future. As Russia became less dependent upon Lend-Lease, Moscow had subtly advanced her own policy. Bit by bit the Soviets had whittled at the

*General MacArthur had been quoted in the Diaries of James V. Forrestal, under date of 28 Feb 1945--when Forrestal was in liberated Manila--as approving the Yalta strategy against Japan:

> On the...question of the war against Japan and vis-a-vis Japan...(MacArthur) expressed the view that the help of the Chinese would be negligible. He felt that we should secure the commitment of the Russians to active and vigorous prosecution of a campaign against the Japanese in Manchukuo of such proportions as to pin down a large part of the Japanese Army; that once this campaign was engaged in we should then launch an attack on the home islands, giving, as he expressed it, the coup de main from the rear while substantial portions of the military power of Japan were engaged on the mainland of Asia.... (MacArthur's) conversation indicated a fear that the Russian plan would be to try to persuade us into a campaign on the mainland of China which would be more costly than on the home islands, and at the end of which Stalin would increase his prestige in Asia by pointing out that he had to come in and assure the victory..

MacArthur has denied making such a statement, but in doing so he was speaking from memory after a lapse of several years. Forrestal, on the other hand, recounted the incident in his Diaries at the reputed time of its occurence.

principles enunciated by the President and the Prime Minister in the early days of the war, and even by 1943 there was little left of the original idealism. Again, by the time of Yalta, the alliance of Russia with the United States had failed to solidify into a satisfactory understanding based upon mutual trust and confidence. In February 1945, the basic problem of Russo-American relations was obdurate, no longer clothed with the pretense of friendship.

Potsdam and the Introduction of Atomic Weapons

In the three months that followed immediately after the Yalta Conference, the Russians openly defied the spirit of the wartime alliance. Stalin completely disregarded the promise made to Roosevelt and Churchill to permit free elections in Poland. The puppet Communist Government was made permanent and the opposition was ruthlessly suppressed. The same policy was followed in Roumania where the Russian armies had come as conquerors, and it was evident that similar fates awaited other east European states. In the Balkans, Communism was checked only in Greece where, due to English intervention in a civil war, free elections were eventually held.

The Americans and British, in contrast, continued to observe the spirit of the wartime alliance with Russia even though the situation unexpectedly turned in their favor. The Russian troops were halted in their advance, and the Anglo-American armies forcefully resumed their march to the east. The British raced to Lubeck which made it possible to liberate Denmark and Norway without Russian assistance. Continuing, both the British and American forces went well beyond the western boundary of the Russian Zone as recognized by Yalta, and the way was open for the occupation of Berlin and Prague. In conformity with the agreement of February, the Americans stopped their advance toward the

German capital and turned to the south, ostensibly to prevent a last ditch Nazi stand in the mountainous terrain of Barvaria. Then, upon the request of the Soviets, the Americans even halted their advance into Czechoslovakia and awaited the arrival of the Russians coming in from the east. If this turn of events had been foreseen in the early days of 1945, the decisions of Yalta might have been quite different.

During the same three months there were other momentous changes. France, under the Provisional Government of General Charles de Gaulle, made valiant contributions to the last phases of the campaign, and, upon American and British insistance, was accepted by Russia as the fourth member of the major Allies. It was agreed that there would be a French Zone in the occupation of Germany, but it is worth noting that it was subtracted from the area assigned by Yalta to the Americans. Russia made no sacrifice. In April President Roosevelt died, and was succeeded by the Vice President, Harry S. Truman. Shortly afterwards Adolph Hitler committed suicide in the ruins of his capital which was occupied by the Russians a few days later. On 6 May the Germans surrendered.

Immediately after VE Day the Americans began to look homeward, and both their air and ground units were set to start back across the Atlantic as soon as possible. Churchill saw Europe being abandoned to the Russians and on 12 May he sent the following message to President Truman:

1. I am profoundly concerned about the European situation. I learn that half the American Air Force in Europe has already begun to move to the Pacific theatre. The newspapers are full of the great movements of the American armies out of Europe. Our armies also are under previous arrangements, likely to undergo a marked reduction. The Canadians will certainly leave. The French are weak and difficult to deal with. Anyone can see that in a very short space of time our armed power on the Continent will have vanished, except for moderate forces to hold down Germany.

2. Meanwhile what is to happen about Russia? I have always worked for friendship with Russia, but I feel deep anxiety because of their misinterpretation of the Yalta decisions, their attitude towards Poland, their overwhelming influence in the Balkans, excepting Greece, the difficulties they make about Vienna, the combination of Russian power and the territories under their control or occupation, coupled with the Communist technique in so many other countries, and above all their power to maintain very large armies in the field for a long time. What will be the position in a year or two, when the British and American armies have melted and the French has not yet been formed on any major scale, when we may have a handful of divisions, mostly French, and when Russia may choose to keep two or three hundred on active service?

3. An iron curtain is drawn down upon their front. We do not know what is going on behind. There seems little doubt that the whole of the regions east of the line Lubeck-Trieste-Corfu will soon be completely in their hands. To this must be added the further enormous area conquered by the American armies between Eisenach and Elbe, which will, I suppose, in a few weeks be occupied, when the Americans retreat, by the Russian power. All kinds of arrangements will have to be made by General Eisenhower to prevent another immense flight of the German population westward as this enormous Muscovite advance into the center of Europe takes place. And then the curtain will descend again to a very large extent, if not entirely. Thus a broad band of many hundreds of miles of Russian-occupied territory will isolate us from Poland.

4. Meanwhile the attention of our people will be occupied in inflicting severities upon Germany, which is ruined and prostrate, and it would be open to the Russians in a very short time to advance if they chose to the waters of the North Sea and the Atlantic.

5. Surely it is vital now to come to an understanding with Russia, or else where we are with her, before we weaken our armies mortally or retire to the zones of occupation. This can only be done by a personal meeting. I should be most grateful for your opinion and advice. Of course we may take the view that Russia will behave impeccably, and no doubt that offers the most convenient solution. To sum up, this issue of our settlement with Russia before our strength has gone seems to me to dwarf all others.

The Prime Minister was well justified. Not only was Moscow misinterpreting the agreements of Yalta, but the Russian generals in Germany proved to be difficult in negotiations. Weeks after the Nazi defeat nothing was done to provide for the establishment of the Allied Control Council, or for the entrance of American, British and French troops into Berlin. On 6 June the Russians formally demanded the withdrawal of the American and British forces from the Soviet Zone. Negotiations were so protracted that General Eisenhower left for the United States, and his deputy, General Lucius Clay, was in command. On 29 June the Allied commanders-in-chief opened a conference with the Russians in Berlin. It was agreed that each of the four powers would have 25,000 troops in the German capital beginning 1 July, and that at the same time the Americans and British would withdraw from the Russian Zone. Concerning the Anglo-American lines of communication with Berlin, which was an island behind the Soviet lines, General Clay has written.*

> We had explained our intent to move into Berlin utilizing three rail lines and two highways and such air space as we needed. Zhukov would not recognize that these routes were essential and pointed out that the demobilization of Soviet forces was taxing existing facilities. I countered that we were not demanding exclusive use of these routes but merely access over them without restrictions other than normal traffic control and regulations which the Soviet administration would establish for its own use. (Lt.) General (Sir Roger) Weeks (the British representative) supported my contentions strongly. We both knew that there was no provision covering access to Berlin,** in the agreement reached by the European Advisory Commission. We did not wish to accept specific routes which might be interpreted as a denial of our right of access over all routes but there was merit in the Soviet contention that existing routes were needed for demobilization purposes. We had already found transport a bottleneck to our own redeployment. Therefore Weeks and I accepted as a temporary arrangement the allocations of a main highway and rail line and two air corridors, reserving the right to reopen the question in the Allied Control Council. I must admit that we did not then fully realize that the requirement of unanimous consent would enable a Soviet veto in the Allied Control Council to block all of our future efforts.... I had no way of knowing that Soviet insistence on border and customs control would serve as the excuse for the initial imposition of the blockade of Berlin. I think now that I was mistaken in

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*Lucius D. Clay, Decision in Germany, p. 25-27.

**Philip Mosely, Assistant to Ambassador John G. Winant, has explained that the War Department resisted attempts to specify in writing, in 1943, a fixed land route to Berlin because it was purely a military matter to be settled at the military level at the right time. Foreign Affairs, July 1950.

> not making free access to Berlin a condition of our withdrawal into our occupation zone. The import of the issue was recognized but I did not want an agreement in writing which established anything less than the right of unrestricted access.... However, I doubt very much if anything in writing would have done any more to prevent the events which took place than the verbal agreement we made. The Soviet Government seems to be able to find technical reasons at will to justify the violation of understandings whether verbal or written.

On 1 July the Allied withdrawal from the Soviet Zone and the Allied occupation of Berlin began. Within a few days the military forces took up the lines prescribed by Yalta, and, as Walter Lippman has said in his book, The Cold War, the armistice was in effect. The negotiations for peace could begin.

In the middle of July, the Potsdam Conference assembled. Its purpose was to consider the principles on which the European peace might be based.* Routinely the conference made its decision concerning Europe. The previously accepted agreements on Poland were confirmed. The four-power division of Germany was officially approved, and it was provided that the country, despite the four zones, was to be treated as an economic unit.** The work of preparing treaties of peace with

*The Potsdam Conference marked the passing of the old order. President Truman was still a novice. Secretary of State James F. Byrnes had been in office only six weeks, having succeeded Edward R. Stettinius 30 June 1945. Stettinius, incidentally, had succeeded Cordell Hull on 30 Nov 1944. A few days after the conference opened a Labor victory in the English elections sent Churchill and Eden from office and called in Clement R. Attlee and Ernest Bevin as Prime Minister and Foreign Secretary. Amidst these radical changes at the top level Stalin continued in power. He acted with the skill of a cunning mind trained in long years of Soviet statecraft and he was ably assisted by Vyacheslav M. Molotov as Foreign Minister.

**This decision was not fulfilled because the French insisted on other methods. The Russians too were unwilling to share agricultural production of the Soviet Zone with industrial productions of the other three zones. The result was close to disaster for the Germans.

Italy, Rumania, Bulgaria, Hungary and Finland was left to the Council of Foreign Ministers which was to meet every three months.

While the Potsdam Conference was in session, the atomic test, known as Operation TRINITY, was held in Alamogardo, New Mexico. The weapon was an implosion bomb and it proved to be far more efficient and to have a far greater yield than General Groves had believed possible in December 1944. Until the TRINITY test was held, the atomic program had been developed secretly by scientists from many nations under the patronage of the American, British and Canadian governments, and with the naive confidence that the Soviets knew nothing of the undertaking. After the first atomic shot the President and Prime Minister, then at the Potsdam Conference, felt honor bound to "inform" Stalin. Churchill recounted in his Triumph and Tragedy how the news was received and how Stalin was told:

> On July 17 worldshaking news...arrived. In the afternoon Stimson called at my abode and laid before me a sheet of paper on which was written, "Babies satisfactorily born." By his manner I knew something extraordinary had happened. "It means", he said "that the experiment in the New Mexican desert has come off. The Atomic bomb is a reality." Although we had followed this dire quest with every scrap of information imparted to us, we had not been told beforehand, or at any rate I did not know, the date of the decisive trial.... Next morning a plane arrived with the full description of this tremendous event in the human story.... The blast had been terrific.... Devastation within a one mile circle had been absolute. Here then was a speedy end to the Second World War, and perhaps to much else besides.
>
> The President invited me to confer with him forthwith. He had with him General Marshall and Admiral Leahy. Up to this moment we had shaped our ideas towards an assault upon the homeland of Japan by terrific air bombing and by the invasion of very large armies. We had contemplated the desperate resistance of the Japanese fighting to the death of Samurai devotion, not only in pitched battles, but in every cave and dug-out. I had in mind the spectacle of Okinawa Island, where many thousands of Japanese, rather than surrender, had drawn up in line and destroyed themselves by hand-grenades after their leaders had solemnly performed the rite of hari-kari. To quell the Japanese resistance man by man and conquer the country yard by yard might well require the loss of a million American lives and half that number of British. Now all this nightmare picture vanished. In its place was the vision—fair and bright indeed it seemed—of the end of the whole war in one or two violent shocks.

Moreover, we should not need the Russians. The end of the Japanese war no longer depended upon the pouring in of their armies for the final and perhaps protracted slaughter. We had no need to ask favors of them. A few days later I minuted to Mr. Eden: "It is quite clear that the United States do not at the present time desire Russian participation in the war against Japan"....

A more intricate question was what to tell Stalin. The President and I no longer needed his aid to conquer Japan. His word had been given at Teheran and Yalta that Soviet Russia would attack Japan as soon as the German Army was defeated, and in fulfilment of this a continuous movement of Russian troops to the Far East had been in progress over the Siberian Railway since the beginning of May. In our opinion they were not likely to be needed, and Stalin's bargaining power, which he had used with such effect upon the Americans at Yalta, was therefore gone. Still, he had been a magnificent ally in the war against Hitler, and we both felt that he must be informed of the great New Fact which now dominated the scene, but not of any particulars. How should this news be imparted to Stalin? Should it be in writing or by word of mouth? Should it be at a formal and special meeting, or in the course of our daily conferences, or after one of them? The conclusion which the President came to was the last of these alternatives. "I think," he said, "I had best tell him after one of our meetings that we have an entirely novel form of bomb, something quite out of the ordinary, which we think will have decisive effects upon the Japanese will to continue the war." I agreed to this procedure.

Stalin showed slight interest in the bomb, perhaps because the Russian system of espionage had kept the Kremlin well informed of the work being done by MANHATTAN District.* But, like Leahy in December 1944, the Soviet leaders probably underestimated the energy to be released. It required the destruction of Hiroshima on 6 August 1945 to convince the Russians that the Japanese were defeated. The situation

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*Moscow seems to have followed the whole atomic energy program with accuracy and detail from 1943 at the latest. Dr. Allen Nunn May operated through the Soviet Canadian spy ring which was directed by Zabotin. Dr. Klaus Fuchs operated through Harry Gold of the Soviet New York spy ring which was directed by Yakovlev. Justin Atholl, How Stalin Knows.

existing at the time of Yalta was reversed and the Soviets hastened to enter the war before Tokyo could capitulate.*

The Postwar Years, 1945-1957

The bomb that burst above Hiroshima did more than burn one poor city and its people. The weapon was as revolutionary in its effects upon thought and life as the fifteenth century discovery of the New World, or the sixteenth century circumnavigation of the globe. The detonation cut many of the tie-lines with traditional human values, and brought society face to face with an unparallelled crisis.

Of all the nations, Soviet Russia was best prepared to adapt herself to the social and military standards of the atomic age. Her government was autocratic, her masters were intelligent, purposeful and unencumbered with the ruins of the nineteenth century. Her people had been uprooted forty years before. Only the older generation remembered czarist days with regret. Communist economy was ready to expand, and the Communist military posture was never more favorable. Russia occupied the pivotal heartland of Eurasia, to borrow a phrase

*Even then there was fear that prolonged resistance might be offered by the Kwangtung Army. On 12 August Harold Baldwin wrote in _The New York Times_ that there was still a question whether the Emperor could persuade the Kwangtung Army to surrender. On 18 August an editorial in _The Times_ explained that "there is little doubt that the Emperor is having some difficulty in securing obedience to his orders from some of his more fanatical leaders." These fears in retrospect seem quite unreal, but during the war, 1941-1945, they were taken very seriously.

from geopolitics,* and as such hold the advantages of interior lines of communication. Russia alone was psychologically, economically, geographically, and militarily free to provide the new weapon with a new strategy.**

Along the periphery of Russia lay the small nations of Europe, and the poor nations of Asia, in the so-called "Inner Crescent." They were wearied by time and by the terrors of World War II. The strongest of them, the United Kingdom, France and the Netherlands, were preoccupied with the task of saving what fragments they could from collapsing empires.

Beyond the Inner Crescent were the lands of the "Outer or Insular Crescent"--Greenland, North and South America, South Africa, and Australia.*** Among all the nations of these islands and continents, only the United States could challenge Soviet supremacy.

The United States, however, although the sole possessor of the atomic bomb, lacked many of the advantages which the Soviets enjoyed in coming to grips with the atomic age. The American Government was not sufficiently independent of public opinion to take arbitrary action

*According to the thesis of the geopoliticians: Who rules East Europe commands the Heartland; who rules the Heartland commands the World-Island; who rules the World-Island commands the World. Sir Harold Mackinder, Democratic Ideals and Reality, p. 150.

**All things considered, the conclusion is unavoidable that if the Soviet Union emerges from this war as the conqueror of Germany, she must rank as the greatest land power on the globe. Moreover, she will be the power in the strategically strongest defence position. The heartland is the greatest natural fortress on earth. For the first time in history it is manned by a garrison sufficient both in numbers and quality." Sir Harold Mackinder, "The Round World and the Winning of Peace," Foreign Affairs, July 1943.

in the field of international politics. The American people understood little of international affairs, were not interested, and were too undisciplined to learn quickly. American statesmen were scrupulous, naive, and idealistic, and they had none of the black courage required to plunge the world into a preventive war. Even the military did not immediately react with a positive plan. They were, for the most part, victory-conservative, and too frequently thought of the future in terms of their World War II experience.

In the first thirteen years that followed the Japanese surrender neither the White House nor the State Department, nor their joint councils evolved a national strategy or national policy that adjusted the interests of the country to the atomic way of life. Without adequate guidance from above, the military tended for a long time to restrict their own thinking to the field of theater or combat strategy. They attempted little more than to adjust the atomic fire power to the conventional concepts of von Clausewitz, Mahan and Douhet. Few saw that in the new age national and theater strategies must be interrelated at all times. Each of them is a jealous science. Yet neither was given the searching consideration that both of them deserved.

American Monopoly of Nuclear Weapons and Their Delivery, 1945-1949.

When the first reports of the Hiroshima bombing were released, it was impossible to analyze the political significance of the weapon. It was still impossible to do so ten years later. Yet accounts of the destruction wrought at Hiroshima and Nagasaki stunned the conscience of the world, and the weapon was not dismissed casually except in Russia.

The universal opinion among the statesmen, scientists and laymen of the non-communist nations was that the bomb used against Japan was the ultimate weapon. By its very violence, it would eliminate the difference between victory and defeat if used extensively by both sides in a great war. Atomic energy threatened civilization, if not the earth itself, unless some means of international control could be found.

In August 1945 President Truman said: "I am aware of the tragic significance of the atomic bomb....We must constitute ourselves trustees of this new force--to prevent its misuse, and turn it into channels of service to mankind....The release of atomic energy constitutes a new force too revolutionary to be considered in the framework of old ideas." Among the scientists who participated in the wartime atomic program there were many who regarded the bomb as a threat to the survival of humanity, and believed that there would have to be a profound change in the balance between nationalism and internationalism if the annihilation of civilization was to be averted. Public opinion seems to have been well summarized by the New York Herald-Tribune which spoke of the bomb "as a devil's blessing, a weapon for achieving universal peace on earth on the plain ground that it is too terrible to use."*

All of these judgements revealed an intuitive appreciation of atomic energy as signifying a radical break with the past. All of these judgements were right in concluding that atomic energy should be put under international control, and that atomic weapons should make future wars impossible. But this type of thinking failed to foresee that the LITTLE BOY-FAT MAN bombs would not long remain

*Other reactions to the atomic bomb are interesting. It was said, for instance, that "man is too frail to possess such power which is certain to lead to the destruction of civilization unless it is rigidly controlled." On 20 August 1945 Time said editorially: "The greatest and most terrible of wars ended, this week, in the echoes of an enormous event....With the controlled splitting of the atom, humanity already profoundly perplexed and disunified, was brought inescapably into a new age in which all thoughts and things were split--and far from controlled. As most men realized, the first atom bomb was a merely pregnant threat, a merely infinitesimal threat." Bishop G. Bromley Oxnam and John Foster Dulles, speaking for the Federal Council of Churches, issued a joint statement that the use of atomic bombs might cause "the sudden and final destruction of mankind." Herman Goering, imprisoned and awaiting his trial as a war criminal, was told of the bomb and said: "A mighty accomplishment. I don't want anything to do with it. I am leaving this world."

ultimate, and that Soviet Russia would soon become an atomic rival of the United States.

Soviet Policies, 1945-1946. When the Germans surrendered, Eastern Europe afforded the Russian conquerors important resources and vast industrial equipment. It also served, as George Kennan pointed out in his Realities of American Foreign Policy, as a bridgehead on the Inner Crescent of Europe. In Asia too the Russians held strong positions thanks to the military situation at the end of the war. Faced with no need for immediate demobilization, the Russians held conventional military supremacy from the Elbe River in Germany to Dairen on the Yellow Sea. The only countermeasure to Soviet strength was the American monopoly of atomic arms and the means of their delivery. The strategy of Moscow during 1945-1946, therefore, was to keep the Russian people ignorant of the real catastrophies at Hiroshima and Nagasaki until the Soviet forces could be equipped with nuclear weapons; to prevent the establishment of an international control of atomic energy while the Soviets developed their own atomic program; to frustrate the efforts of the United States and the United Kingdom to resume normal diplomatic relations with the defeated countries of the Axis alliance; and to make as many additional gains along the Inner Crescent as could be done without incurring open hostilities.

For this latter policy, China was the perfect victim. When the Japanese surrendered, large quantities of their arms fell into the hands of Mao Tse-Tung. Hence Chiang Kai-Shek could not destroy his domestic enemies as he had hoped to do. That gave the Russians time to send in their own support, and Mao began a systematic attack on the Nationalist Troops. In November 1945 Washington attempted to save the situation by sending General Marshall to China as a special envoy. His mission was to prevent China falling into Soviet hands by reconciling Chiang and Mao. Marshall's efforts were valiant, but he fought a lost cause, as he himself reported in September 1946. He remained at his post for another four months while the Nationalists began their protracted retreat to Formosa.

The Russians sought to do essentially the same thing in Iran. In 1946 they refused to withdraw their troop from the northern part of the country, as they were bound to do by a wartime convention. For weeks they threatened to take Teheran, but the Western powers, possibly sure of their atomic advantages, stood firm. The Russians dared not make the overt act that would lead to war; rather they contented themselves by supporting a Communist faction in Iran, and in stirring up hatred of the "western imperialists." Iran was an honourable victory for London and Washington, but Moscow did not altogether cease her troublesome ways. Moscow was waiting.

Meanwhile, on 15 November, three months after having said that "we must constitute ourselves trustees for this new force," the President conferred in the White House with British Prime Minister Clement R. Atlee and Canadian Prime Minister MacKenzie King. The three statesmen recommended that the United Nations, whose Charter had been signed in San Francisco on 26 June 1945, should create an international Atomic Energy Commission—never to be confused with the United States Atomic Energy Commission of January 1947. The purpose of the UN commission would be to:

1. Arrange for the free exchange of basic scientific information among all countries.
2. Establish controls to see that atomic energy was used only for peaceful purposes.
3. Draw up a convention for the elimination of atomic and all other mass-destruction weapons from the arsenals of the nations.
4. Set up safeguards to see that the convention would be faithfully adhered to by all nations.

Doubtless in issuing their joint declaration the American, British and Canadian leaders sought to take advantage of the universal fear of nuclear weapons. They also sought to establish an effective international control of atomic energy while the United States still possessed absolute monopoly. For a while it looked as if they might succeed, and the Russians expressed sympathy with the idea. In preparation for the first meeting of the United Nations Assembly, held in London in January 1946, the Americans drew up the Baruch Plan which called for an "international MANHATTAN District" under the supervision of the United Nations.* If the Baruch Plan had been accepted it might have prevented the Russo-American race in nuclear and thermonuclear arms. Such a situation, however, would have been contrary to Moscow's strategy, and the Kremlin had its UN delegation defeat the proposal.

Up to that time the Russians had also been successful in forestalling the preparation of peace treaties.

As agreed to in the course of hostilities, the Allies called no peace conference at the end of the war. Peace was to come through many meetings of the Council of Foreign Ministers of the five great powers --China, France, the Union of Soviet Socialist Republics, the United Kingdom, and the United States. The treaties thus derived were then to be submitted for ratification to the United Nations.

Although the Germans surrendered in May, no attempt was made to negotiate the treaties until the end of Japanese resistance.
The Council of Foreign Ministers held its first meeting in London during the second half of September. The Russian Foreign Minister, Viacheslaw Molotov, was in a bad mood, doubtless on instructions from Moscow. He obstructed every effort made by the other powers to achieve a settlement for Italy, Trieste, the Balkans, and Hungary.

*See Vol. II for details

Since these problems covered most of the agenda for the conference, little was done except prepare a peace treaty with Finland.*

The Kremlin should have been well pleased with Molotov. He had performed brilliantly, and would continue to do so in the future. He was master of procrastination, an artist equally at ease in every phase of the blow hot-blow cold game of stalling. He welcomed the Foreign Ministers to Moscow in November, and proved a sullen host in December 1945. He was hostile at Paris in April and May 1946, but cordial in June. He agreed to a peace conference in Paris in July and kept it stalled until October without accomplishments. He obstructed the Council in New York in November and December, but acquiesced to treaties with Italy, Roumania, Bulgaria and Hungary when Byrnes threatened to close the meeting. He could afford to make these latter concessions, for Germany, Austria and Japan were still "occupied countries", and would still play major roles in keeping the world on edge.

Meanwhile there had been a complete change in the attitude of the nations toward the atomic bomb. As early as October 1945 Sir Stafford Cripps was quoted as saying: "The thing I fear is that as the months and years pass the story of Nagasaki and Hiroshima will fade into the background and that ... this new power of destruction will cease to have its compelling force upon our political action." Time proved that Sir Stafford was something of a prophet.

*The Italian Treaty snagged on the questions of reparations and the type of administration to be accorded Mussolini's former colonies in Africa. In the matter of creating a government for Trieste as a free port, the British and Americans wanted a strong and highly centralized authority to prevent Communist infiltration; the Russians wanted the opposite for the sake of easy infiltration. In the Balkans and Hungary the Russians insisted that the Communist dominated governments were needed to prevent a revival of Naziism; the British and Americans considered this claim absurd and held out for democratic governments. The British protested that the Russians remained overlong in Greece; the United States proposed to demilitarize Germany for twenty-five years; the Russians would have none of it.

Molotov is reputed to have said in September 1945, at the first meeting of the Council of Foreign Ministers, that Byrnes "doesn't need to persuade anyone. He just has to hold up a little bomb."* The situation was very different a year later. Wearied by the Russian policy of obstruction, London began to speak openly, in the early days of 1946, of an atomic war. It was in this same vein that Sir Winston Churchill gave his stirring speach at Fulton, Missouri, on 5 March. A few months later, 1 July 1946, the first of the post-war atomic tests went wrong. The ABLE Shot of Operation CROSSROADS, missed the target, and, as far as "official observers" could see, caused very little damage.**

An eyewitness described the explosion as follows:

> The Thing...was no dud....After a moment, an immense cloud arose, reaching for the sky....Awful as it was, it was less than the expectation of many onlookers. The Russian observer, Professor Simon Alexandrov, shrugged and said with ill-considered haste: "Not so much."

The effect was felt in chancelleries and ministries of war around the world. In September 1946 Stalin issued a prepared statement which said:***

> I do not believe the atomic bomb to be as serious a force as certain politicians are inclined to regard it. Atomic bombs are intended for intimidating weak nerves, but they cannot decide the outcome of war, since atomic bombs are by no means sufficient for this purpose. Certainly monopolistic possession of the secret of the atomic bomb does create a threat, but at least two remedies exist against it: (a) monopolist possession of the atomic bomb cannot last long; (b) use of the atomic bomb will be prohibited.

A yet more remarkable change was that found in public sentiment. An integration of polls taken in the autumn of 1946 showed that American

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*Time, 8 Oct 1945.

**Although the bomb missed the target, it did serious damage to the target fleet, but the official observers were much to far away to see anything more than that the fleet had not been destroyed.

*** The London Sunday Times, 24 Sep 1946.

and British opinion was as follows:*

1. At least 85% believed World War III, with atomic bombs more powerful than those of 1945, was inevitable.

2. At least 70% believed the war would come within twenty years, and atomic bombs would be used against American cities.

3. At least 90% believed that the enemy in World War III, if it should come, would be Russia.

Thus, one year after Hiroshima and Nagasaki, the world was psychologically ready to accept atomic warfare. This attitude was even more astonishing because already there was talk of bombs that would go far beyond those of 1945, weapons that would destroy millions of lives with radioactivity.**

The Formalization of Alliances, 1947-1949. When Byrnes returned to Washington in December 1946 from the Council of Foreign Ministers in New York, he and the President could no longer agree. On 7 January 1947 Byrnes resigned, and the White House announced the appointment of General Marshall as Secretary of State. A new era was at hand.

Marshall's experience in Peking convinced him that nothing could be done to save China, and he turned his attention to Europe. Here he suddenly faced unexpected misfortunes. On 27 February, while he was preparing to attend another meeting of the Foreign Ministers in Moscow, he learned that the United Kingdom could no longer support its forces in Greece, or continue its aid to Turkey. The empire was more vulnerable economically than Washington had believed, and a sector of the western defense line was crumbling at the very moment that China was being abandoned. The situation was ripe for catastrophe. Out of this danger came the Truman Doctrine of 12 March that the United States was determined "to help free peoples maintain their free institutions", with specific reference to Greece and Turkey.

Quickly thereafter two alliances crystalized.

*The Commonwealth, Nov 1946, and Opinion News, Jan 1947.

**The Bulletin of Atomic Scientists, Jan 1947.

On 5 June the Secretary of State, in the course of an address at Harvard University, announced the "Marshall Plan", a program to assist the European nations by a mutual aid and self-help. It required months, of course, to implement the policy with proper legislation, and it was not until 2 April 1948 that Congress passed the Recovery Act which did so much to revive and unify the states of Western Europe. To counteract the Plan, the Kremlin offered the European nations an alternative series of bilateral agreements with the Soviet Union. At the same time Stalin created the Cominform. It was an alliance, in a way, a permanent coordinating committee of the Communist parties in the Soviet Union, Poland, Czechoslovakia, Hungary, Roumania, Bulgaria, Yugoslavia, Italy and France.

The next move was up to the Western Powers. On 7 June there came the announcement that they would establish a West German State which would have its own constitution though the country would continue to be occupied, and therefore would not be sovereign. The Russians retaliated on 26 June by declaring a blockade of Berlin, which the Allies in turn defeated through the heroic accomplishments of the airlift. On 12 May 1949 the Russians admitted their defeat, and for a time they were more conciliatory. On 23 May they went so far as to propose the unification of Germany under four power control. The offer might well have been accepted a year earlier, but in May 1949 Washington was not interested in compromise, and insisted upon the unification of Germany on Allied terms. The weakness of the American position was a complete lack of "Allied terms." The United States wanted a unified Germany, but in truth London and Paris did not.

Indeed, the inability of West European states to agree on the status of Germany was one element in their need for a formalized alliance with the United States. The German issue would obviously remain a source of crises for years to come, and if there was to be a war, American support was essential. The result, after due negotiation, was the North Atlantic Pact, signed in Washington 4 April 1949, and ratified by the Senate on 25 July. The North Atlantic Treaty Organization (NATO) began to function at once, and bound the United States, the United Kingdom, France, Belgium, Canada, Denmark, Iceland, Italy, Luxemborg, the Netherlands, Norway and Portugal into a formal alliance.

The agreement gave the United States substantial military advantages as well as responsibilities. There could then be American air bases in the United Kingdom, France, Morocco, Turkey, and other countries within range of targets deep in Russia. Thus Europe accepted the possibility of war, but one that would be waged against Russia largely by American aircraft armed with atomic bombs.

The philosophy of NATO was ably but anomalously presented to the public by George Kennan, a high ranking official of the State Department. He wrote under the pseudonym of "X", and his article "The Sources of Soviet Conduct," appeared in Foreign Affairs of July 1949. His theme was patience and firmness in dealing with Russia as a sure means of preventing the outbreak of World War III. The Communist dictatorship carried within it the seeds of its own destruction. Although the Soviet Union had solved the problem of obedience, and had built up great industrial strength, the Russian people were suffering under the tyranny of Moscow, and had become spiritually and physically tired. Moreover the Russian economic development was spotty. Heavy industry had been advanced out of proportion to other industries. Roads and railroads were primitive; construction was hasty, maintenance inadequate and depreciation vast; and politically there was no established order for the transfer of power from one autocrat to another. Therefore, although the United States would have to regard Russia as a serious rival, Russia was certain to remain the weaker party. Consequently the whole Russian position would warrant the United States "entering with reasonable confidence upon a policy of firm containment, designed to confront the Russians with unalterable counter-force at every point where they show signs of encroaching upon the interest of a peaceful and stable world."

The philosophy of containment was nothing more than the philosophy of encirclement. When accepted as the purpose of NATO, the concept meant that the North Atlantic Treaty Organization sought to adapt strategy to the firepower of the atomic bomb by encircling Russia with airfields and naval aircraft carriers along the European Inner Crescent of geopolitics. From these bases long range bombers could attack the main Soviet industries. There were however certain weaknesses in the doctrine. Its effectiveness depended upon the economy of NATO outlasting the economy of Russia; upon the ability of Inner Cresent countries withstanding Russia's fifth column tactics to overthrow powers friendly to the United States; and upon the maintenance of American monopoly of atomic weapons and the means of their delivery. Failure of NATO in any one of these three areas was certain to mean the inability of the Western Powers to enforce encirclement.

The Race for Thermonuclear Weapons, 1949-1954

No responsible person ever believed that the American atomic monopoly was immutable. In the natural course of events other nations were certain to possess nuclear weapons. No great scientific secret can be kept long, and indeed the scientific aspects of atomic energy were never secret once Sir Ernest Rutherford began the exploration of the nucleus in 1920.* The roster of MANHATTAN scientists would indicate that Los Alamos Scientific Laboratory, 1943-1945, was a long-lived international convention of physicists. Obviously the United Kingdom could produce atomic weapons if willing to pay the cost of duplicating

*See Chapter I, this volume.

wartime work, much of which was done by her own scientists. Germany could have made a nuclear bomb during the war if Hitler had given the same support to an atomic program that President Roosevelt did. Russia—whose scientists were long leaders in biology, physics and chemistry—was not ignorant of the nuclear theory, and her system of espionage kept her well informed of what was being done at Los Alamos. The secret of MANHATTAN District was not the laboratorial fact of fission, which any reputable physicist knew in 1939, but the fact that the United States Government had embarked upon the development of a fission weapon for use in World War II. That secret was successfully kept from the governments of Germany and Japan, but not from the Government of Russia.

Once the first atomic bomb was fired, Moscow knew that a chain reaction was possible, that U-235 could be separated from natural uranium, and could be combined with geometries of high explosives in detonations of kilotonage yields. Thereafter, in order to place atomic bombs in Soviet arsenals, it was only necessary for Russia to support her own scientists. The fact that Russia utilized the knowledge of some captured Germans and some information stolen from Los Alamos hastened the day of Soviet success, but it was the overall situation that made it possible for the Russians to produce atomic bombs in four years, something that it took the Americans, and their "allied" scientists, six and a half years to accomplish. When Stalin said in September 1946 that the monopolistic possession of the atomic bomb would not last long, he was fully aware of the progress being made by the Kremlin's atomic program. In the succeeding years the Soviets showed phenomenal success.

The United States, on the contrary, began to lag. There was the scarcity of uranium ore, which seemed to preclude the extensive use of atomic weapons; the faith that atomic energy would be placed under international control; and the provincial conceit that American scientists were intrinsically superior to the Russians. Moreover, between 1945 and 1949 the United States went through the distractions of several major readjustments. In 1946 the President and Congress decided to place responsibility for the atomic program in civilian rather than military hands, and the Atomic Energy Commission came into being on 1 January 1947. By that time there was the distracting issue of the unification of the military services into a single National Military Establishment or Department of Defense. The National Defense Act of September 1947 recognized the Air Force as a third service, but envisioned no strategy other than that used in World War II. In 1948 there was political preoccupation with a Presidential election. The administration was kept in power, but there was nevertheless an extensive shift in top level personalities.

Mr. Truman's second inauguration was in January 1949. Secretary of Defense James E. Forrestal was succeeded immediately by Louis Johnson whose theme was economy. The appropriations requested by the Three Services were reduced. A large military investment was scorned because of the American monopoly of atomic weapons and their delivery. The Secretary of Defense must have believed that the strategic advantages of NATO offered a satisfactory expression of the containment policy. In addition, American intelligence seems to have assured Washington that Russia could not possibly produce an atomic bomb for several years.

On 25 July when the United States Senate ratified the North Atlantic Treaty Organization, the western powers were sure that they had won a long term advantage over the Soviets.

Then came stunning news.

On 23 September 1949 the President announced that the Soviets had successfully detonated an atomic bomb or device somewhere in Siberia. The balance of power so laboriously built up since 1945 was seriously affected by the Russian accomplishment, and this was a severe blow to the policy of containment. As far as the European nations were concerned an atomic war against Russia meant that there would be an atomic retaliation against the industrial and population centers of Germany, France, Italy and the United Kingdom. There was also the possibility that Russia would exercise her potential power of initiative by an atomic Pearl Harbor against the NATO allies of the United States.

The American Government lost no time in adopting two new policies that were intended as countermeasures to the Russian success. First, in making his announcement of 23 September, the President said that the Russian detonation "emphasizes once again...the necessity for...international control of atomic energy." Four months later, 31 January 1950, after careful consideration of all implications, the President stated that the Atomic Energy Commission would proceed immediately to develop thermonuclear weapons, and would continue to do so "until a satisfactory plan for international control of atomic energy is achieved."

The years 1950-1953 were very critical. The background of course, was the secret work conducted by the scientists at Los Alamos—and their opposite numbers in Russia—in the Russo-American race for thermonuclear weapons. Outwardly there were also momentous events. The President, fully aware of the dangers that would come to the world with the mastery of thermonuclear energy, sought in October 1950 to have the United Nations tie in the international control of nuclear and thermonuclear power with general disarmament. The plan failed late in 1951 because of Russian obstruction. And while the Western Powers sought a means of diminishing the probability of war, the Russians sought first to disrupt Allied unity by creating new crises in Europe and Asia. In October 1949 Moscow recognized the East German State, and thereby gave a semblance of permanency to the division of Germany. In 1950 Russia permitted the rearming of East Germany while the Allies quarrelled over the rearmament of West Germany, the status of the Saar, and the admission of Bonn to NATO membership. It was on those points that the magnificently conceived but ill-fated European Defense Community rose and fell in 1952. In contrast, when the Communist North Koreans perpetrated their sudden attack on the Republic of South Korea on 24 June 1950, the Western Powers exhibited a surprising demonstration of solidarity. They accepted the leadership of the United States, and participated in a common military effort that, despite many errors of political and military judgement, at least held the Communists in check.*

*The Korean War was one of many crises in the Far and Middle East where there had been a welter of intrigue ever since the end of World War II. After Marshall left China, Chiang Kai-Shek fought valiantly and sometimes victoriously. But he weakened his own cause by his inability to create an effective and honest administration. His armies fell back toward the coast and were cornered. In 1948 the Communists took most of Continental China while the Western Powers concentrated their attention on the implementation of the Marshall Plan, the reorganization of Germany, the loss of Czechoslovakia, the blockade of Berlin, and the creation of mutual defense pacts. In 1949 Chiang retreated to Formosa. Soon afterwards, the Chinese Communists boasted that they had executed 2,000,000 counter-revolutionaries, and Mao stood out as the ruler of vast areas and enormous populations; he was also the champion of Asiatic nationalism against the remnants of occidental imperialism although this latter had shrunk to insignificance after 1948 when Great Britain withdrew her last viceroy from India and gave that nation independence.

During these same years the Russians succeeded in causing serious trouble in the Middle East and the Near East. The disturbances were most grave in Iran where the Russians were supported by a Nationalist-Communist front and by rebellious Kurds in the provinces. The Communists attempted to overthrow the Iranian Government by internal revolution. The struggle went on for several years. In 1951 Mohammed Mossadegh became premier, the Shah Mohammed Reza Phalevi became practically a prisoner, and the grip of the Anglo-Iranian Oil Company in the oil industry was broken when the wells were nationalized. In 1953 the trouble came to a climax when the Shah was first driven from the country by Mossadegh only to return a few days later when Mossadegh himself was overthrown and tried for treason. This was undoubtedly a defeat for Russian interests.

Meanwhile Jewish nationalists had been attempting to create an independent state of their own in Palestine. After years of bitterness the crisis developed in 1948 when the British mandate of Palestine terminated. The proclamation of the Israel State led to open hostilities with Egypt, Lebanon, Transjordan and Syria. In the conflict Israel was victorious by 1949 but frontier incidents continued which kept the situation uneasy.

In Egypt there was a protracted dispute with the British over the Suez Canal and in Syria, Morocco, and Algeria there were uprisings against the continuance of French rule. In all these instances the Soviets prodded the natives with memories of nineteenth century European Imperialism.

The Korean War lasted for three years, and long before the last shot was fired, reports came in from the thermonuclear race that had begun in 1950. Undoubtedly the United States achieved the first fusion detonation. That was in 1951, but technical improvements required further tests in 1952 and 1954 before production of a deliverable bomb could be undertaken. Meanwhile in 1953 the Russians claimed a TN weapon, although their shot may well have been nothing more than a device.*

Whether the Russian shot was a device or a deliverable bomb is of little historical importance. The point is that by 1953-1954 it was evident that fusion weapons could not be monopolized by the United States as had been possible with the fission weapons from 1945 to 1949. A new weapon had come into being, but its strategic effectiveness depended in large measure upon the "ultimate vehicle of delivery". The objective of the military both in Russia and the United States by that time was the development of an Intercontinental Ballistic Missile (ICBM) capable of carrying a thermonuclear warhead across the continents and seas of the earth.

*In 1955 the Russians made the first air drop of a TN weapon, and this achievement was duplicated by the Americans in 1956.

Meanwhile the British had fired their first fission device in 1952 and they fired their first fusion device in 1957. Without in any way belittling the British achievement, their successful fission and fusion programs did not alter the international situation. The rivalry was between the United States and Russia. The following table summarizes the "first" fission-fusion detonations of the three nations:

Time	United States	United Kingdom	USSR
Jul 45	1st fission bomb		
Aug 49	. . . .		1st fission device or bomb
May 51	1st TN device		
Oct 52	. . . .	1st fission device	
Nov 52	2nd TN device		
Aug 53	. . . .		1st TN, device or bomb
54	3rd TN device		
Nov 55	. . . .		1st TN bomb dropped
May 56	1st TN bomb dropped		
May 57	. . . .	1st TN device	

The Loss of American Monopoly of Nuclear Delivery, 1954-1957

World War I and World War II were fought and won by the Allied armies because they had technological parity with, and numerical superiority to, their enemies. It was thus relatively a simple matter for Britain, France and the United States to enforce their national strategy, and prevent a German hegemony in Europe. The unconditional surrender of Germany and Japan in 1945 altered the whole situation. The national strategy of the United Kingdom, France and the United States had then to be the prevention of Russian hegemony in Europe and Asia. Their problem was to make this strategy effective in an age when numerical superiority in armed forces had passed to Russia, and when superiority in conventional weapons might pass to Russia within a few years. The atomic bomb in 1945 both simplified and complicated policies for the future. As long as America maintained its atomic-air supremacy, it could serve as a substitute for or counterbalance to Russian superiority in men and conventional weapons. Loss of atomic-air supremacy was certain to mean a drastic shift of the balance of power in Russia's favor. The atomic supremacy was lost in 1949, and confirmed in 1953 when the Soviets demonstrated their mastery of fission and fusion techniques. Thereafter the battle of technology was concentrated in the field of atomic delivery.

On 20 January 1953 Dwight D. Eisenhower became President of the United States. His administration was based upon two cardinal doctrines--a balanced budget at home, and military defense through the collective security of the United Nations and the North Atlantic Treaty Organization. Both of these required a "new look" at the strength and organization of the Armed Forces.

Mr. Eisenhower began his reduction in the national budget at once. He discarded the Truman plan to increase the strength of the Air Force from 100 wings to 143 wings. In a cut across the board for the Army, Navy and Air Force the latter lost $5,000,000,000, and a reduction in planned strength to 114 wings. General Hoyt S. Vandenberg, C/S USAF, protested, but the new Secretary of Defense, Charles E. Wilson, replied that the contemplated cut only eliminated "the military's great extravagance and waste." He added that "the brass was only playing the old military trick" of crying wolf."* The budget was further reduced by having the appropriations cut down for projects of research and development.

In foreign affairs Mr. Eisenhower turned his attention first to Asia, where he was already committed, by his campaign pledges, to terminate the Korean hostilities at the earliest possible date. Peace was restored to the peninsula on 26-27 June 1953, but that did not remove Asia from the worries for Washington. Indeed, the situation became much more serious as time went on. As early as 2 February 1953, in his first State of the Union Message, the President announced that he had removed the Seventh Fleet from the Straits of Formosa so that Chiang Kai-Shek was freed to reconquer the mainland from the Communist. This action roused the anger of Mao Tse-tung who was strong in his denunciation of the new policy. Mao began at once his plans for the occupation of the small islands near the coast held by Chiang's forces. Within a year the Communists opened a bombardment of Quemoy, and the Nationalists struck back by attacking Red troop concentrations between 7-9 September. There followed a critical period of six months, September 1954-March 1955, when it seemed that American support for Chiang might develop into a war between Washington and Peking, the end of which could

*Facts on File, 1953.

not have been foretold. The uneasy weeks passed, however, and the threat of war went too, although there was no settlement of the issue.*

In Europe time moved more favorably for the Americans. On 5 March 1953, less than two months after Eisenhower's inauguration, Stalin died, ending twenty-nine years of autocratic rule. Despite the hopes of many people, Moscow did not plunge into chaos as had been predicted. Although there was undoubtedly a fierce battle being fought within the "jungle" of the Kremlin, successor followed successor with outward show of order. Georgi Malenkov succeeded Stalin. On 8 February 1955 Malenkov accused himself of incompetance, and resigned. The next Premier was Marshal Nikolai A. Bulganin who openly shared his authority with Nikita S. Krushchev, the Secretary General of the All-Union Communist Party Central Committee. For three years these two men walked side-by-side, a dual personification of the Russian State and its Voice. On 27 March 1958 Bulganin dropped by the wayside, and Krushchev was the State.

*The significance of Quemoy and Matsu came from Chiang's insistence that he could use them as a means of imposing a blockade on the Communists' staging area for an assault on Formosa. In the early part of 1955 Peking seized Yikiang Island, and occupied the Tachen Islands which were defined as steps toward the freeing of Formosa. At the same time Peking began the construction of elaborate air complexes in Fukien Province from which to attack Formosa. Washington then decided that a Communist attack on Matsu and Quemoy would serve as a justification for an American attack on the airfields in Fukien, but with the use only of conventional weapons. In late February or early March 1955 Washington learned that the complexes were much more extensive than had been believed, and the President was told that the Communists' installations could be destroyed only by the use of tactical atomic weapons. The President and the Secretary of State faced a dilemma. They could not use atomic weapons without seriously alienating support in Asia and Europe, and in the United States too; but they could not allow Chiang to be defeated. The President then decided, as far as can be judged, against the use of atomic weapons because of the serious repercussions that would follow. The United States in this instance was deterred from decisive action by the very strength of the weapons upon which rested the validity of her own policy of deterrence.

Within thirty days of Stalin's death, the Kremlin put on a peace campaign, and kept it going for several years. The President recognized the new attitude in Moscow when he delivered an address before the American Society of Newspaper Editors on 16 April 1953. He said that the hunger for peace was great, but that the new regime in Russia would have to win the confidence of the world by actions not by words alone. He urged the creation of a free and unified Germany, and a peace treaty with Austria, as pledge of Moscow's sincerity.

The situation changed on 8 August 1953 when the Soviets announced that they had fired a thermonuclear weapon. This fact suddenly lent great force to the fears previously expressed by Sir Winston Churchill who had returned to Downing Street in October 1951.* As early as 11 May 1953 he had called for summit conversations between France, the United Kingdom, the United States and Russia as a means of easing the international tension. For the time being he was not heeded, but after the Russian announcement of 8 August Washington too seems to have been somewhat alarmed. On 6 October the President said, in the course of an address in Atlantic City, that the physical isolation of the United States had disappeared before the long-range bomber and the destructive power of a single bomb....We are face to face with the utmost extraordinary physical development of all time--the application of nuclear fission and nuclear fusion to the world's armaments.... The mysteries of the atom are known to Russia...(and) we are forced to concentrate on building such stores of armaments as can deter... attack."

The President seems to have been moved by the same dread thoughts in December 1953 when, after unenthusiastically attending the

* Churchill was Prime Minister for the second time from 26 Oct 1951 until his retirement on 5 Apr 1955. He was knighted by the Queen on 24 Apr 1953.

Bermuda conference with the French and British prime ministers, he flew to New York and addressed the General Assembly of the United Nations.* He warned that should there be an atomic war in the future its fearfulness would be beyond comprehension. In conclusion he proposed that the nations develop a peacetime use of atomic energy as the first step toward reversing the atomic military build-up.

Dread of the thermonuclear weapon continued to grow. On 12 March 1954, Molotov, who still served as the Soviet's Foreign Minister, said that use of the bomb would destroy civilization. On 31 March, after a powerful fusion blast in the Pacific, Lewis Strauss, Chairman of AEC, warned that such a weapon could annihilate any city in the world. Churchill declared in Commons that the perils of the H-bomb "fill my mind out of all comparison with anything else." On 5 April Newsweek wrote that if "you live in a strategically important city, the odds against your survival in an H-bomb war would be about a million to one." World opinion built a pressure on governments everywhere to find a means of preserving peace. The President expressed this sentiment in October when he said: "Since the advent of nuclear weapons, it seems that there is no longer any alternative to peace."

Diplomatically Washington sought to strengthen the position of the western powers by having West Germany recognized as a soverign state and as a member of NATO. This end was not easily achieved since

*In an attempt to cover somewhat the futility of the Bermuda meetings the three statesmen decided to reopen the Council of Foreign Ministers, which had lapsed in 1949. A meeting was held in Berlin early in 1954 and was attended by the Russian representatives, but accomplished nothing. The complete list of Council meetings, 1945-1954, is as follows:

1. London, 11 Sep - 2 Oct 1945
2. Moscow, 16 Dec - 27 Dec 1945
3. Paris, 25 Apr - 12 Jul 1946
4. New York, 4 Nov - 12 Dec 1946
5. Moscow, 10 Mar - 24 Apr 1947
6. London, 25 Nov - 15 Dec 1947
7. Paris, 23 May - 20 Jun 1949
8. Berlin, 25 Jan - 18 Feb 1954

the French appeared still adamant in their opposition. Negotiations dragged on for months, and it was not until 27 March 1955 that the French Parliament ratified the West European Union, successor of EDC, which gave sovereignty to Germany. Other ratifications followed quickly, and on 7 May the Allied occupation of Germany ended. Four days later West Germany was admitted to NATO.*

The West European Union and the admission of Germany to NATO were regarded in Washington as great victories for the free world. After 27 March 1955 there was no doubt that WEU would come into being, for after the ratification by France all other ratifications were routine. The White House and the Department of State felt that Russia was very much impressed. They were encouraged by Moscow's continued attempt to establish reconciliation with the democratic powers at least to the extent of coexistence. Moscow sought a high level conference with the President and the British and French prime ministers, and in the midst of the negotiations proposed, on 9 April 1955, that an Austrian treaty should be drawn up at once. With surprising expedition the treaty was ready for signature on 15 May. It provided that all occupational forces should be withdrawn from Austria by 31 December, and that thereafter the country would be recognized as a neutral state as was Switzerland.

While the Austrian treaty was being written, Sir Anthony Eden, who had succeeded Sir Winston Churchill as Prime Minister on 5 April 1955, said that the time had come for the summit conference which Russia had been seeking. Washington and Paris agreed. On 10 May the United

*Chronology in the evolution of the West German Republic:
7 May 1945 Germany surrendered.
2 Aug 1945 Four Power Control Council est.
6 Feb 1948 UK and US set up Bizonia.
23 May 1949 West German Fed Republic unarmed.
7 Oct 1949 East German Democratic Rep.
18 Sep 1950 Allies end State of War.
27 May 1952 European Defense Community signed.
30 Aug 1954 French reject EDC.
23 Oct 1954 West European Union drawn up.
27 Mar 1955 WEU ratified by French.
7 May WEU put into effect.
9 May 1955 Germany a member of NATO.

Kingdom, France and the United States jointly invited Russia to a meeting in Geneva some time during the summer. On 13 June the Kremlin accepted.

Hopes were high when the conference opened on 18 July. When the President left for Geneva, Washington seems to have believed that there was practically no chance of a war with Russia for many years to come. The President himself was very optimistic, and said that his "sixth sense" made him believe that all would go well. Yet when the conference ended, hopes were not high. No progress was made toward the unification of Germany which remained the greatest obstacle to a new order in Europe. The Soviets made no concessions, but learned that Washington, London and Paris were bent upon peace.

Neither the Department of State nor the Whitehall Foreign Office could have been other than disappointed. Yet there had been many signs over the years that Russia had pursued a policy of biding her time until she could at least match the American air-atomic power; that she had made steady progress toward this goal since 1945, as evidenced by the fission and fusion detonations in 1949 and 1953; and that she had made consistent and successful efforts to overtake the lead of the United States in long-range bombers.

Prior to 1945 Russia had fought all of her wars on land, as Raymond Garthoff has pointed out in his book, Soviet Strategy in the Nuclear Age. Her historical enemies were Sweden, France of the Napoleonic era, Germany, Austria-Hungary and Turkey. Even her conflicts with England and Japan came from overlapping frontiers of interests in the Middle East and the Far East, areas that were contiguous to her own homeland, and the decisive battles that were fought occurred in the Crimea and Manchuria. Again in the 1941-1945 conflict with Hitler, Russian air power was used almost entirely for the actual support of ground forces.

When peace came, the American atomic-air ascendency convinced Moscow that in the future Russia might have to fight a different kind of war, and she began to prepare for it to the best of her ability. With neither experience in nor weapons for strategic bombing, her first thought was air defense. To this end she developed fighter planes, and by 1955 she had 15,000 MIG-15's and 8,000 MIG-17's--or so it was estimated. Meanwhile she had also gone far toward creating a Soviet version of SAC. When a B-29 crash landed in Soviet territory during the war, the Kremlin returned the crew but kept the aircraft. Within a short time Russia had her own version of the B-29, and it was known as the TU-4. In 1951-1952 foreign observers in Russia saw a modified version with turboprop engines. This plane was probably Moscow's answer to American air bases in Europe and North Africa.

Washington was not disturbed by the TU-4. Long before the Russians had this plane in production, SAC had the B-36 which was the first real intercontinental carrier of atomic weapons. Moreover, in 1946 the Air Force drew up specifications for the B-52, a long-range, swept-wing jet bomber; in March 1951 Boeing was authorized to tool up for the production of this aircraft; and in 1954, eight years after the Air Force stated its requirements, the first production model was available.

That same year, 1954, Russia showed in the course of May Day celebrations one four engine jet bomber which military observers judged to be as large as the B-52. Washington assumed that, even if the observers were correct in their evaluation, the plane was nothing more than a prototype, and that production was years in the future. In may 1955, however, observers saw formations of new planes take off from the Tushino Air Field. There were between twelve and twenty of the B-52-type aircraft, designated as BISON by the Western representatives. These long-range bombers were believed to have a one-way range of 6,000 miles, and a speed of 600 miles per hour. In addition, the observers saw at least fifty planes of the B-47 type called BADGER; nine very long-range four-engine turboprop planes dubbed BEAR that could have a one-way range of 8,000 miles, and a speed of 500 mph, for which there was no American counterpart; approximately seventy fighters called FARMER which appeared to be a new version of MIG with 50° swept-back wings, and probably capable of 800 mph, in the general class of the USAF F-100 or F-104; and finally, twenty FLASHLIGHT all-weather fighters similar to the F-89, F-94 and F-102. Washington soon learned that the BADGER was in large-scale production, with 1200 probably operational. At that rate, the Red BADGER strength would equal the SAC B-47 strength by 1957.

Throughout all this period Secretary Wilson remained calmly convinced that the Russians were three or four years behind the Americans. He dismissed the May 1955 reports as unimportant. The Russians were merely putting on a false front, and could not possibly equip their heavy bomber wings with BISON before 1960. Mr. Wilson was soon challenged by evidence that current production of BISON had reached six per month, and would increase to twenty-per month by 1956. From these estimates, which seemed fairly well substantiated, it was possible for USAF to deduce that the Russians must have begun work on the BISON very late in 1949 or early in 1950, after the first atomic shot in Siberia. That meant the Russians in producing the BISON, had done in four years what the Americans had done in eight years with the B-52. There could be no question of the high proficiency of Soviet industrial techniques. Moreover, the BISON program had gone far toward closing the technical gap that previously guaranteed the preservation of the American atomic-air ascendency.

There were many who had long disagreed with Mr. Wilson's complacency. On 4 October 1953, soon after the Russian thermonuclear success, and two days before the President's address in Atlantic City, Representative Sterling Cole, Chairman of the Joint Congressional Atomic Energy Committee, stated in the course of a TV appearance that he was ready to surrender the balanced budget to pay for defense. That same day Arthur S. Flemming, Director, Office of Defense Mobilization, declared that "Russia is capable of delivering suddenly and without warning the most destructive weapon ever devised." On 12 January 1954 Secretary Dulles sought to meet the challenge by announcing the doctrine of massive retaliation, which amounted to an official acknowledgement that atomic-air ascendency had slipped from the American grip. On 21 January, in his second State of the Union Message to Congress, the President reverted to the Air Force plan that he had repudiated the year before. He called for 137 wings of which 126 would be combat. In May 1955 the administration permitted the B-52 schedule to be advanced so that the Air Force could have eleven SAC wings equipped with the new intercontinental bombers by late 1958 instead of 1959.

By the latter part of 1955 evidence was also accumulating that the Russians were testing and perfecting missiles of various types and ranges. The situation seemed serious to those who objected to the severe budgetary restrictions placed upon research and development. On 1 February 1956 Senator Henry M. Jackson said in the Senate:*

> Seven years ago, in 1949, our conventional armed forces were vastly outnumbered by the Communist legions. But, in contrast, our air-atomic power then stood unchallenged. We alone possessed the only true long-range bomber then existing--the B-36. We alone had flight tested the world's first jet strategic bomber--the B-47. And above all, we alone possessed the atomic bomb.

*The New York Times, 3 Feb 1946.

Jackson continued, that actually the United States had lost its dual atomic-air monopoly between 1949 and 1954. In conclusion he pointed out that if the Russians possessed ballistic missiles with a range of 1,500 miles, as seemed probable, the Soviets could threaten all of the SAC B-47 bases in Europe without sending an infantryman or a manned aircraft outside the Iron Curtain. On 5 February Hanson Baldwin had an article in The New York Times which showed the danger to America of the Russian missile program:

Location of 800 Mile Missile	Area Within Range
Germany	England
Hungary	Eastern France and all Italy
Bulgaria	Greece and Turkey
Leningrad	Norway and Sweden

Location of 1500 Mile Missile	Area Within Range
Germany	All Western Europe

The pressure became strong and Secretary Wilson appointed a Missile Czar who was to tie together all the various missile projects within the Department of Defense.

The Russians soon had an opportunity to inject the threat of missile attack in an international crisis. For a long time there had been unrest in the Middle East, and Soviet agents had exploited the discontent to the disadvantage of the western powers. Already Middle East oil had been channeled into a devisive stream between the United Kingdom and the United States. In 1951 the Anglo-Iranian Oil Company had been expelled from Iran, and London continued to resent what was generally considered to be a lack of American support. Again, in the summer of 1954, the British on the insistence of Mr. Dulles, who was seeking to win Arab fidelity to the West, withdrew the last of their troops from Egypt. This concession made Colonel Gamel Nasser the hero of all nationalistic Arabs, and he used his position to wheedle assistance from both the Soviets and the democracies. When his double dealing was discovered, Washington and London adopted the punitive measures of withdrawing their assistance for the Aswan Dam. On 26 July 1956 Nasser nationalized the Suez Canal. His action resulted in an Anglo-French-Israel military intervention on 26 October 1956, undertaken without the approval, indeed without the foreknowledge, of Washington. The issue went before the United Nations, and the United States joined Soviet Russia in demanding an immediate withdrawal. At the same time Russia threatened France and Britain with attacks by rockets carrying nuclear warheads. The Russian warning was tantamount to an official declaration that the Soviets had indeed developed missiles with an 800-1500 mile radius.

The Suez incident was almost a disaster for the West. In the midst of the humiliation imposed upon France and Britain, Russia showed her complete disregard of public opinion by her ruthless resubjugation of Hungary. The power-bankruptcy of France and England became evident, and western unity, which was the strength of NATO, seemed practically to have vanished. In January 1957 Sir Anthony Eden resigned as Prime Minister and was succeeded by Harold MacMillan. The change of ministers made it possible to begin a London-Washington reconciliation, but it did not fill the political vacuum created by British withdrawal from, and defeat in, the Middle East. Under the circumstances it was necessary for President Eisenhower to announce his new doctrine of giving military support to any nation in the Middle East threatened by the Soviets. Congressional approval was obtained in March 1957.

Time moved on. In the summer there was a five-power United Nations Disarmament Conference in London. Again American hopes were high, but again nothing was accomplished, and the end came with bitter denunciation by Moscow of Washington's motives.

Much more serious days were ahead.

On 27 August Moscow announced that the Soviets had perfected an Intercontinental Ballistic Missile which was capable of delivering a fission-fusion warhead anywhere in the world. If the Russian claim was true it gave the Kremlin great advantages because the United States missile program was not so far advanced. There had been only one test firing of an ICBM, the ATLAS, designed to travel 5,000 miles at a speed of 15-20,000 mph, and the test had been a failure. There was some incredulity that the Russians were actually capable of employing the ICBM. The White House took the position that there was no need to be alarmed since the Americans had known for some time that the Russians were testing ICBM's and IRBM's as well.

The flutter of national concern grew still. Then, on 4 October the Russians launched a 184-pound satellite in orbit around the earth. There was dismay not only in the United States but throughout the entire free world. Russia had successfully challenged American leadership in science. With customary restraint The New York Times editorialized on 7 October:

> Why did not our policy makers realize the tremendous prestige, propaganda, and political gains likely to accrue to the Soviet Union if it was the first to send up a space satellite, and why were not adequate steps taken to assure that eventuality would not arise?

Other critics were less placid, and certain members of the Senate called for an investigation of the missile and satellite programs. Some officials took cover behind witticisms, and some repeated the doggerel that there was nothing to fear because the United States had long known about the Russian plan. The President, however, was very frank when he delivered his State of the Union Message on 9 January 1958. "Admittedly", he said, "most of us did not anticipate the intensity of the psychological impact upon the world of the launching of the first satellite." Undoubtedly the Russian success was interpreted by many as marking the loss of American technological leadership. Militarily Sputnik was even more significant. It meant definitely that Moscow had at least the prototype of an ICBM that could hurl fission and fusion warheads upon any city in the United States.

<u>A Backward and a Forward Glance</u>

In looking back over the first half of the twentieth century, it is evident that the state of the world in 1957, and the military significance of atomic weapons, depended largely upon three major factors:

First, the nineteenth century balance of power had vanished from the earth. In 1914 there were five Great Powers -- Russia, Germany, France, the British Empire and the United States. They held the fate of the world, supported by their second-rate power allies, and by their "spheres of influence." In 1945 there were two world powers -- Russia and the United States.

Second, the vast political and economic empires of 1914 that stretched across the distances of Africa and Asia were gone in 1945. In their place there had come a multitude of small states -- weak, scientifically and economically backward, and often politically unstable. They seemed too frequently to be sure only of their right to freedom. They were the eloquent demonstration that self-determination could conceivably be close to international nihilism.

Third, air power had begun to make itself felt during World War I, and had become a new dimension of strategy in World War II. Previously the political unit, whether city state, nation or empire, had definite boundaries that could be defended or lost by city walls, frontier fortifications, mobile armies, and fleets upon the sea to protect lines of commerce. In no case was the interior of the nation or empire threatened except by the relatively slow advance of hostile armies across the countryside that lay between the frontier and the capital. In World War II air power introduced the novel form of striking at the innermost strength of a nation by bringing destruction at once into what otherwise would have been invulnerable areas.

These three factors alone meant that reconstruction of society after World War II would have been something that neither the nineteenth century nor the first half of the twentieth century could have conceived. The impact of the atomic bomb upon this confusion was a death blow to the many of the remaining standards of the old order. The creation of thermonuclear weapons increased the horror. And the marriage of nuclear and thermonuclear warheads with ballistic missiles meant that any corner of the world could be destroyed, at any moment, without any practical warning. There was only one weapon that seemed capable of preventing the holocaust -- man's fear of destroying himself in the process of destroying his neighbor. Between 1945 and 1949 atomic bombs in the monopolistic possession of the United States probably prevented the complete occupation of Western Europe by Soviet armies. From 1949 to 1954 there was the Russo-American race for thermonuclear weapons, and the race was too close for either nation to consider itself the victor. From 1954 to 1957 America dreamed of preserving the peace by frightening Russia with massive retaliation. In 1957 the success of the Russian missile program turned the "bipolar balance of power" between the Soviet Union and the United States in favor of the Communists.* The struggle then was for the United States to exert herself, exercise the discipline and the sacrifice which alone could restore the balance of terror for the security both of the nation and of the civilization of free man.

During the years between the end of the war and the announcement of Sputnik I the Air Force atomic program was no ship-in-the-bottle, but an important part in the give-and-take of political reality. It was one of the factors, perhaps the most important factor, in the preservation of peace. Of course the program was not perfect--nothing ever is. Nevertheless it was successful in the course of its evolution in

*John A. Herz had spoken of the impact of bipolarity of Russian and American world power in his book, International Politics in the Atomic Age.

meeting the unprecedented problems of a new way of life, a new method of warfare, and a future of unlimited possibilities. The probability of human error in judgement was never greater, and the need for courageous decisions never more demanding. *

* * * * * *

The purpose of the history that follows is to set forth something of the effort that went into the atomic program. Although written as an Air Force project, the history necessarily dealt with other components of the Government—the President, the Congress, the Atomic Energy Commission, the Department of State, the Department of Defense, the Army and the Navy. Every effort was made to read and use the available documents accurately and objectively, but of course there have been many mistakes, both in facts and in interpretation. Moreover, no such study, with its wide range of coverage, could possibly please everybody. Perhaps it will please no one. Yet its usefulness cannot be altogether invalidated if it has preserved for the future even a scant record of the thought and devotion of those who were responsible for the defense of the United States in the uneasy days of world transition.

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*Unfortunately, a lack of time made it impossible for this Introduction to be critically read and judged. The author, therefore, assumes personal responsibility for its contents and its statements of interpretation.

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Chapter I

DISCOVERY OF ATOMIC ENERGY

In an introductory passage to his remarkably interesting book, The Nature of the Physical World, Sir Arthur S. Eddington, the philosopher-scientist, wrote:[1]

> I have settled down to the task of writing...and have drawn up my chairs to my two tables. Two tables! Yes; there are duplicates of every object about me—two tables, two chairs, two pens.
>
> This is not a very profound beginning to a course which set out to reach transcendent levels of scientific philosophy. But we cannot touch bedrock immediately; we must scratch a bit at the surface of things first. And whenever I begin to scratch, the first thing I strike is—my two tables.
>
> One of them has been familiar to me from earliest years. It is a commonplace object of that environment which I call the world. How shall I describe it? It has extension; it is comparatively permanent; it is coloured; above all it is substantial....
>
> Table No. 2 is my scientific table. It is a more recent acquaintance and I do not feel so familiar with it. It does not belong to the world previously mentioned—that world which spontaneously appears around me when I open my eyes, though how much of it is objective I do not here consider. It is part of a world which in more devious ways has forced itself upon my attention. My scientific table is mostly emptiness. Sparsely scattered in that emptiness are numerous electric charges rushing about with great speed; but their combined bulk amounts to less than a billionth of the bulk of the table itself.

Eddington here expressed in twentieth century terminology the ageless problem facing the philosophically thoughtful. The common-sense world in which we live has the inestimable value of the pragmatic—it works. Yet there have always been philosophers and philosopher-scientists who described the common-sense world as "unreal", "illusory" or "misleading."

No one ever phrased more perfectly the philosopher's disbelief in the reality of the external world than the seventeenth century idealist, George Berkeley. "All those bodies which compose the mighty frame of the world have not any substance without a mind, and their being is to be perceived or known, and consequently so long as they are not perceived by me or do not exist in my mind, or that of any other created spirit, they must either have no existence at all, or else subsist in the mind of some Eternal Spirit."[2] Centuries before Berkeley there were others who denied the reliability of sense perception, and philosophers of the occident and the orient throughout history have likened matter to a mirror, seemingly filled with all things but actually empty of everything.[3]

On the other hand, the common-sense people, sometimes more humorous than wise, tenaciously defended the veracity of their senses. Thus, when Berkeley denied the reality of the material world he was "refuted" by the clumsy argument of Samuel Johnson who kicked his foot against a rock to prove that the rock was there. But the attempt of the philosopher—scientists to find reality beyond the world of appearances went on despite the ridicule of those who delight in the obvious. Although the two tables of which Eddington spoke occupied the same space at the same time, they were two very different tables, and for centuries they were in deadly conflict. By the mid-years of the twentieth century victory seemed to rest with the scientific table, especially since its existence depended upon a theory that ironically produced the mightest power ever conceived by man.

The world in which Eddington's scientific table had its being should not be confused either with the world of the philosopher-idealists or with the world of common-sense thinkers although both made indispensable contributions to the development of science. To deny the adequacy of our sense perceptions is the beginning of scientific curiosity; but we must affirm the objective nature of external phenomenons if scientific data is to be accumulated.

By the 1930's there were two contradictory but well substantiated hypotheses concerning the nature of the physical world.

One theory, advanced in 1913 by Niels Bohr, the great Danish physicist, was a conceptual scheme which showed a striking analogy between the sun and its planets and an atomic nucleus and its electrons.* Thereafter it was possible to speak of atoms in terms of astronomical systems, but always of course with the understanding that fundamental differences made this simplication very dangerous to truth. With this reservation in mind it was permissable to say that the atomic structure, the solar system and its galaxy, and all the other galaxies of heaven repeated over and over the same basic pattern that appeared throughout the depths of telescopic and microscopic space.

The other theory, advanced in 1925 by Louis de Broglie, maintained that phenomenons involving both matter and radiation could only be understood by regarding electrons as waves. By 1927 there was much evidence, as Lincoln Barnett said in his book The Universe and Dr. Einstein, that all the basic units of matter lacked substance. "The old-fashioned spherical electron was reduced to an undulating charge of electrical energy, the atom to a system of superimposed waves. One could only conclude that all matter is made of waves and we live in a world of waves."**

*Niels Bohr was born in Copenhagen, Denmark, in 1885. In July 1913, while working at the University of Manchester, England, he published a paper "On the Constitution of Atoms and Molecules," in the Philosophical Magazine. The paper was one of the milestones in the history of atomic and nuclear physics.

**Lincoln Barrett, The Universe and Dr. Einstein (New York, 1950). Sir James Jeans develops the same ideas in his two books: The Mysterious Universe (New York, 1942); Physics and Philosophy (New York, 1943).

The solar model and wave theories of atomic structure appeared for a time to be unacceptably divergent. In the early 1930's Werner Heisenberg and Max Born, working in German universities, concluded that phenomenons in the realm of atoms could quite properly be described as waves or as particles, that electrons might well be waves before they escaped from the sphere of nuclear control but would behave as particles once they separated from a given atomic system.# It was therefore possible to think of electrons either as waves or as particles depending upon the purpose of the research worker.

In harnessing atomic energy to produce weapons, most of the scientists, though thoroughly conversant with the wave theory, found it convenient to think of atoms as miniature nuclear-suns with electron planets.

In order to appreciate the inifinitesimally small but complex world with which the scientists worked, it should be compared by analogy and scale with the solar system and with the system of galaxies.

It was general knowledge that the sun, 864,000 miles in diameter, was the gravitational center around which nine planets revolved in eliptical orbits, ranging in radius from the 36,000,000 miles of Mercury to the 3,670,000,000 miles of Pluto, giving the solar system

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"When an atom was broken up, electrons came out of it, but these ingredients might have changed their attributes in the process of breaking up; the electron tied inside the atom might be something quite different from the electron free in space." Sir James Jean, The Growth of Physical Science (New York, 1948), p. 351.

an extreme diameter of 7,340,000,000 miles.* These figures were so vast as to be nearly incomprehensible, but they were as nothing in comparison with the distances and immense areas of space which separated other astral bodies. To understand even slightly the depth of inter-stellar space it was necessary first to grasp the lesser distances of the solar system, which could be made comprehensible if reduced to a scale within human experience. If the sun were one inch in diameter the solar system would measure as follows:

Planet	Diameter	Distance from the Sun
Mercury	1/288 inch.	3 feet 6 inches
Venus	1/108 inch	6 feet 6 inches
Earth	1/108 inch	9 feet
Mars	1/216 inch	13 feet 8 inches
Jupiter	1/10 inch	47 feet 8 inches
Saturn	1/12 inch	85 feet 6 inches
Uranus	1/28 inch	172 feet 2 inches
Neptune	1/26 inch	269 feet 2 inches

The solar system appeared to be almost entirely empty, but, gravitational force bound the sun and planets together so that they moved in a larger orbit which was part of the cosmic movement of the

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*It may be of value to repeat here the distance separating the planets from the sun:

Planet	Diameter of Planet	Distance of Planet from Sun
Mercury	3,000 miles	36,000,000 miles
Venus	8,000 miles	67,000,000 miles
Earth	8,000 miles	93,000,000 miles
Mars	4,000 miles	142,000,000 miles
Jupiter	87,000 miles	484,000,000 miles
Saturn	72,000 miles	887,000,000 miles
Uranus	31,000 miles	1,785,000,000 miles
Neptune	33,000 miles	2,781,000,000 miles
Pluto	4,000 miles	3,670,000,000 miles

stars. The sun and its satellites combined were thus, for all practical purposes, one star among billions of stars moving in the galaxy of the Milky Way, part of which was so far off that it seemed to be a continuous stream of light. The distance between the sun and the nearest star in the Milky Way was calculated to be twenty-four trillion (24,000,000,000,000) miles, more conveniently expressed as four light years, or the distance traversed by light in the course of four years while travelling at the rate of 186,000 miles per second. The diameter of the Milky Way was estimated as approximately 100,000 light years. Yet that whole galaxy, containing perhaps one hundred billion stars, would appear as a single unit of light if it could be viewed at a distance of 100,000,000 light years from its center. Again, the hundred billion stars of the galaxy, like the sun and planets, were held together by gravity as a single system that rotated around its minor axis, one revolution being completed by the sun in about 225 million years.[4]

Beyond the Milky Way, a hundred million other galaxies were known to exist within a distance of something like a billion light years, which was as far as the telescope had penetrated.## These billions and billions of stars were moving in a pattern so immense that it had not been determined whether the universe was expanding or contracting.[5]

The entire substructure of the universe was composed of atoms, and each of these particles seemed to be a miniature solar system. A small mass of material was concentrated in a sun-like nucleus around which revolved at relatively great distances a varying number of planetary electrons.# As the solar system was held together by

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#The hydrogen atom has only one electron.
##This seems to have been the distance probed by the telescope at Mt. Palomar.

gravity, so the atom was held together by an electromagnetic force. Moreover, within given areas, each atom played its part in the structure of matter as the solar system played its part in the structure of the Milky Way. Since the atoms were infinitessimally small they were further removed from sense perception than the stars. Although not more than 7000 stars were visible to the naked eye, millions of others could be seen, and billions photographed through the largest telescopes. Yet not even an electron microscope could reach down into the emptiness of a grain of sand and reveal an atom.

If atoms were to be "visualized" they too had to be placed upon a comprehensible scale. It was necessary to reduce the solar system to a model of inches, and the atom had to be magnified to the same size if the atomic dimensions were appreciated. Under Bohr's scheme the distance between a nucleus and its electron or electrons was recognized as inconceivably small but proportionately as large as, or larger than, the distance between the sun and its planets. If the hydrogen atom had been magnified twenty-five trillion times its nucleus would have been one inch in diameter and its single electron planet would have revolved on an orbit with a radius of 1400 feet. This radius was relatively almost four times as great as the radius of the solar system in which Pluto, the outermost planet, was 3,670,000,000 miles from the sun. When the solar system was reduced to a scale in which the sun had a diameter of one inch, the 3,670,000,000 miles of Pluto's radius became a little less than 353 feet.# It was thus apparent that the hydrogen

#It would be very erroneous to take the analogy of the solar system and the atom too seriously. The chief value of the comparison was to show the relative emptiness of the two systems and to point out that in the case of the atom, the solar system and the galaxies, each unit preserved its entity, despite its vast internal distances, through gravity or electromagnetic force.

atom was relatively more empty than the solar system, and inescapably the solidity of matter was regarded as much of an illusion as the Milky Way's continuous stream of light.[6]

The astronomical-atomic analogy represented the simplest possible summary and explanation of the status of atomic-nuclear physics, and the philosophy of physics, in 1939. Although the idea of atoms was very old, it was not until the late nineteenth century that their existence could be proven. Even then the proof was circumstantial, and presented a new problem in epistemology. Knowledge of atoms did not come from direct observation of them, since they were far too small to be seen, but rather through an analysis of their reaction with and upon the instruments of observation.*

It is only through the history of the discovery of atoms, and of the early exploration of their spatial structure, that it is possible to understand the techniques employed by the physicists between 1939 and 1945 to release and control nuclear energy for human use.

Prior to 1939 the history of human thought as it pertained to nuclear physics passed through six periods, all of which were rather sharply drawn. They became progressively shorter, and, from the viewpoint of knowledge gained, progressively more important. The first period began with recorded history, approximately 4,000 B.C., and continued unhurried through 1400 A.D., thus covering nearly 6,000 years. It was in these centuries that the human mind changed from its faith in the appearance of the external world as a revelation of truth, to faith in research as a means of discovering truth. The

*Niels Bohr gave repeated emphasis to this point in a number of essays and lectures which were collected and published in book form, _Atomic Physics and Human Knowledge_ (New York, 1958). Pierre Teilhard de Chardin made essentially the same point in his work, _Le Phénomène Humain_ (Paris, 1955).

second period, 1400 A.D. to 1660, a mere 260 years, was the actual transition from tradition to experiment. The third period, 1660 to 1895, or a total of 235 years, was that of the experiments which definitely established the existence of the atom. The fourth period, 1895 through 1920, some twenty-five years, was one of exploration within the atom when its structural pattern was studied. The fifth period, 1920 to 1934, fourteen years, saw the actual development of nuclear physics. During the sixth period, 1935 and 1939, only four years, such progress was made that for the first time atomic power was placed within the domain of immediate possibility.

The First Period: The Heritage of Antiquity

From the end of prehistoric ages, marked by the invention of writing, and dating from approximately 4,000 B. C. until 1400 A. D., many contributions were made to scientific thought. Some were purely theoretical, some were mathematical and astronomical, and some were immediately practical. All of them helped prepare the way for the sudden advance made in western Europe about 1400 A.D. Of all the contributions from antiquity, four were of outstanding influence. First there was the conviction among the ancient and medieval peoples that nature operated in accordance with unalterable laws which, therefore could be studied. Second, there was the concept of elements, fixed, abiding and indestructable. Third, from very early days there was belief in an atomic substructure underlying the superficial appearances of nature. Fourth, from the idea of natural laws, elements, and atoms it followed that though the senses could not reveal the full truth about the external world, its real pattern was in accord with law and could be discovered through theory, research, and interpretation.

One of the most common tenets of thinkers in antiquity and the middle ages was the macrocosmic-microcosmic theory. There was only one pattern throughout the universe, repeated over and over again in large and small designs. Its repetition went from the infinitely great to the infinitesimally small, and though there were many variations they were slight and generally limited to details. The world was like a series of numberless mirrors each reflecting a perfect image of the original pattern, and the variations were merely the result of quality differences in the mirrors themselves. The basic pattern was reality, that which did not change and which could therefore be studied through its innumerable manifestations. The purpose of speculation and of experimentation, where there was experimentation, was to understand more perfectly the fundamental principles.

The macrocosmic-microcosmic theory was a scientific hypothesis based upon observations, but without sufficient data. The human eye lacked the range of vision to penetrate beyond the obvious, and the widely accepted analogies were either superficial or false. As a result, the ancient and medieval speculators became lost in a maze of comparisons which tended to blind the mind to rational explanations when the latter were finally attained with the aid of instruments. Nevertheless the macrocosmic-microcosmic theory was of great value because it instilled the thought that since nature was not chaotic it could be understood.

As part of the macrocosmic-microcosmic theory was the idea of elements, divisions of matter which could not be broken down into something else. During many centuries only four elements were listed--earth, air, fire and water--though Aristotle had a fifth, quintessence, which was the binding force that kept the world glued together. The philosophers did not think of these four or five elements as tangible but rather as principles manifested over and over again in the solidity, fluidity, temperature, moisture, and coherence of every object. For instance, the ancients maintained that the human body was composed of earth, air, fire, and water in its flesh and bones, in its breath, its warmth, and its blood.* In a metaphysical sense, the elements were part of a religiophilosophical system of symbolism which signified such abstractions as permanence, change, quality, and vitality. Whatever significance was attached to those hypothetical elements, and regardless of the error involved, the concept did much to prepare the way for an appreciation of actual elements discovered at a later date, without which nuclear physics could not have been realized.[7]

There were other minds in antiquity which desired to get beyond the four elements, to discover the common matter from which all things were made. The Greek philosopher Democritus, 460 - 362 B. C., formulated the first atomic theory, but in all probability there were others before him. At any rate, Democritus affirmed that there was nothing in the universe but atoms and vacuum. To him, atoms were innumerable, indestructible, and the invariable constituent of all things. He attributed to these atoms the shape of billiard balls, and he said that they were in constant motion which fluctuated under various conditions, such as pressure and collision with other atoms. He described change as the combination and separation of atoms in a constantly varying form. Democritus then gave additional strength to the idea of natural law which could be studied,

*This theme was repeated over and over by many writers from the time of Aristotle through the medieval metaphysicians.

for he said that the movement of each individual atom was regulated. Consequently nothing arbitrary could take place in the physical world. Every effect was the result of a specific cause, and cause and effect were both determined by the natural law which governed the motion of atoms. After the time of Democritus the atomic theory was never completely lost. Certainly the pagan religions of Greece and Rome, and the medieval theologians as well, rejected the complete materialistic interpretation of nature deduced by Democritus. There were others, such as Epicurus of Greece and Lucretius of Rome, who reiterated much of the Democritan doctrine, and the medieval theologians accepted his general thought when they insisted that nature followed divine law.[8] It did not matter what law nature followed, as long as its phenomenons were not accidental.

From the ancient and medieval conception of the elements and atoms came the belief that the structure of the material world was quite other than indicated by appearances. It was almost as though man understood by a sixth sense that his five senses had led him astray. It was this understanding that things are not what they seem which justified and perhaps inspired the desire for research, and it was confidence in the existence of a law of nature that gave man the courage to attempt what his intellect urged him to do. As far as the development of atomic energy is concerned, these were the important ideas in the European mind as the Middle Ages came to an end and the Renaissance broke with tradition about 1400 A.D.

The Second Period: The Scientific Significance of the Renaissance, 1400 - 1660

Within the 260 years between 1400 and 1660 A.D., the world of western Europe changed its point of view from that of authoritative tradition to experimentation. It was a revolution in attitude far greater than any which had ever come in the past, and it altered the political and social history of the world as nothing else had done since the invention of writing. The medieval peoples produced a great synthesis of values governing every action of the individual. The synthesis was justified on the basis of absolute authority, and where facts did not fit the synthesis, the former were cast aside as probably erroneous. With the coming of the Renaissance there was a reversal of attitude which, though extending over a span of two centuries, was, historically speaking, achieved with remarkable rapidity.

The Renaissance was not interested in synthesis. Figuratively, the movement was an "electrolysis" of the medieval scheme of values. Both philosophically and religiously the new age was concerned with individuals. Individual interpretations of scripture supplanted the pronouncements of the Universal Church; the supremacy of the nationalistic state replaced the universal empire; art for art's sake dominated painting, sculpture, and music; and knowledge for the sake of knowledge prevailed in the realm of scientific investigation and speculation. From a medieval point of view the Renaissance glorified chaos; but from a twentieth century point of view the Renaissance prepared the way for amazing scientific progress.

The new philosophy of science made possible the use of new techniques and the invention of new instruments for a closer and more careful scrutiny of nature. For instance, Nicholas of Cusa, 1401-1464, invented a hygroscope to test the changing humidity of the atmosphere. The invention itself was not particularly important except as showing the sudden impetus toward the practical approach to the study of nature. In line with the same thought was the great work of Nicholas Copernicus, 1473-1543, De orbium coelestium revolutionibus, in which he explained, after careful observation, the apparent motions of the sun and planets as due to the movement of the earth and other planets around the sun. Although there was still strong opposition to such an hypothesis, supporting evidence accumulated too rapidly for the Copernican theory to be disregarded.[9] Thus Johannes Kepler, 1571-1630, strengthened the Copernican theory by discovering that all the eccentricities in the movements of the planets could be accounted for by assuming their orbits to be ellipses rather than circles. More important than anything else was the invention of the telescope and the microscope about 1610. By these two instruments it was possible to see the satellites of planets and some of the intricacies of botanical and biological structures. So there was proof of the timeless belief that there were heights and depths in nature beyond the range of the human eye. Within 260 years scientific observation and scientific instruments had taken the human mind forward to the nearest frontiers of space, but there were to be another two hundred years before the atomic theory could be proven.

The Third Period: The Discovery of the Atom, 1660-1895

Perhaps the greatest contribution made to science by the Renaissance—other than the Philosophiae Naturalis Principia Mathematica of Sir Isaac Newton, 1642-1727*—was the invention of the laboratory and the laboratorial method. One of the first to profit by the new technique was Robert Boyle, 1627-1691. He himself established a laboratory at Oxford where he employed several assistants. By 1660 he announced his

*This work explained a large part of inanimate nature in mechanical terms through the law of universal gravitation, but it was not in direct line with the development of atomic energy.

"law" of gases. It was deduced from a simple experiment. He poured into the open end of a U tube some mercury and found that the trapped air in the closed end of the tube offered resistance to the mercury. He wrote up this experiment and it was nonsensically criticised by Franciscus Linus, professor at Luttich in Holland. Boyle disregarded Linus, and went on with his work. After a series of experiments he found that the volume of air trapped in the closed end of the tube varied inversely with the pressure. He published this information and it came to be known as Boyle's Law.[10]

It has happened many times in history that a man has failed to appreciate the significance of his discoveries. It was so with Boyle. His experiment showed some interesting facts, but it required more years of research by others, who repeated Boyle's experiments, to realize what Boyle's Law meant, that all gases consist of separate particles too small to be seen but kept in constant motion. Thus when the container of a gas is made smaller, as by pouring more mercury into the open mouth of a U tube, the particles of gas have less distance to travel, hit the sides more often, and therefore exert more pressure. After Boyle, other experimenters found that heat applied to the container increased the pressure, and this was explained as meaning that when heated the particles of a gas again move faster and exert greater pressure. Daniel Bernoulli, 1667-1748, a Swiss physicist, was the first to see that Boyle's Law meant that gases are composed of particles similar to the atoms of Democritus, but no effort was made at the time to apply this doctrine to the construction of all matter.

Yet Boyle and his contemporaries were very much interested in the search for a basic substance from which all else was made.

Boyle picked up the old theory of four elements and worked with this idea for a while. He claimed that, in order to think clearly about the subject, an element should be defined as a substance out of which nothing but itself can be obtained. This definition led to startling results in the course of little more than a century. Soon, experimentation broke with the four elements of antiquity and found forty-two others.

By 1800, thousands of experiments were going on all over Europe in countless laboratories. The technique of science was becoming accurate. Careful observation, "exact" weighing and measuring, the patience to repeat and repeat an experiment beyond the point of doubting its correct meaning, became the standards of every reputable thinker. Gradually there re-emerged a recognition of the need to interpret the accumulating evidence in order that an overall meaning might be given to the whole work, an hypothesis or theory which in turn would have to be proven or disproven by further experimentation. As the scientific movement gained momentum it swept beyond the original aim of Renaissance men to perform only one experiment for the sake of knowing the truth about some isolated subject. In the bewildering details of discovery there was a growing nostalgia once more for a synthesis which would explain the underlying pattern of the physical world and of human life.

About 1800 the distinction was seen between a physical mixture and a chemical compound. In the mixture of two substances, such as salt and pepper, the ingredients could be stirred together in any amount, in any proportions, and the nature of the ingredients remained unaltered. In any mixture, however, where there was a chemical reaction the result was very different and a "compound" was created.

For instance, if two elements reacted to form a chemical union or compound, the reaction occurred only in fixed proportions. It was also discovered that the weight of matter entering into the chemical reaction was exactly equivalent to the weight of the product of the reaction, which was taken as implication that matter could never be destroyed.

John Dalton, 1766-1844, set out to determine the relative weights with which the various elements united into compounds. To his surprise, he found that in any chemical reaction the fixed weight of the elements that combined with any selected elements was always in the ratio of whole numbers. Thus, in a reaction of sulphur and carbon, and oxygen and carbon, he found that exactly twice as much sulpher as oxygen would unite with a given amount of carbon. This ratio of whole numbers in mixing elements into compounds convinced him that there was only one possible explanation. Compounds were formed by individual particles of one element combining with a specific number of particles of another element to form units of the compound. Dalton then announced the atomic theory in 1808, and declared that all elements were composed of atoms, the smallest indivisible particles, which in turn combined with atoms of other elements to form a molecule of a compound. These atoms and molecules were in constant motion, like particles of gas.

The theory was not accepted without criticism, and some of the opposition came from the most respected scientists of the first half of the nineteenth century.[11] When more supporting evidence was uncovered, however, other scientists began an investigation of the relative weights of atoms in the various materials. This was done, not by weighing the atoms themselves, but by weighing quantities of each element that went into a reaction, comparing the weights and setting up numbers which represented the relative weight of the atoms. In a short time the scientists established a weight table of all the known elements, based upon the hydrogen atom as No. 1, since it was least heavy.

Several attempts were made to relate atomic weights with the physical properties of elements. The first successful scheme was that drawn up by Dmitri Ivanovitch Mendeleeff, 1834-1907, who in 1870 arranged the names of the elements in a list of ascending atomic weights. He discovered that the elements thus arranged displayed a periodicity and that each eighth element had somewhat similar properties. All the elements were fitted into a table where the similar elements were placed under each other in columns. The table made it possible to predict the existence and properties of certain elements then unknown, but they were discovered later. Mendeleeff thought of his law as a demonstrable statement of fact, but the evident relationship which it showed as existing between elements made many scientists consider anew the possibility of discovering the basis of matter, and it was thought that hydrogen was the element of elements. It was seen, however, that the atomic weight of the other elements would then have to be whole multiples of the atomic weight of hydrogen which was taken as one. The theory broke down with chlorine which steadfastly exhibited an atomic weight of 35.457.[12]

Despite many inadequacies in their theories, as the nineteenth century drew to a close, scientists became humorously complacent. They thought they knew that there were elements which could not be broken down into any other substances. They believed the substructure of all matter to be billiard-ball atoms, an hypothesis which gave them an explanation of change and permanence. Their knowledge was so great they could even predict the existence and properties of elements as yet undiscovered, and they knew how elements combine to form compounds. Only one major problem was left to them, as they saw it, and that was how the atoms were attracted to each other and how they combined to form molecules in the compounds.

The Fourth Period: The Exploration of the Atom, 1895-1920

The period between 1895 and 1920 was one in which the scientists experimented to discover the nature of electricity. It was this particular research which in the end led the way to an understanding of the atomic structure.[13]

Throughout antiquity and the Middle Ages very little attention was paid to electrical phenomenons. Three hundred years after the Renaissance, nothing had been learned about electricity except that there were two kinds which were mutually attractive. They were at first called vitreous and resinous, and it was Benjamin Franklin who later named them positive and negative. Franklin assumed that each of the two was a weightless, colorless, and invisible fluid, a constituent of all mater but different from matter. He believed that objects with a positive charge had a superabundance of the fluid and that those with a negative charge suffered from a deficiency of the fluid. He then explained the attraction between bodies with opposite charges as due to a balancing of the surplus and deficit. Later, in the nineteenth century, experimentation turned from a theoretical explanation of electricity to its practical use in laboratory batteries whereby the decomposition or electrolysis of compounds was accomplished. The process of electrolysis, however, remained a mystery, though in the end it proved to be the "sesame" to atomic energy.

The first scientist to attempt an explanation of electrolysis was Michael Farraday, 1791-1867. He found the process to be more rapid and thorough if the substances being decomposed were in a dilute liquid solution. This fact convinced him that electrolysis was due to the motion of particles since he knew, of course, that particles moved more easily in a liquid solution than in a solid. He called these particles ions, which means travellers. He also found that the amount of the decomposed material deposited at the electrical terminals depended entirely on the atomic weight of the material and the quantity of electricity passed through the solution. Thus, when a solution containing a hydrogen compound was electrolyzed by a quantity of electricity, the same amount of hydrogen always appeared at the negative terminal regardless of the strength of the solution. Furthermore, he found that the same quantity of electricity that separated one gram of hydrogen from solution also separated 107.05 grams of silver, and this was significant since the atomic weight of silver was 107.05 times that of hydrogen. So it was with all the elements involved in electrolysis. "The same quantity of electricity always liberated an amount of each element that was exactly equivalent in chemical properties to one gram of hydrogen." Electrolysis thus proved that the same amount of each element had been freed from solution by an equivalent amount of electricity. Evidently, individual units of electricity were attaching themselves to individual ions, and the scientists should have concluded that electricity consisted of single, separate units, just as Dalton's experiments with compounds showed that solid matter was composed of atoms. However, Farraday and his contemporaries in 1833 were so blinded by their preconceptions of electricity as something different from matter, something continuous, that no one would accept evidence to the contrary.[14]

Between 1833 and 1895 little further progress toward an understanding of electricity was made.* Then in 1895 W. K. Roentgen, 1845-1923, was working with a cathode-ray tube and discovered that a fluorescent screen would glow even with objects placed between it and the tube. It appeared that a mysterious radiation was passing through the tube and through the solid object in front of the screen. Further experimentation indicated that the ray would penetrate paper, wood, aluminum, and even animal tissues though bones remained opaque. It therefore became possible to photograph the skeletons in living bodies. Not knowing the nature of the new rays, Roentgen called them "X-rays."[15]

Sir Joseph John Thomson, 1856-1940, began to devote his attention to the cathode rays in 1896. Within a year's time, he concluded that the rays were composed of particles, and he wondered whether they were "atoms and molecules, or matter in a still finer state of equilibrium."[16] In seeking an answer he set up a cathode ray tube and bent the cathode ray by means of a magnetic field. In addition, he set up an electric field at right angles to the magnetic field, placed metal plates at right angles to the poles of the magnet, and connected each plate to the opposite end of a high voltage source. He made further refinements

*True, the scientists used cathode-ray tubes, the interior reduced to near vacuum and containing a wire sealed in each end. The wire at one end of the tube was connected with a positive terminal of a high voltage source and the wire at the other end of the tube was attached to a negative terminal. Rays of light passing from the cathode to the anode were subjected to various experiments and through the use of magnets were "bent" out of line, but still no one was willing to admit that the rays were composed of particles of matter.

by building highly efficient vacuum pumps and reducing the air pressure within the tube to one thirty-millionth of that at sea level. With this set-up he tried cathodes of various materials, and learned that, regardless of the material used, the particles of the cathode ray were always negative and bore the same charge as the small units of electricity in a solution. In 1897 he announced that the particles in the cathode ray and the units of electricity discovered by Farraday in electrolysis were one and the same thing, and he declared that all matter was composed of these particles which were already called electrons. It was then possible to understand that the "flow" of electricity was nothing more than the movement of electrons.[17]

It was obvious that atoms could not consist merely of electrons which were negatively charged and repelled each other violently. Thomson therefore assumed that atoms consist of small negative charges, that is, electrons, embedded in a larger sphere of positive points. This made the atom appear as a golf ball with large headed pins stuck into the grippage pits on the surface. The concept was entirely erroneous in its image of the atom, but the theory accurately explained that electricity was composed of electrons separated from atoms. The theory also accounted for the flow of electricity in ionized gases by showing that when the atoms in the gases were hit the electrons were knocked off, leaving the atoms positive and causing them to move in an electric field.[18]

Thomson's work excited the interest of many of the leading scientists of the day. It was realized that he had made the first step toward understanding the structure of the atom, and that beyond dispute there were smaller particles in matter than the atom. Thomson also proved that gas, liquids, and solids possessed the same fundamental structure, and that electricity was a basic part of all matter, and in itself was merely part of matter which for the instant was unrelated to the other ingredients.

Meanwhile, in Paris, Henri Becquerel,* 1852-1909, was studying the problem of X-rays. He tested the behavior of various substances which showed fluorescence after being exposed to X-rays. He took some uranium compounds and placed them near photographic plates wrapped in black paper. He then discovered that uranium compounds without any kind of external stimulation fogged the photographic plates. He mistakenly assumed that uranium compounds were giving off X-ray and he called it radioactive material. Further investigation showed that some compounds were more active than others. Becquerel saw that the next step was to find out which part of the uranium compounds caused radioactivity, and Pierre Curie, 1859-1906, and his wife, Marie, 1867-1934, undertook the necessary experiments.[19]

The Curies had no suitable laboratory, no assistants and practically no funds. For many of their experiments they used an abandoned shed near the School of Physics, Paris, with little protection against the weather. Yet in July 1898 they discovered a new element, polonium, and in the following December they discovered radium. They did not know the atomic weight of radium until 1902 when it was settled as 225, though Madame Curie revised it to 226.2 in 1908. The intense radioactivity of radium caused a sensation when it was first discovered, and contributed a great incentive to further research.[20]

No sooner had polonium and radium been discovered than some of the

*Henri Becquerel should not be confused with his grandfather, A. C. Becquerel, or with his father, Edmund Becquerel, both of whom were distinguished scientists of their own generation.

outstanding physicists of the period began experiments to identify accurately the radiation coming from the new elements. It was not long before they found that there were three kinds. In one experiment radioactive material was placed in the bottom of a deep, narrow hole in a block of lead with a small opening at the top. The beam of radiation which was shot out from the material in the lead block was passed through the positive and negative poles of a power magnet. Part of the beam was bent toward the negative pole and was called the alpha ray; a second part was bent toward the positive pole and was called the beta ray; a third part escaped without deflection and this was called the gamma ray.

In 1903 Ernest Rutherford,* 1871-1937, discovered that the alpha or positive particles coming from the radioactive material were unduly scattered in passing through thin sheets of aluminum. He then began to doubt Thomson's theory of atomic structure and felt that a careful check was necessary. The work was done by two of his co-workers, Hans Geiger and Ernest Marsden. They allowed a beam of alpha particles to hit a thin gold foil at an angle of 45° to see whether they would bounce off and strike a screen coated with zinc-sulphide. It was believed that each particle hitting the screen would cause a bright green flash which could be seen through a microscope. The flashes were observed, but the meaning of this phenomenon was not clear.

In a second experiment, particles of the alpha ray travelling

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*Rutherford was born in Austrialia but he was educated at Cambridge, England. He taught physics at McGill University in Canada and later in Manchester and Cambridge universities, England. He was knighted in 1914 and elevated to the peerage in 1931. He died in Cambridge and was buried in Westminister Abbey. (Arthur Stewart Eve, Rutherford (New York, 1939), passim.) Arthur Holly Compton wrote of Rutherford: "He was for me the greatest of all nuclear physicist". (Atomic Quest (New York, 1956), p. 13.)

with the speed of 10,000 miles per second were sent into gold foil. In accordance with the atomic theory a large proportion of the particles should pass through the foil without striking any of the sparsely scattered atoms. Others however were certain to strike atoms.. If Thomson's theory of the atomic construction was correct the particles striking an atom should behave in one of two ways. All of them should pass through the atom with a slight deflection or, if the atom were sufficiently hard, they should all bounce back. As it was, most of them were deflected but a few were ejected back through the foil. This meant that some of the particles passed through the atoms, and only occasionally did one rebound violently. Rutherford considered the evidence and decided that Thomson's theory of atomic structure was no longer tenable. The experiment was like firing thousands of bullets into a mud wall in front of which had been constructed a parallel wood screen. Most of the bullets passed straight through the wall, but a few of them were ejected as though by a violent force and splintered back against the wood screen. Under such conditions he would have assumed that at intervals in the mud wall there were inconceivably hard points which had the power not only to halt the bullets but to hurl them back in the general direction from which they came. In view of the evidence that many alpha particles passed between the atoms and almost as many were slightly deflected, apparently because they passed through the atoms, Rutherford concluded that the atoms were not constructed as depicted by Thomson.[21]

Rutherford maintained that the mass and charge of an atom were not distributed over a relatively large sphere, but that they were concentrated in an infinitesimally small point which he called the nucleus. He believed the nucleus to be approximately one ten-thousandth the size of the whole atom and the electrons to be distributed around the center at relatively great distances. Consequently the nucleus for Rutherford seemed to be an unimaginably hard particle with an indescribably concentrated positive charge capable of rejecting the positive alpha particles. Rutherford cast aside the idea of a solid spherical atom, indivisible and unchangeable. He substituted a spacious entity consisting of a nucleus in the midst of electrons like "a fly in a cathedral".[22]

Wonderful as Rutherford's experiments had been, there were numerous problems which his diagram did not fit. For instance, some of his contemporaries asked why the electrons did not fall to the nucleus. Others reminded him that, according to spectroscopic observations, radiation resulted from an apparently endless movement of the electrons, a phenomenon not congenial with his scheme.

Meanwhile in 1900, Max Planck, at the University of Berlin, formulated in his Quantum Theory that radiant energy was emitted as separate particles or quanta, and not as a continuous stream. Expressed mathematically, the energy of each particle, E, equalled "hv" where v was the frequency of radiation and h was a mysterious constant that approximated the inexplicable decimal fraction written as .000000000000000000000000006624. Five years later, in 1905, Dr. Albert Einstein affirmed that all forms of radiant energy--such as light,* heat, and X-rays--moved through space as separate particles. His doctrine surprised many of the physicists of the day.

*Einstein gave the name of photons to light particles.

Most of them accepted as well demonstrated the particulate nature of matter, but they believed that light had consistently behaved as a wave, a theory that was justified by the observed phenomenons of diffraction and interference.[#] If Einstein was right he had discovered a disturbing duality in the nature of light.

For the time being no one seems to have thought of the particle-wave duality as applicable to the whole structure of the entire material world. Consequently in 1913 Bohr was free to go one step beyond the 1903 advance of Rutherford and proclaim that the atom was a miniature solar system with a nuclear sun and planetary electrons, the latter held in their orbit by electromagnetic force. Bohr postulated that:

1. An electron can revolve about its nucleus only in certain special circular orbits.
2. The ordinary electron revolves around the nucleus in an invariable orbit, without radiating or absorbing energy.
3. Radiation takes place only when an electron falls from an orbit of greater energy to one of less energy near the nucleus. Under such a system an orbit becomes an energy level and if the electron falls from one level to another the change is immediately manifested in the spectrum of the element.

Thus it was possible for the atom to contain a number of electrons

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#Actually Einstein was reverting to the corpusular structure of light which had been widely accepted between 1700 and 1800. It had been rejected because when light passed the edge of an opaque body, or went through a narrow slit, it bent and spread out from its linear path in a phenomenon known as diffraction or wave-like movement. Also, if light passed through a series of narrow slits very close together, the emergent rays fell on the screen, not as an equal number of thin strips of light, as might have been expected, but as a series of light and dark bands in what was called an interference pattern. Samuel Glasstone, Sourcebook on Atomic Energy (New York, 1958), p. 65.

without loss of stability.*[23]

The theory was strengthened as soon as it was announced by the experiments of H.G.J. Moseley** who bombarded a number of elements with cathode rays. He found that the X-rays given off differed in wave length in the same order as that with which the elements appeared in the periodic table. He saw immediately that his results indicated a progressive change in regular steps from one element to another, and by a complicated mathematical process he calculated a corresponding atomic number for each of the elements. The numbers which showed exactly how the positive charge of the nucleus increased from element to element, were more accurate than atomic weights in placing the elements in the periodic table.[24]

In yet another way the numbers were important to the thinking of 1913 because they were immediately applicable to an understanding of experiments then being performed by Thomson. He found that the atomic weight of neon was 20.2 but that there were actually two neon ions, one with a mass of 20 and one with a mass of 22. It was therefore evident that neon, instead of being a single gas, was actually composed of two gases with the atomic weights of 20 and 22. They were

*The electrons were held in their orbits by the balance between the centrifugal force, and the coulomb force. (The force of gravity was negligible.) Consequently the electrons continued to revolve in their stable paths unless knocked into unstable orbits by collision with a foreign body. Even so, an electron knocked into an unstable path, it was believed, would tend to return to its normal orbit thereby restoring the stability of the atom as a whole.

**Moseley, who was among the more capable of the young physicists, was killed in action in 1914 as a soldier in the British Army.

mixed in such proportions that the net weight of the combination was 20.2, the atomic weight of neon. This was a very surprising discovery for it meant that two gases with different weights had the same properties and this was inexplicable except in terms of Moseley's theory. It was evident that both gases had the same atomic number and therefore occupied the same place in the atomic table. For this reason the heavier gas was called an isotope, which means "occupying the same place." Obviously then, it was not the weight of the atom but the positive charge within its nucleus which indirectly determined its chemical properties.

When World War I began scientists were wondering what the relationship could be between atomic weight and atomic numbers. Weight had served as evidence for the periodic table which had been even more exactly substantiated by Moseley's numbers. Clearly the connection between weight and number was of fundamental importance to an understanding of the nature of matter. Scientists were also baffled by the fact that the nuclei of certain elements, like radium, would suddenly disintegrate and transform themselves into other elements.

As far as could be theorized in 1914, the nucleus of the atom held the innermost secrets of matter. The weight of the nucleus seemed to determine the number and behavior pattern of the satellite electrons. Apparently the nuclei generated the physical characteristics of the elements, and the electrons, especially those of the outermost orbits, created the chemical properties.[25]

If further progress was to be made, it was necessary to pass on from atomic to nuclear physics. Rutherford led the way. He undertook to penetrate the inner regions of atoms by bombarding the nuclei of gaseous nitrogen with alpha particles from a strong radioactive source. Chance of success was poor. In terms of atomic diameter, the distances between nitrogen atoms, and between their nuclei and electrons, were known to be tremendous. As Dr. Albert Einstein said, Rutherford had about as much chance of hitting a nitrogen nucleus as a hunter would have of hitting a bird on a dark night in a country where there were very few birds. Rutherford nevertheless believed that with patience he could succeed. World War I interrupted his work, but in 1919 he returned to his project, and soon justified his faith. He succeeded in striking the nuclei, and found that swiftly moving particles were detached from the nitrogen which had the mass and positive charge of a hydrogen nucleus.*

Though he did not know it, Rutherford had achieved the first artificial transmutation in history. He had changed nitrogen into oxygen with resultant hydrogen nuclei as residue. In principle, Rutherford did what the medieval alchemists attempted to do in their efforts to change lead into gold, but he accomplished far more than the medievals

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*The apparatus used by Rutherford in the experiment consisted of a box covered over at one end by a thin silver foil through which the alpha particles could easily pass. In this box he put some radio-active material and on the other side of the foil he placed a metal plate covered with zinc sulphide. When he filled the box with oxygen, the atoms absorbed all the alpha particles and there were no flashes on the screen. When dry nitrogen was substituted for the oxygen, flashes appeared on the screen. He felt that particles were then being produced in the box more penetrating than alpha particles, and to measure these he used a Wilson Cloud Chamber in place of the zinc sulphide screen. The Chamber consists of a cylinder out of which a piston could be pulled allowing the expansion of gas. This causes a drop in temperature and the condensation of moisture on any ionized particles in the Chamber. Atomic particles ionized a gas as they passed through and their path could be traced by photograph: as the particles lit up the moisture condensed on the ions formed in their path. When Rutherford allowed those particles knocked free of the nitrogen nucleus to pass into the Chamber, the photographs showed their paths from which he could calculate their mass and charge when sent through magnetic and electrical fields.

could have dreamed of doing. Had the alchemists succeeded, gold presumably would have lost its value and the world would have been neither richer nor poorer. Rutherford, on the other hand, brought science to the shoreline of nuclear physics. He prepared the way for a new form of warfare, a new world economy, and possibly for a new type of world empire. Intellectually, Rutherford did even more. In his overthrow of the solid atom he substituted space for solidity, and established an emptiness comparable only to that already seen in the solar system, in the galaxies, and in intergalactic distances. The full implications of Rutherford's achievement, however, could not be seen at once, and there were still years of work before his accomplishments were fully appreciated.

The Fifth Period: The Development of Nuclear Physics, 1920-1934

In 1920 Rutherford announced in a lecture before the Royal Society that the nucleus of all atoms must be composed of a number of positive particles each of which was exactly the same as the nucleus of a hydrogen atom. The positive particles detached from the nitrogen atom were called protons. Rutherford said that the number of protons in a nucleus determined the nature of the atom, and that for each proton concentrated in the nucleus there was one electron or negative charge orbiting the nucleus. If the nucleus was composed only of positive charges or protons, its positive charge should be equal to its weight.[26]

When Rutherford announced his discoveries in 1920, the physicists were stung into new theorizings concerning the structure of nuclei. Between 1920 and 1930, experiments were repeated over and over again which verified Rutherford's findings and at the same time improved the technique of atom smashing. It was found, however, that there was some evidence contrary to the theory that the positive charges of an atom equalled its weight. The helium nucleus, for instance, had a positive charge of 2 but a weight of 4.. There were two interpretations. Some believed that the helium atom had four protons and two electrons which would account for its mass of 4 and its positive charge of 2, since the two electrons would cancel two of the protons. Others felt that such an interpretation was necessarily wrong since the electrons and protons would combine. Furthermore, there was no satisfactory explanation of why unmatched protons, mutually repulsive by similar charges, should remain locked together in the nucleus. Rutherford advanced the theory that there was yet another particle existing in the nucleus which was without a charge of any kind.[27]

It was in 1930 that two German physicists, Walther Bothe and Heinrich Becker, bombarded beryllium, boron and lithium with alpha particles from polonium, and found that each of the three elements gave off a very penetrative radiation. There was no solution to the mystery for two years. In 1932 an Englishman, James Chadwick, pointed out that this radiation could be interpreted as a particle having the mass of a proton but without charge. Such particles, soon named neutrons had great power of penetration. Since they were without positive or negative charge they could not be deflected by electrical fields around the atoms and therefore could be stopped only by head-on collision with a nucleus.[28]

It thus became apparent that an atom consisted of electrons revolving around a nucleus composed of protons or particles with a positive charge, and neutrons or particles with the mass of protons but without a charge. The number of electrons orbiting within a neutral atom equaled the number of protons in the nucleus, but the mass of the nucleus equaled the mass of protons and neutrons. The importance of the theory was that it explained the isotope. Thus some atoms—in addition to the equally balanced number of protons and electrons, from which came physical properties—were made "heavy" by having an unusually large number of neutrons. At the same time, because there was a rough proportion between the average number of neutrons and protons in a nucleus normally appearing in nature, weight could give a general indication of chemical properties without a direct causal connection.[29]

Meanwhile in 1930 P.A.M. Dirac, an Englishman, while working on some abstract computations in connection with mass energy, came across an equation which could only be satisfied by the existence of a particle having the mass of an electron but possessing a positive charge. On the afternoon of 2 August 1932, Dr. Carl Anderson, of the California Institute of Technology, photographed an experiment in connection with his work on cosmic rays. When he examined the plate he saw to his amazement the tract of a particle having the mass of an electron and the positive charge of a proton. He realized that this particle fulfilled exactly the requirements of Dirac and he called it "positron". Many other scientists began similar experiments, and in a short time they found that a positron and an electron could merge and disappear in a unity which immediately transformed itself into two gamma rays with a total energy equal to the original mass of the electron and the positron. Reversing the process, if a gamma ray struck an atom, under proper condition, the ray disappeared and its place was taken by a positron and an electron. These discoveries were dramatic justification of the theories previously advanced by the youthful Einstein in 1905* when he announced the doctrine of relativity, gave

*Einstein was born in 1879. In 1905 he was a clerk in the Swiss Patent Office.

mathematical preef of molecules, declared that energy, such as heat and light, existed net in the ferm of waves but as bullet-like particles, and stated that matter could be converted into energy and vice-versa.[30] In the light of Einstein's theories and Andersons' experiments,, energy had te be regarded as the potentiality of material manifestation.

There were two ether experiments between 1920 and 1934 that should be mentioned. In 1932 Julius D. Cockroft and E.T.S. Walton, both of whom were Englishmen, bombarded lithium with a beam of high speed protons. The latter were produced by drawing positive hydrogen from a gas discharge inte a lew pressure tube where they were accelerated by a charge ef 700,000 volts. When this was done, Wilson Cloud Chamber photographs showed that alpha particles—helium nuclei less two electrons, and therefore positively charged—were created. The presence of the particles could be explained only by assuming that one proton of the hydrogen atom combined with the three protons and four neutrons of the lithium. Here was another demonstration of the transmutation of elements. Two years later, 1934, Irene Curie and her husband, Frederick Joliet, bombarded aluminum with alpha particles from polonium. After the removal of the polonium the aluminum retained radioactivity which was thus created by man for the first time.[31]

The Sixth Period: The Vision of Atomic Power, 1935-1939

By 1935 the theory of atomic structure was well advanced and it was apparent that hithertoo unrelated pieces of information gained through the patient labor of centuries were slipping into place. The threshold of unimaginable achievements had been reached. The remaining barriers, however, could be penetrated only if atom smashing, begun by Rutherford in 1920, could be continued on a scale commensurate with its importance. A mechanical method was required, and Ernest O. Lawrence solved the problem by designing the cyclotron, an invention "of epochal importance in nuclear physics," especially in producing new artificial isotopes.[32]

The instrument-machine was conceived 1929, and a small prototype was made in 1931. Because it functioned as predicted improved models were turned out in the succeeding years, and by 1935 a large one was operating at the University of California where Lawrence was teaching. The device succeeded in accelerating a particle through relatively small potential differences by changing the polarity of the electrodes 10,000,000 times per second.* Protons could thus be hurled in an

*Cyclotrons were of various sizes. In the University of California the instrument weighed several thousand tons. The mechanics of the cyclotron had been described in the "Particle Acceleration" article of the Encyclopedia Americana, (New York, 1953, I-XXX Vols), Vol XXI, p. 353a-353b, as follows: "The machine consists of a pair of flat hollow, semi-circular electrodes in a vacuum chamber which is placed between the poles of a large electromagnet. The electrodes are called dees from the resemblance of their shape to the letter D. Ions are formed in the center of the vacuum chamber, in the space between the two electrodes. If one electrode is positively charged and the other negatively charged, the ion will be accelerated toward the electrode which is negative since the ion carries a positive charge. The ion passes inside the hollow electrode, and the electric field no longer acts on it, but is now acted upon by the magnetic field produced by the electromagnet. This bends its path into a circle so that after the ion has completed a half circle it is again in the space between the electrodes. By this time the polarity of the electrodes has changed so that the particle is again approaching a negative electrode, and hence is accelerated to a high velocity. It is now bent into a circular path of larger radius. The process continues, the ion gaining in velocity every time it courses the gap between the electrodes, and spiraling outward with an ever-increasing radius of curvature. If the voltage between the two electrodes is 50,000 and the particle crosses the gap 100 times, its final velocity will be the same as if it had been accelerated through a single potential difference of 5,000,000 volts." The particles employed in the cyclotron were deuterons, the nuclei of heavy hydrogen atoms in heavy water. The cyclotron could break the deuterons away from their orbiting electrons.

outward spiral until they attained the velocity of 100,000 miles per second.[33] The projectiles were focussed into a beam, pulled through a metal window of the cyclotron and directed against a target in the bombardment chamber by a deflector charged to a high voltage of the opposite polarity.[34]

At the same time that work was being done with cyclotrons, protons and the bombardment of atoms, Enrico Fermi, then a young physicist in Italy, became intensely interested in neutrons, only recently discovered by Chadwick. Fermi saw that neutrons, because they were particles with neither a positive nor negative charge, were better instruments for the exploration of atoms than protons could be. Beginning with hydrogen, Fermi undertook a systematic bombardment of all the elements. In his experiments he found that neutrons were more useful as projectiles when slowed down by moderators of such hydrogenous materials as water or paraffin. In 1934 he began the bombardment of uranium with artificially slowed neutrons, and thereby obtained, what he believed to be, its transmutation into hitherto unknown transuranic elements. Actually he split the U-235 isotopic atoms, but that was still regarded as impossible, and Fermi's erroneous interpretation was widely, indeed almost universally, accepted by physicists.[35]

Nevertheless, there were some few scientists who felt that the evidence did not exactly justify Fermi's claim. Ida Noddack, the distinguished German chemist, even suggested that the uranium nuclei had been split into known elements. This thesis, which came so close to a formulation of the theory of fission, was disregarded as physically impossible. But Fermi's interpretation remained unsatisfactory, and was rejected in 1937 by Otto Hahn, Fritz Strassmann and Lise Meitner who were then doing research in the Kaiser Wilhelm Institute of Chemistry in Berlin. However this trio of scientists, though skeptical of Fermi's conclusions, offered no explanation of their own. They were handicapped because their approach was as chemists rather than physicists.[36]

In 1938 Irene Curie and Frederic Joliot again bombarded U-235. They found a substance that they could not account for, and, like Fermi, they believed that they too had discovered a new transuranic element. Hahn and Strassmann, however, were disturbed by the Curie-Joliot interpretation, and decided that they would repeat the experiment themselves. They substantiated the Curie-Joliot findings, but were amazed to see that the so-called "new element" seemed to be an isotope of radium. This latter could have been created only if the U-235 had ejected two alpha particles. More investigation was needed and the new material had to be isolated. The procedure for chemically separating small amounts of radium was to add barium which would unite with radium in a joint separation from the other elements. Thereafter the radium could be separated from the barium. Everything went as expected until the time came to separate the new element from the barium. The two could not be pried apart, and the inevitable conclusion was that the new element was nothing but radioactive barium. Since the original reaction had been carried through without the use of barium, its presence in the final results could only be accounted for by the "bursting of uranium", as Hahn and Strassmann phrased it, which had then yielded barium and some other element not detected at the time. On 6 January 1939 Hahn and Strassmann published an account of their experiments which were "at variance with all previous experiences in nuclear physics."[37]

Meanwhile Lise Meitner had begun to feel the intolerance of

Hitler's anti-semitism. Fearing that she would be sent to a concentration camp she succeeded, with the aid of friends, in escaping to Sweden and arrived in Stockholm early in December 1938. As soon as Hahn and Strassmann were convinced that the radioactive barium in their experiment had resulted from the action of neutrons on uranium, they sent word to Meitner. With a deeper knowledge of physics than could be claimed by either Hahn or Strassmann, she saw that Bohr's model of the atom would permit a revolutionary explanation of the phenomenon--the heavy nucleus of U-235 had been split by the bombarding neutrons into two nuclei near the middle of the table. She hastened to Copenhagen and described the Hahn-Strassmann experiments to Dr. O. R. Frisch. He agreed with her conclusion, and on 16 January 1939 they announced their interpretation. The U-235 atom had "fissioned"--it was they who first used the term--into barium and krypton, and in so doing had released an unprecedented amount of energy which equalled the difference between the mass of the U-235 atom and the total mass of the barium and krypton atoms.[38]

Prior to his joint statement with Meitner, Frisch discussed the idea with Bohr. The latter saw at once the immense importance of the theory and left for New York on the next ship. He arrived in the United States on 16 January 1939, the same day that Frisch and Meitner made their announcement in Denmark. Bohr got in touch with Einstein who called together at Columbia University a group of the leading physicists in America. On 25 January they performed the determining experiment and gathered evidence that Meitner's interpretation was correct. Uranium 235 could be split, thereby forming two elements while at the same time releasing 170,000,000 electron volts per atom. This meant that uranium could produce 5,000,000 times the energy of coal per unit mass.[39]

Further calculations were made to determine the nuclear energy of the other elements. It was found that if the light weight atoms could be fused into medium weight atoms, there would be a greater conversion of mass into energy than could be obtained by the fission of U-235.*[40] It was understood, however, that the fusing of light weight elements would require a temperature not then within human capability. If nuclear energy was to be utilized in the near future the work would have to be done with a fission rather than a fusion process. The method would not be the ideal way to liberate nuclear energy, but it promised a power hitherto inconceivable.[41]

*The conversion of hydrogen into helium within the sun explained how that star had radiated great amounts of energy over millions of years without appreciable loss of mass.

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Chapter II

THE DEVELOPMENT OF THE FIRST TWO ATOMIC BOMBS

The success of the Columbia experiment was stimulating.[1] It seemed that the time might be at hand when large quantities of radioactive material could be produced through fission and used by medicine, industry,[2] and the military.*[3] There remained, however, some fundamental difficulties in the science of physics that had to be overcome before the scientists could realize their hopes. The requisite financial support was certain to surpass the resources of institutional endowments, and it was only a matter of months before the scientists appealed to the government for aid. Their plea was fortified by the international crisis of 1939. The result was the establishment of

*Prior to the development of atomic energy, medical application of radium was kept to amounts measured in terms of grams. Now twentieth century physics promised new radioactive elements that could be produced in quantities corresponding to equivalent tons of radium. The idea of the medical significance of fission seems to have been regarded as particularly important by those who participated in the work.

The scientists also knew that the amount of energy released by a radioactive material would be very large per unit weight and might therefore serve as a fuel for driving ships or aircraft. It was foreseen, however, that the psychological effects of various radiations would make it necessary to provide elaborate shields for the operating crews. It appeared that proper protection could only be had through the use of large amounts of lead thereby creating a serious problem of weight for airplanes. On the other hand, the quantities of lead shielding would pose no insuperable difficulties in utilizing the new energy as power for ships or in production plants.

The scientists were also aware that atomic energy might be used to construct extremely dangerous bombs and in view of the threat Hitler was then holding over Europe, such weapons in the hands of the free world might well prove to be the means of salvation. The effect of these weapons could be no more than roughly estimated although the blast would far exceed the destructive power of TNT.

Such were the thoughts held by those who understood the significance of proven fission.

MANHATTAN District and the creation of atomic bombs in time to be used during the last days of the war against Japan.

The Appeal of Scientists for Government Aid

It was clear to all scientists conversant with nuclear physics that, if atomic energy was ever to be made applicable either to industrial or military usage, a chain reaction would be necessary. The experiments in Europe and at Columbia University had split the atoms of U-235 by bombarding them with slow neutrons. This technique was entirely laboratorial. If a chain reaction was possible it would depend upon the internal, self-bombardment of U-235 by its own fast neutrons in their effort to escape. No one knew whether, under these circumstances, a chain reaction was feasible. Dr. Enrico Fermi maintained that if the fission process could be begun there would be released not only energy but also a few fast neutrons from the split atoms, and they could be utilized to perpetuate a form of atomic bombardment that would be a chain reaction.

It was objected that Fermi's theory could not account for the existence of uranium for, were his ideas correct, the element would have exhausted itself centuries before. A theoretical answer was supplied by Niels Bohr and J. A. Wheeler, an American. They pointed out that the fission achieved in experimenting with U-235 would not have been tolerated by U-238. The explanation accounted for the continued existence of uranium but it posed another problem. The only known isotope that could be broken down by fission was U-235 and it was found only as one part in 140 parts of U-238. It would require 140 pounds of U-238 to supply one pound of U-235. More than that, there was no known method by which U-235 could be separated from U-238 in usable quantities.[4]

An additional difficulty was the fact that in 1939 uranium was very scarce.# Only moderate quantities had been found in the United States, though the total deposit in Canada was estimated as 3,000 tons. There were also approximately 1,500 tons in Czechoslovakia but already that country was under the domination of Nazi Germany. Large amounts of uranium ore were in the Belgian Congo and undetermined quantities in Russia but neither was a convenient source for the United States.[5]

Before the fission of U-235 could acquire a practical significance, therefore, three requirements had to be met—Fermi's theories had to be substantiated; sufficient quantities of U-238 had to be obtained to insure an ample supply of U-235; and means had to be devised to extract U-235 from the U-238. Hundreds of scientists would have to be employed in a cooperative effort to develop and perfect new techniques. Millions of dollars would have to be spent in building and equipping new laboratories as temples of science. The time had come for large-scale engineering in scientific research.## There was only one way in which all these needs could be met in a few years. The government of a great power would have to lend its authority and its wealth to the program.

As the year 1939 advanced it was filled with fear. In Asia the Japanese pursued a vicious imperialism that defied world opinion. In Europe crisis led to crisis and western appeasement of

#The doctrine of scarcity, recognized in 1939, continued to be held through 1948 and into 1949. After the end of World War II scarcity of fissionable material played an important part in shaping the policy both of AAF and USAF in their part of the overall atomic energy program.

##This same point was made indirectly by Arthur Holly Compton, Atomic Quest, (New York, 1956), p. 5.

Nazi Germany was followed by the Communist alliance with Hitler. Between Germany and Russia lay Poland. Her hour struck in September when the Nazis crossed her border from the west. A few days later Soviet forces crossed from the east. France and England cast feeble declarations of war at Germany and the world settled down into the dark night of terror and extermination.

At the same time that the tragedies of World War II were being unlosed, Einstein, Meitner, Bohr, Wheeler, Fermi, and others were concerned with ways and means of making their recent discoveries of value to the nations threatened by the totalitarian aggressor. In March 1939 the physicists made a futile attempt to interest the Navy through Rear Admiral S. C. Hooper, Director of Technical Division, Office of the Chief of Naval Operations.# The scientists knew there was no

#On 16 Mar 1939 George B. Pegram, Chairman of the Department of Physics, Columbia University, wrote the following letter to R Adm Hooper:

"Experiments in the physics laboratory at Columbia University reveal that conditions may be found under which the chemical element uranium may be able to liberate its large excess of atomic energy, and that this might mean the possibility that uranium might be used as an explosive that would liberate a million times as much energy per pound as any known explosive. My own feeling is that the probabilities are against this, but my colleagues and I think that the bare possibility should not be disregarded, and I therefore telephoned....this morning chiefly to arrange a channel through which the results of our experiments might, if the occasion should arise, be transmitted to the proper authorities in the United States Navy.

"Professor Enrico Fermi, who, together with Dr. Szilard, Dr. Zinn, Mr. Anderson, and others, has been working on this problem in our laboratories, went to Washington this afternoon to lecture before the Philosophical Society in Washington this evening and will be in Washington tomorrow. He will telephone your office, and if you wish to see him will be glad to tell you more definitely what the state of the knowledge on this subject is at present."

This letter was quoted in full by Laura Fermi in her very interesting book, Atoms in the Family (Chicago, 1954), p. 162. Fermi was courteously received and thanked for his trouble and that was the end of the matter. Commenting on the incident, Compton wrote in

(Cont'd on following page)

time to accept delay. If the Nazis were the first to master atomic energy* they might overwhelm both Europe and the United States. In July Leo Szilard and Eugene Wigner discussed the matter with Einstein who agreed that a letter, composed jointly by several scholars, should be addressed to the President informing him of the danger and asking government support for future research in nuclear physics. The letter was completed and signed by Einstein on 2 August 1939.** 6 It was

(*Con't from preceding page)
his book, Atomic Quest, p. 26: "The obvious weakness of Pegram's warning was its super-caution. The Navy would not understand that for an academic scientist even to make such a suggestion as this meant that he considered the matter of urgent importance. How should the Admiral have known that the uncertainty expressed was the professional way of saying, 'Though I'm not sure of its full meaning, here is something vital to the nation's safety. Prudence demands every effort, I mean every effort, to find at once what the possibility of uranium bombs may be.'"

*It seemed probable in 1939 that the Nazis would proceed at once with an extensive and intense atomic energy program. Fortunately, however, Hitler gave but half-hearted support and many German scientists, well versed in nuclear physics were not used in atomic projects. Hahn wrote: "Strassmann and I did not concern ourselves with the harnessing of the complex fission procedures." (Otto Hahn, "The Discovery of Fission," The Scientific American, Feb 1958).

**By 1939, Einstein's doctrines of relativity, particulate energy, and the equation of matter and energy were no longer radical. Much progress had been made in nuclear physics since 1905 and Einstein was venerated as the dean of scientists. His word bore something of the prestige of infallible authority. If he said that atomic energy might be harnessed in the most devastating weapon ever conceived, few laymen would have the temerity to express a doubt. The atomic scientists could not have been wiser, therefore, in persuading Einstein to sign the letter to the President.

Mr. Roosevelt was remarkably far sighted in accepting the risk of supporting the physicists. It may be that his most unassailable claim to greatness will one day depend upon his willingness to accept the ideas of the nuclear physicists. Of course he was well aware of the dangerous isolation surrounding the United States at that time, but it may be that he would have been far less interested in the suggestions had they not come to him above the signature of Einstein. Certainly at no other time in American history would the suggestion have won the support of the White House.

delivered to Mr. Roosevelt personally on 11 October* by Dr. Alexander Sachs, and it is here quoted in full:[7]

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island
August 2nd, 1939

F. D. Roosevelt,
President of the United States,
Washington, D. C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable--though much less certain--that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an inofficial (sic) capacity. His task might comprise the following:

*It may be that the Roosevelt-Sachs meeting did not take place until 12 October. The accounts of the conference are not clear on this point. However, the discussion undoubtedly occurred either 11 or 12 October.

a)to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action giving particular attention to the problem of securing a supply of uranium ore for the United States;

b)to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsacker, is attached to the Kaiser-Wilhelm-Institute in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,

/s/ A. Einstein
(Albert Einstein)

After the President read the letter, Sachs went into more detail and elaborated the problems of atomic energy and the potentialities of its untapped power.[8] Whether the ideas were altogether new to Mr. Roosevelt is problematical for he was a well-read man. In any event he realized that he could not afford to overlook nuclear physics in planning for the defense of the United States.[9] His prompt action is indicated in the note of acknowledgment sent to Einstein on 19 October 1939:[10]

I want to thank you for your recent letter and the most interesting and important enclosure.

I found this data of such import that I have convened a Board consisting of the head of the Bureau of Standards and a chosen representative of the Army and Navy to thoroughly investigate the possibilities of your suggestion regarding the element of uranium.

I am glad to say that Dr. Sachs will cooperate and work with this Committee and I feel this is the most practical and effective method of dealing with the subject.

Please accept my sincere thanks.

Government Support for an Atomic Program

The Board which the President mentioned to Einstein was known officially as the Advisory Committee on Uranium. It was composed of Dr. L. J. Briggs, head of the Bureau of Standards, who served as chairman, Colonel K. F. Adamson of the Army Ordnance Department, and Commander G. H. Hoover of the Navy Bureau of Ordnance. The Committee was directly responsible to the President and it maintained contact with the scientists through Sachs. It also had liaison with three other important scientific agencies of the Government--the National Academy of Sciences (NAS), the Council of National Defense (CND) and the National Research Council (NRC).

Each of these organizations had a long history of its own. The self-perpetuating Academy of Sciences was established by Act of Congress on 3 March 1863 to direct scientific endeavors applicable to the military problems of the Civil War. In later years the Academy continued its work by investigating, at Government request, any subject pertinent to science. In 1916, when faced with the probability of another war, President Wilson wanted to coordinate industries and resources "for the national security and welfare." To this end he created the Council of National Defense consisting of the secretaries of War, Navy, Interior, Agriculture and Commerce. Like the Academy, the Council was placed on a permanent basis, reported to the President and could organize from time to time such subordinate bodies as might assist in the work. Demands on scientific research became so heavy during the war that on 11 May 1918 the President removed a committee from the Academy, reorganized it as the National Research Council and placed it on a permanent basis "to stimulate research in the mathematical, physical and biological sciences." The Research

Council too was responsible to the President.[11]

Between 1918 and 1939 there were no fundamental changes in the organization or functions of NAS, CND and NRC, nor were any changes made during the first six months after the Committee on Uranium began its work, October 1939-April 1940. Then in May the Germans suddenly occupied the Netherlands and Belgium, outflanked the Maginot Line, defeated France and threatened to invade the British Isles. The prospect of a Nazi victory in Europe revealed the need for an overall organization of American science for war. Four Americans of outstanding academic reputations--Dr. Vannevar Bush, Dr. Karl T. Compton, Dr. James B. Conant and Dr. Frank B. Jewett*--went to President Roosevelt and urged immediate action to remedy the situation. On 27 June 1940 the Council of National Defense, acting under instructions from the President, established the National Defense Research Committee (NDRC). Its purpose was "to coordinate, supervise, and conduct scientific research on the problems underlying the development, production, and use of mechanisms and devices of warfare, except scientific research on the problems of flight." In addition, Vannevar Bush, who was chairman of the Committee, was in direct

*In 1940 Bush was President of the Carnegie Institution of Washington, Compton was President of Massachusetts Institute of Technology, Conant was President of Harvard University, and Jewett was President of the National Academy of Sciences.

Dr. Karl T. Compton was the brother of of Dr. Arthur Holly Compton, whose book, Atomic Quest, was quoted on p. 1 of the Introduction.

personal liaison with Briggs, Chairman of the Advisory Committee on Uranium.[#12]

Although NDRC did an excellent job as an advisory committee to the Council of National Defense, it did not bridge the many gaps that existed between the completion of research and the beginning of procurement. It was essential for NRDC to carry its research projects through an intermediate phase of engineering development. Bush was not satisfied with the limitations of his work and urged a reorganization that would combine research and development in one agency. The President approved these ideas and on 28 June 1941 established by Executive Order the Office of Scientific Research and Development (OSRD). The Director, Dr. Vannevar Bush, was to be assisted by an Advisory Council** and by a new National Defense Research Committee.

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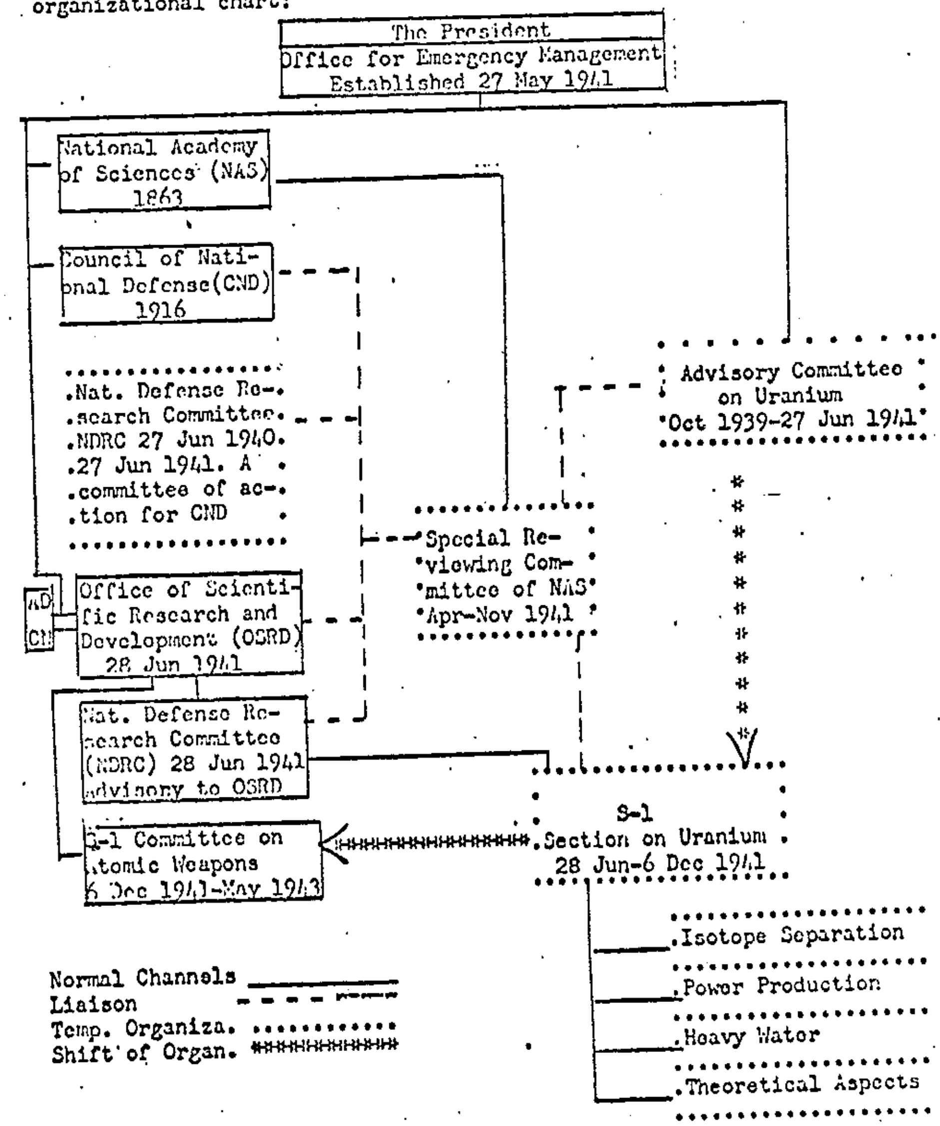
*In addition to Bush, NDRC consisted of R Adm H. B. Bowen, C. P. Coe, K. T. Compton, J. B. Conant, F. B. Jewett, Brig Gen G. V. Strong—soon succeeded by Brig Gen R. C. Moore—and R. C. Tolman. The latter was professor at the California Institute of Technology and Coe was the Commissioner of Patents.

**The Advisory Council consisted of the Director of OSRD, Vannevar Bush, the Chairman of the new NDRC, the Chairman of the Committee on Medical Research, and one representative each of the secretaries of War and Navy.

The latter, under the new setup, was to be concerned largely with the mobilization of scientific personnel and the character of contracts between the Government and universities, institutes and industrial laboratories. At the same time that these important changes were made, the Committee on Uranium was reorganized and made the S-1 Section of the new NDRC.[13]

The four subsections of the Uranium Committee dealt with isotope separation, power production, heavy water, and theoretical aspects. Not one of them was directed toward a definite war objective, and as late as April 1941 the members of the Committee believed that the uranium research would contribute nothing to the military. The situation throughout the world, however, made it apparent that time was running out on American neutrality and the question was whether the uranium project should be postponed until the end of the war in order to give greater support to programs that were of more value to the Armed Services. In April 1941 Briggs, as Chairman of the Uranium Committee, requested the National Academy of Sciences to appoint a committee of its own to review and evaluate the work on uranium. Within a matter of days the Academy set up the Special Reviewing Committee chairmanned by Dr. Arthur Holly Compton who was assisted by some of the most distinguished scientists in the country.* The Committee's

*The other members of the Committee were W.D.Coolidge, E.O.Lawrence, J.C.Slater, J.H. van Vleck, B. Gheradi, O.E.Buckley, L.W.Chubb, W. K.Lewis, R.S.Mulligan, and G.B.Kistiakowsky. The place of the Committee in the overall scheme of Government agencies interested in one way or another in the atomic program is shown by the following organizational chart:



work was invaluable in what appears to have been the most critical phase of the whole war-time Atomic Energy Program.[14]

As soon as organized the Committee began the preparation of its First Report which was issued 17 May 1941. It evaluated the progress made to that time. Perhaps in the future atomic power might be used for propulsion of ships and submarines. There was as yet no way of establishing a controlled nuclear chain reaction and before a bomb could be manufactured it would be necessary to find a way to separate U-235 from U-238 and to accumulate many pounds of the fissionable material. Nevertheless the Committee recommended that further study should be made of the uranium program. Even in the second report, issued 11 July, the Committee showed no optimism for the program as an aid in the development of new weapons, but counseled continuation of research and the establishment of a central laboratory to further the study of chain reaction.[15]

Shortly thereafter there were the first unmistakable signs of a breakthrough. Scientists at Columbia reported good results in their efforts to separate U-235 from U-238. Of even greater promise for the immediate future were experiments confirmed at Berkely, under the direction of Lawrence, in the transuranic elements which had so puzzled the scientists in Berlin in 1937. He found that when U-238 was cyclotronically bombarded with neutrons there was a yield through transmutation of a new element, No 93 later called neptunium. This element in turn was unstable and quickly changed into No 94, eventually called plutonium. When this latter element was bombarded with slow neutrons it proved to be more easily fissionable than U-235.* Thus two items appeared at about the same time that advanced the

*Americium was created in 1944-1945, and curium in 1946.

probabilities of an atomic bomb—the separation of U-235 from U-238 and the derivation of plutonium from U-238 as a new fissionable material.* In addition, the members of the Reviewing Committee were familiar with the recent accomplishments of the British physicists. The latter had concluded that much less U-235 would be required for an atomic explosion than had been originally calculated by the Americans. The British views were confirmed by Enrico Fermi at Columbia. Consequently by the time that the Committee prepared its third and final report, the recommendation was made that every effort should be bent toward perfecting a fission U-235 bomb.[16]

The report was submitted to Vannevar Bush on 6 November 1941 and three weeks later reached the President's Committee consisting of the President, the Vice President, the Secretary of War, the Chief of Staff USA, Dr. Conant and Dr. Bush. The recommendations of the Reviewing Committee were approved and the President acted promptly to permit implementation. On 6 December the S-1 Section of NDRC was abolished and an S-1 Committee, composed of James Conant, chairman,

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*Compton has explained the process by which plutonium is created as follows:

"We have already explained that uranium 238 captures many of the neutrons but does not undergo fission as a result. It is this that makes it so difficult to effect a chain reaction in the normal mixture of U-238 and U-235 isotopes. What happens when a U-238 nucleus catches a neutron is simply that its mass is increased by one unit. Thus it becomes U-239. This nucleus is, however, radioactive. It emits an electron of charge minus 1 and of very small mass. This loss of one unit of negative charge increases the atomic number from 92, uranium, to 93. The name given to the new element number 93 is 'neptunium.' The atomic weight remains unchanged at 239.

"Neptunium 239 is also radioactive, giving off another electron. The nucleus then has the atomic number 94, still retaining an atomic mass of 239. This new element, No. 94, is called 'plutonium,' with the abbreviation Pu.

"It takes about two days for half of the U-239 to become transformed to Pu-239. After two weeks the transformation is practically complete."

Arthur Holly Compton, The Atomic Quest, p. 50-51.

L. J. Briggs, E. V. Murphree,* E. O. Lawrence, Harold Urey and A. H. Compton, was established in NDRC. Conant was thus immediately responsible to Bush who continued to have direct access to the President's Committee and to the President personally. The function of the Committee was to direct and coordinate the various research projects in the Atomic Energy Program. The great problem remained that of obtaining sufficient fissionable material to permit the manufacture of an atomic bomb, and it was decided to pursue both the separation of U-235 and the creation of plutonium. Urey was made responsible for coordinating two gaseous diffusion methods at Columbia University; Lawrence was to supervise a magnetic separation work at the University of California; Murphree was to direct studies in a centrifuge method at the Bayway Laboratory of the Standard Oil Development Company of New Jersey. Compton was given the task of producing plutonium at the University of Chicago, and of designing the bomb.** The latter work, however, delegated to Gregory Breit at the University of Wisconsin, was not given immediate emphasis. There was no point in having a weapon designed unless it was possible to obtain an adequate amount of fissionable material. Moreover it was understood that when the time came to make the bomb, the work would be turned over to the War Department.[17]

*E. V. Murphree was Director of Research for the Standard Oil Company of New Jersey and therefore had at his disposal the facilities of the Bayway Laboratory. Murphree was assisted by J. W. Beams at U. Va.

**Breit, a theoretical physicist, was selected by Compton to start work on the bomb design and for all practical purposes he headed a group of physicists in a number of other universities who began collecting pertinent data which was of importance somewhat later when the chain reaction guaranteed that in time there would be enough fissionable material to permit the construction of a bomb.

The Committee met in Washington quite frequently, about once every two weeks, and despite serious obstacles and difficulties, substantial progress was made in the four endeavors being conducted to obtain fissionable material. Under these circumstances Bush submitted an important paper to the President on 9 March 1942 making the following points:

1. The scientists engaged in the program believed that an atomic bomb was feasible.
2. If the bomb was to be made it would be necessary to construct:
   a. A gas diffusion pilot plant for the separation of U-235;
   b. An electromagnetic plant for U-235;
   c. A thermal diffusion plant for U-235.
   d. An atomic pile plant for the production of plutonium.
3. Responsibility for the construction of these plants should be given to the Chief of Engineers, CE, USA.

The report was approved by the President's Committee in due time and was initialed by the President on 17 June. The next day the Chief of Engineers instructed Colonel J. C. Marshall to form a new district to undertake the work.[18]

The Era of MANHATTAN District

On 13 August 1942 Colonel Marshall activated the MANHATTAN District.* Its activities at first were limited entirely to the construction of the plants required for the production of fissionable material. Later, in the spring of 1943, the authority of the District was extended to

*The authority of the President and the Secretary of War to create and administer MANHATTAN District was derived from Public Law 703, 76th Congress, 3rd Session, 2 Jul 1940; PL 354, 77th Congress; 1st Session, 18 Dec 1941; PL 507, 77th Congress 2nd Session. These three laws legalized the construction, contracts and acquisition of real property by MANHATTAN District.

include responsibility for the scientific research work that was also part of the atomic energy program.[19]

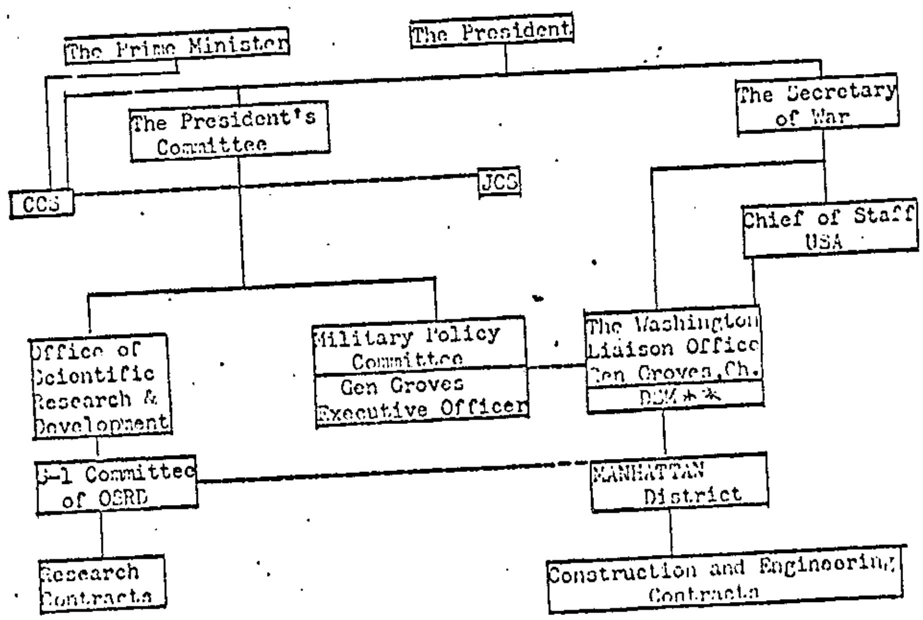
The Production of Fissionable Material, August 1942-July 1945

The MANHATTAN Headquarters was originally located in New York but it was soon moved to Oak Ridge, Tennessee. In the summer of 1943 Marshall went on to other duties and Colonel K. D. Nichols assumed command of the District and served in that capacity until the end of 1946. During all that time Headquarters remained small and consisted of not more than fifty officers. Operations were conducted through a large number of contractors with whom MANHATTAN maintained contact by area engineers, each with a small staff of his own. Probably there were never more than 1,200 officers and 3,000 enlisted men assigned to the District itself and the great number of people generally associated with MANHATTAN were civilians employed by the contractors.

A few weeks after the activation of MANHATTAN, the Secretary of War concluded that there should be an agency to correlate all the atomic activities and on 17 September 1942 selected Colonel Leslie R. Groves to do this work as the head of a "Washington Liaison Office." Groves, who became brigadier general on 23 September 1942 and a major general on 9 March 1943, held a unique position. He was directly responsible to the President, the Secretary of War and the Chief of Staff, USA; he was also the immediate superior of the Commanding Officer, MANHATTAN District, and maintained personal liaison relations with the S-1 Committee of OSRD and with the Military Policy Committee which he served as Executive Officer. This last mentioned responsibility was particularly important because the Committee related the Atomic Energy Program to the Global Strategy of the Joint Chiefs of Staff and through them to the Combined Chiefs of Staff. Thus from

September 1942 until April 1943 Groves coordinated the decisions of ; the Military Policy Committee, the scientific projects directed by the S-1 Committee through its research contracts, and the work of MANHATTAN District as performed through its engineering and construction contracts. It was also Groves' duty personally to inform the President, the Secretary of War and the Chief of Staff, USA, of the progress made.* The Secretary of War designated all of Groves' many activities as the Development of Substitute Materials (DSM). ** 20

*Organization Chart of atomic activities Sep 1942-Apr 1943:



**DSM was not an agency; it was a collective term for all atomic energy activities under the coordination of Groves.

After his indoctrination as Chief of the Washington Liaison Office Groves saw that there were eight problems to be met and solved with the least possible delay:[21]

1. Establishment and maintenance of a security system that would brook no violation of secrecy.
2. Construction of plants for manufacture of fissionable material.
3. Realization of unprecedentedly slight tolerances in the machinery to be employed.
4. Efficient operation of plants and machinery in the most difficult manufacturing processes ever attempted.
5. Completion of the research needed for the military use of atomic energy.
6. Development of special techniques called for by atomic energy.
7. Design, construction and test of an atomic bomb.
8. Careful planning for the use of atomic weapons against the enemy.

The security program was remarkably successful. From the summer of 1942 until August 1945 the Atomic Energy Program was the most carefully guarded secret of the war. That secrecy prevailed was the more wonderful because there was already widespread knowledge among those interested in science that an atomic bomb was possible,* and also because of the large number of people employed under MANHATTAN industrial contracts. Probably there was no serious breach of security** because Groves insisted on a policy of compartmentlized knowledge so that many of those engaged in MANHATTAN activities did not understand

*One example will suffice to prove the point. In the early days of the Atomic Energy Program, one representative of the University of California wrote that "a small piece of uranium metal, composed entirely...(of atoms of weight 235) should act like a bomb and explode with far greater violence than any known explosive." (Harvey C. White, Classical and Modern Physics (New York, 1940), pp. 615-616.

**This applies to the Germans and Japanese, not to the Russians.

the nature or purpose of their work.

Security, however, though of utmost importance, was only a protective measure. Groves' primary objective in 1942 and the first few months of 1943 was to construct and operate the plants to supply the needed amounts of fissionable material. It was here that he faced an unavoidable delay. He did not want to invest enormous sums in buildings and machinery unless there was good reason to believe either that U-235 could be separated from U-238 or that plutonium could be created and chemically extracted from U-238 in greater quantities than those of a laboratory experiment. In this matter Groves had to depend upon the advice of the nuclear physicists and he relied upon the S-1 Committee of OSRD as an advisory cabinet on nuclear science. The S-1 Committee in turn depended upon the results achieved in various universities and laboratories under the terms of numerous research contracts.[22]

In February 1942, seven months before Groves came to head the Liaison Office, Dr. A. H. Compton of the S-1 Committee got permission from the University of Chicago to organize a secret project, known as the Metallurgical Laboratory, in the squash court under the west stands of the Stagg Athletic Field. Here Compton directed the attempt to secure plutonium and he invited Fermi to come from Columbia to construct an atomic pile or reactor. The principle was simple, but whether it would operate no one knew. The idea was to slow down the neutrons derived from the spontaneous fission of U-235 atoms scattered through a given amount of uranium so that they might be captured by other U-235 atoms and set up a chain reaction. The latter would liberate enough neutrons to transmute some of the U-238 into neptunium and thence into plutonium. Fermi's scheme was to surround small quantities of uranium in nests of graphite which would serve as a moderator. Control of the reaction was by the use of cadmium or boron steel bars, or both of them, since either could absorb neutrons and shut off a chain reaction at any given moment. Construction of the reactor began 7 November. It was ready for testing on 2 December 1942 and its consequent successful operation meant that the atomic age had come.[#23]

The success of 2 December convinced Groves that the production of plutonium should be pushed as rapidly as possible, and this decision led to vast projects of construction. Within a matter of weeks the Metallurgical Laboratory was moved from the squash court to buildings newly erected in the Argonne Forest outside of Chicago and thereafter it was known as the ARGONNE Laboratory. It was there that further research was carried on in graphite and heavy water reactors. But that was not enough. The main reactor was to be built at Hanford, Washington, on the Columbia River. Because this work would require time, Groves determined to set up a pilot or intermediate plant at Oak Ridge, Tennessee, to supply sufficient plutonium for further experimentation.[24]

It was also in January 1943 that Groves decided to begin at the earliest time possible the construction of plants that would separate U-235 from U-238. Thermal and gaseous diffusion, and magnetic separation plants were built at Oak Ridge along with the plutonium pilot

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"It was the middle of the afternoon before the preliminary tests were completed... Finally Fermi gave Weil the order to draw out the control rod another foot. This we knew meant that the chain reaction should develop on an expanding scale. The counters...faster and faster until...the meters showed a reading that meant the radiation...was beginning to be dangerous. 'Throw in the safety rods! came Fermi's orders. They went in with clatter. The spot of light from the galvanometer moved back to zero....Atomic power! It had been produced, kept under control, and stopped. The power liberated...marked a new era in man's history." Compton, Atomic Quest, pp. 142-143.

plant.[25]

The growth of MANHATTAN was amazing. Except for the small ARGONNE Laboratory in Chicago, no construction was begun before the spring of 1943. By June 1944, MANHATTAN operated facilities in approximately thirty cities, and possessed 59,000 acres of land in Tennessee, over 400,000 acres in the State of Washington, and 45,000 acres in New Mexico. The District employed 129,000 persons of whom 10,000 were scientists and technicians. The cost of the atomic energy program rose proportionately. In February 1940 the President transferred $6,000 from Army and Navy funds as financial support for the early plans of the Uranium Committee. By November 1940 an additional $40,000 was acquired for further experiments. On 1 November 1941 the Government entered into contracts connected with the program that amounted to $300,000. In March 1942 it was seen that additional research, to be conducted under OSRD, would require $31,000,000 and that at least $54,000,000 would have to be appropriated for construction. In 1944 the annual payroll of MANHATTAN was somewhat more than $200,000,000, and the overall cost of the program had mounted to $2,000,000,000.[26]

The investment was not in vain.

Fortunately, before MANHATTAN was activated, the United States Government acquired a sufficiently large amount of 65% uranium ore to supply the needs of the reactors and the separation installations. In 1940 a ship bearing 1200 tons of ore from the Belgian Congo made its way to Antwerpt. Before the cargo was unloaded the Germans staged their invasion of the Netherlands and Belgium. When it was seen that nothing could halt the Nazi advance the ship sailed for New York and arrived safely. Edgar Songier, director of the Kantaga Congo mines, had the ore stored a warehouse. More than a year later, when the atomic energy program was well under way, the Government procured the entire amount.*

The next step was to produce pure metallic uranium from the ore. After the scientist tested several methods in many universities, the Mallinckrodt Chemical Works contracted to perform the purification and in May 1942 had sixty tons of the metal available. It was this material which made possible the reactors in Chicago, Oak Ridge and Hanford, as well as the electromagnetic, gaseous diffusion and thermal diffusion, plants in Tennessee. All of these plants were very complex and each of them marked a phase in the transition of science from the laboratorial to the industrial and engineering stage.** By March 1944 the pilot

*This interesting incident was recounted for the first time by Arthur Holly Compton in 1956 in his book, Atomic Quest, p. 96-97. Compton himself does not seem to have known it until long after the war, but he got it direct from Sengier.

**The reactor at Oak Ridge was a cube, 24'x24'x24', made of thousands of pieces of graphite, supplied by the National Carbon Co. and the Speer Carbon Co. The pile was air cooled, and the uranium was placed in aluminum cylinders four inches long and one inch in diameter. The control rods were boron steel. The reactor was constructed and installed by E.I. du Pont de Nemours and Co. without profits or patent rights. The pilot reactor began to operate 3 Nov 1943. The reactors at Hanford were larger and they were water cooled by tapping the Columbia River. With each reactor there had to be a chemical plant to separate the plutonium from the uranium.

Both the electromagnetic and gaseous diffusion processes were derived from the fact that U-235 was not as heavy as U-238. This made it possible in the electromagnetic diffusion to separate the U-235 from the U-238 atoms by whirling them through a magnetic field and sending them out on two divergent paths toward two different containers. In the gaseous diffusion system, the different mass of U-235 and U-238 made it possible to separate the atoms by reducing the uranium metal to uranium gas. The latter was pumped into a chamber divided into two parts by a thin porous barrier with billions of submicroscopic perforations. The U-235 atoms, being lighter than the atoms of U-238, moved faster and a greater number of them penetrated the barrier and passed into the second half of the chamber. So slight were the filtering effects, however, that the gas had to be passed through

(Cont'd on following page)

reactor at Oak Ridge was producing several grams of plutonium a month. The electromagnetic plant, known in code as Y-12, was less successful than anticipated, but it produced the first usable amounts of U-235. The gaseous diffusion plant, coded as K-25, soon made its own contributions and a gradual accumulation of U-235 began ~~the amount of U-235 increased rapidly~~ during the last few months of 1944. The thermal diffusion plant was unsatisfactory and in the end was used only to assist in the work being done by Y-12 and K-25.[27]

By the early summer of 1945 the plants had produced enough fissionable material to insure the completion of a few bombs, both of the U-235 gun-type and the plutonium-implosion type, for use against the Japanese Empire.

<u>Making the Bombs at Los Alamos, April 1943-July 1945</u>

During the first six months of 1942 Gregory Breit continued to coordinate the data that was pertinent to the actual construction of an atomic bomb. In the summer, however, it was evident to the S-1 Committee that more positive action would soon be required and Compton, as head of the Metallurgical Laboratory, invited Dr. J. Robert Oppenheimer from Berkeley to Chicago to undertake the actual design of the weapons. Oppenheimer selected a group of very eminent theoretical physicists and in June he returned to California and began the work. Progress was so great that by September 1942 Oppenheimer's

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(*Cont'd from preceding page)
approximately 4,000 barriers before a satisfactory purity of U-235 was attained. For these reasons K-25, or the gaseous diffusion plant, became the largest plant in the world.

Construction of Y-12 began in March 1943. The parts were manufactured by Westinghouse, General Electric, and Allis-Chalmers. The K-25 plant was designed by M.W.Kellogg Company, constructed by J. A. Jones Company and operated by Carbide and Carbon Chemicals Corporation. These facts give some idea of the number of contracts made by MANHATTAN District with commercial and industrial firms in the course of the wartime Atomic Energy Program.

group had to consider the possibility that an atomic explosion might trigger an earth shattering detonation of nitrogen in the atmosphere or hydrogen in the sea. Detailed calculation proved there was no danger of such catastrophies but definitely established the possibility of a super-blast hydrogen bomb triggered by an atomic device. The idea was discarded for the time being, however, and work went forward on preliminary plans for atomic bombs. It was at this point Groves came into the program.[28]

At the same time there was a general feeling among the scientists of the S-1 Committee, the Metallurgical Laboratory and Oppenheimer's group that the site for further work on the bomb should be more sequestered. Groves was in agreement and in November 1942 he and Oppenheimer selected Los Alamos, usually referred to as "the Hill", for further research on Project Y, code name for the development of the weapons. Situated on a large mesa or shelf about sixty-five air miles north of Albuquerque, New Mexico, and about twenty-five air miles northwest of Santa Fe, Los Alamos was ideal for the type of work to be done. The shelf projected from the western mountains like a finger from a clenched fist and rose precipitously from immense chasms to the north, east, and south. Without railroads and approached only by a winding highway, the tableland possessed something of the quality of a medieval castle after the closing of a drawbridge. Entrance could be carefully checked, and eventually a small runway strip on the east end of the mesa accommodated Beechcraft flying in from Albuquerque. Beyond this rampart was ample space for living quarters, a laboratory and a proving ground. The area was turned into a military reservation and placed under constant guards whose challenge meant obedience or death.

In January 1943 procurement of Project Y material got under way, and the University of California contracted LASL personnel to MANHATTAN.

Ten weeks later, 15 March, Oppenheimer and a few members of his staff arrived at Santa Fe. They set out at once for the Laboratory though it was not activated until 1 April. For administrative purposes it was organized into several divisions* each of which reported to Oppenheimer. On paper, Oppenheimer was responsible to Colonel Nichols, the head of MANHATTAN District, but in practice and by verbal agreement, Los Alamos became another province and Oppenheimer reported directly to Groves.**

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*In the course of the next two years, 1943-1945, the organization was changed several times, and the number of divisions varied slightly from time to time. In the spring of 1945 there were seven divisions and the organization of the Laboratory was as follows:

J. Robert Oppenheimer, Director

1. H. Berthe, Chief of the Theoretical Physics Division.
2. R. R. Wilson, Chief of the Experimental Nuclear Physics Division.
3. J. W. Kennedy, Chief of the Chemistry and Metallurgy Division.
4. Capt W. S. Parsons, USN, Chief of the Ordnance Division.
5. G. B. Kistiakowsky, Chief of the Explosives Division.
6. R. F. Bacher, Chief of the Bomb Physics Division.
7. Enrico Fermi, Chief of the Advanced Development Division.

Henry De Wolf Smyth, Atomic Energy for Military Purposes, (Princeton, 1946), p. 214.

**This point was made very clear in the course of the Oppenheimer hearings. On 15 April 1954 General Groves said:

While "the laboratory officially was under General Nichols, because the whole district was under Nichols, by an understanding between Nichols and myself, because that left me doing nothing but telling Nichols what to do, and it was beyond his capacity to do everything, in general a division of direct responsibility was made, and Nichols took over essentially Oak Ridge and the general administration. With respect to Los Alamos, it was directly my responsibility in every way, everything that happened. The orders were issued direct. We tried to keep Nichols informed to such extent as was necessary. So from a practical standpoint, though not on paper, the chain of command was direct from me to Dr. Oppenheimer."

AEC, In the Matter of J. Robert Oppenheimer, transcript of hearing, 12 Apr-6 May 1954 (Washington, 1954), p. 171-172.

The activation of the Laboratory meant that the entire atomic energy program was under the direction and control of the War Department. With its great work practically complete, the S-1 Committee began a slow phaseout.

British and Canadian Contributions. In 1939 many British physicists were leaders in the field of nuclear research. Therefore they were not surprised in March 1950 when Professor Robert Peierls and O. R. Frisch--who had recently come to England--suggested that uranium bombs be attempted. Sir Henry Tizard, Chairman of the Committee for Scientific Study of Warfare, created a subcommittee headed by Sir George Thomson to consider the feasibility of such weapons. In April the subcommittee became an independent committee and operated under the cover name of MAUD.[29] Its function was to coordinate various atomic research projects and to determine the feasibility of developing a fission bomb within the period of the war.[30]

The scientists in England, like those in the United States, were at first primarily concerned with the problem of obtaining sufficient fissionable material to guarantee an atomic detonation. The British gave much thought to ways of separating U-235 from U-238. They soon concluded that gaseous diffusion would be the simplest and most efficient method and designed a large scale plant. Like the Americans, the British were fully aware of research regions in the transuranic elements and were certainly as far advanced as Lawrence when he performed his experiments that led to the creation of plutonium in early 1941. On 15 July the MAUD Committee drew up a report which summarized the thinking of British physicists as of that date. It concluded that gaseous diffusion would separate U-235 from U-238 in sufficient quantities to permit the construction of a feasible uranium bomb; that U-238 could be transmuted into neptunium and then into plutonium in a heavy water moderator system; and that plutonium could be chemically separated in usable quantities from U-238 and could be employed in a plutonium bomb.[31] The accomplishments of the British physicists, though here meagrely presented, are enough to show that between 1939 and 1941 the British atomic energy program paralleled that of the United States.[#]

Through the excellent personal relations that Bush and Conant had with the British physicists, there was early contact between the Advisory Committee on Uranium and MAUD. Also, Lawrence and Frisch cooperatively exchanged plutonium data, 1940-1941. On 11 October 1941 President Roosevelt, prompted by Bush, sent a letter to the Prime Minister suggesting that the British and American efforts might be beneficially conducted on a joint basis. The Prime Minister was

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[#] The first step after the creation of Thomson's Committee "was to establish the nuclear data on which depended the possibility of an atomic bomb and which determined its size. This work had already begun at Liverpool early in 1940 under Professor Sir James Chadwick and it was now pushed on more rapidly with Drs. Frisch and Rotblat as his senior collaborators. As the work developed and furthur problems appeared, it was extended to the Cavendish Laboratory, Cambridge, under Drs. Feather and Bretscher....The many theoretical aspects of the problem were investigated by Professor Peierls, assisted by Dr. Fuchs and others in Birmingham University, and also by Dr. M.H.L. Pryce, in Liverpool....Professor Sir Geoffrey Taylor, of Cambridge, examined certain points in connection with the effect to be expected from the explosion of an atomic bomb....Research on...(methods) of separation was taken up by a team of workers under the direction of Dr. F.E.Simon in the Clarendon Laboratory, Oxford. They were aided on the theoretical aspects by Professor Peierls and his group, and on the chemical side by Professor W.N.Haworth and a group of men under his direction in the Chemistry Department, Birmingham University. The Metropolitan-Vickers Electrical Company and Imperial Chemical Industries Ltd. were consulted on the many technical questions which were involved. Some experimental work on the diffusion method was also started at Imperial College, London University." British Information Service Statement, "Britain and the Atomic Bomb," 12 Aug 1945, quoted in full as Appendix 7, Smyth, pp. 272-274.

sympathetic.[32] The next month Pegram and Urey, both of Columbia University, went to England, the first NDRC S-1 Section mission to the Tube Alloy project, as the British atomic energy program was called. The next spring, February-April 1942, a British atomic mission consisting of Mr. W. A. Akers, Dr. H. Halban, R. Peierls and Dr. F. Simon came to America and, through the S-1 Committee of OSRD, brought about a reasonably close coordination between the two programs. As a result, a British-Canadian Research Group was set up in Montreal under the direction of the National Research Council of Canada, in convenient proximity to the Metallurgical Laboratory in Chicago. Halban, along with most of his Cambridge physicists, moved to Montreal and worked with Canadian scientists and a few Americans.[33]

Pearl Harbor brought the British and American programs even closer together. With the United States participating in the war Washington and London agreed to concentrate the whole atomic effort on American soil as a precaution against German bombing. Churchill himself urged the unification of the two programs during his visit to Hyde Park in June 1942. He and the President concluded that, if the bomb could be built, it should be built somewhere in the United States through the joint endeavors of the British and American scientists. Neither nation, however, was ready to implement the decision at the time. In May 1943, a month after the activation of Los Alamos, Roosevelt and Churchill discussed the matter again in the course of the Quebec Conference. The President and Prime Minister agreed that:

1. The United States and the United Kingdom would never use the weapon against each other.

2. Neither the United States nor the United Kingdom would use the weapon against a third party without the consent of the other.

3. Neither the United States nor the United Kingdom would communicate information on the weapon to a third party except by mutual consent.

4. During and after the war the United States and the United Kingdom would freely exchange information on technical developments pertinent to atomic weapons.

5. The British Tube Alloy Research Groups would come to the United States and complete their work in conjunction with the American Atomic Energy Program.*

The British physicists came to America at once. During the remainder of the war there was almost no nuclear research conducted in the United Kingdom, but the British scientists made invaluable

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*In commenting on this agreement Churchill wrote: "I do not think that one could have asked for more. However, in 1946 a measure was passed by the American Congress which most severely curtailed any chance of the United States providing us with information. Senator (Brien) McMahon, who sponsored the bill, was at the time unaware of the Quebec Agreement, and he informed me in 1952 that if he had seen it there would have been no McMahon Act. The British Socialist Government certainly made some sort of protest, but they felt unable to press it home and they did not insist on the revelation of the Quebec Agreement, at least to the McMahon Committee, which would have vindicated our position and perhaps saved us many years of wearisome and expensive research and development." (Winston Churchill, "The Cold 'Peace' and Our Future", Look, 29 Apr 1958.) Churchill seems to overlook the fact that the McMahon Act was drawn up in anticipation of international control which would give all nations information on atomic energy for peaceful use. (See Chapter I, Vol II of this History.) The Quebec Agreement was formally abrogated on 7 Jan 1948. (See Chapter III, Vol III of this History.)

contributions to the work done at Los Alamos,* Montreal, Berkeley and other places in the United States and Canada.[34] The efforts of the three nations were directed by the Combined Policy Committee set up in

*The contributions made by British scientists to the work at Los Alamos was summarized as follows by J. Robert Oppenheimer:
Sir James Chadwick was the initial head of the mission. He served as consultant and advisor to the Director, and as a member of the governing body of the Laboratory which determined technical policy. The specific design of the gun-type weapon was frequently discussed with him, and the actual specification of the weapon agreed with his recommendations. Professor Peierls became head of a group in the Theoretical Division responsible for the calculation and design of the explosion components of the implosion weapon. He played a large part in the determination to use lenses--which he suggested--for the explosive system, and in the theoretical guidance of their experimental development. Sir Geoffrey Taylor contributed indispensable understanding, both to the work on the detonation of atomic weapons by implosion, and to the theory of effects of atomic explosions themselves. His guidance and his calculations proved of the greatest value in the design of the implosion weapons, and in the precautions taken to avoid undesirable hazards at the test explosion at Alamagordo. Professor Niels Bohr--whose son was with him--contributed in a most detailed way to the design of some components of the implosion weapon. In particular, the urchin initiator was devised by him. Dr. William Penney played a decisive part both in the theory and the practical development of the implosion weapons. Dr. Ernest Titterton played a most responsible part in the development of the electronic gear used for the detonation of the implosion bomb. He had the primary responsibility for the electronic measurements carried out at the test explosion at Alamagordo. Dr. Philip Moon worked in the same fields as Dr. Titterton. Dr. James Tuck was closely associated with the experimental work on detonation and shock required for the design of the explosive elements and nuclear core of the implosion weapons. Drs. Fuchs and Skyrme were associated with Peierls in the Theoretical Division. Dr. Marley was responsible for important chemical and experimental work in the Explosive Division. Drs. Bretscher and French and their colleagues worked on the development of the deuterium super-bomb and made the discovery of deuterium's reaction with tritium on which all later work in the field was based. Dr. Frisch invented and operated the nuclear dragon. Drs. Sheard and Littler both participated in the Alamagordo test.
Summing up his statement, Oppenheimer wrote: "From the above brief summary, it will be clear that members of the United Kingdom Mission at Los Alamos played an integral part in a very important and responsible way, in the actual wartime development of atomic weapons." Memo from Lalor, JCS, for Adm Denfield, Gen Bradley and Gen Vandenberg, sub: British Participation in Work at Los Alamos Laboratory, 21 Jul 1949. Encl, as requested by the Deputy to the Secretary of Defense for Atomic Energy Matters: Memo from J. R. Oppenheimer for the US AEC, sub: Participation of the United Kingdom in the Wartime Development of the Atomic Bomb, 15 Jul 1949. (The Mission was established early in 1944 and included twenty scientists.)

August 1943 and consisting of Secretary Stimson, Bush and Conant for the United States; Field Marshal Sir John Dill—who died in 1944 and was replaced by Field Marshall Sir Henry Maitland—and Colonel J. J. Lewellin for the United Kingdom; and C. D. Howe, Minister of Munitions, for Canada. The Policy Committee was advised by a Technical Committee composed of Dr. Richard C. Tolman for the United States, Sir James Chadwick for the United Kingdom and Dean C. J. Mackenzie for Canada.[*35]

<u>The Design and Construction of the First Weapons.</u> The scientists of the Los Alamos Laboratory's Technical Division began their work with the knowledge that nuclear fission would yield 170,000,000 electron volts per nucleus which meant that in U-235 the yield would be 7×10^{17} ergs per gram. The energy from TNT was known to be about 4×10^{10} ergs per gram. From this data the scientists computed

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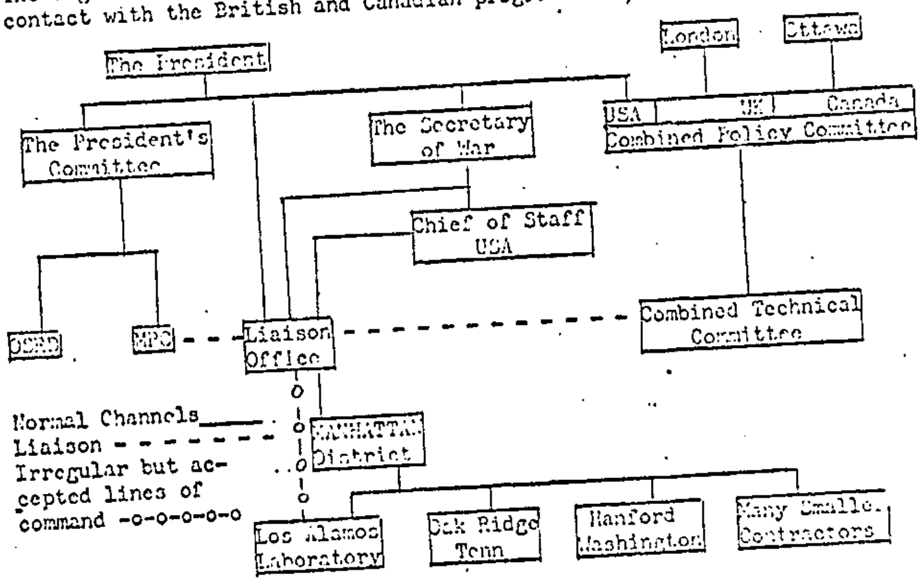
*The organization of the American atomic projects 1943-1945 and their contact with the British and Canadian programs:



that the detonation of a kilogram of U-235, if 100 per cent efficient, would be equivalent in energy release to 17,000 tons of TNT or 17 kilotons (KT).[36] Beyond this edge of calculation there was uncertainty.

The contemplated marriage of fissionable material with the emergent theories of a fission bomb presented a body of contradictory demands seldom encountered before in any scientific project. In brief, the personnel of Project Y had, first, to invent mechanisms for the control and direction of nuclear activity; second, to alliance the mechanisms with flexible methods of determining the altitude of detonation; and third, to adjust the whole machine to the requirements of delivery.

The maximum tolerances of the nuclear world, far below the comfortable levels of practical mechanics, had never been part of traditional weaponry, but would be part of the most elementary plans for atomic bombs.[37] To begin with, fissionable material was per se active, and the period for its inner changes, comparable to billions of years in the astronomical scale, was counted in microseconds. Laboratory experiments had already shown that Uranium 235 in its natural state was subcritical, that is, the material remained relatively stable because too many neutrons escaped without contributing to a chain reaction. The Chicago University experiment of December 1942 proved that under artificial conditions the material could be made critical, that is, a chain reaction could be maintained but controlled to prevent the explosive accumulation of energy. It followed that the material would become explosively supercritical if the chain reaction was unrestricted. At this point a weakness became apparent. Such an explosion would be a low order detonation, a [illegible] streamlet of the weapon's full potentiality. As correction, the [illegible] required a built-in dam to hold back the rising flood until its strength could burst outward in a deluge of energy.

In brief, then, here was a new level of weapon complexity. The bomb would have to accommodate a given amount of fissionable material, preserve its subcriticality indefinitely, convert it with the quickness of magic to supercriticality, and simultaneously withstand the explosive pressures for several generations of the fissioning process. 43 No one ever assumed that the detonation could be postponed until the fission was 100 per cent, but no one knew how long the postponement could be continued, and therefore no one could accurately forecast what the efficiency or the yield of a bomb would be.

Out of these uncertainties two mechanisms appeared on the drawing boards. They were the gun-type and the implosion-type bombs, and they were different in their functioning. The gun-type was the first conceived and eventually, because it was the smaller of the two, it was called the THIN MAN. It was also the simpler and the less problematical. The implosion-type, derived from the idea that a subcritical mass of fissionable material might be compressed into supercriticality, intrigued the physicists. Its first design was discarded as too theoretical--though it later proved to be highly efficient--and the work began over again. Its second version was carried through to production, and because of its size and weight it became known as the FAT MAN. In the course of its development it went through many vicissitudes, sometimes promising, sometimes not. 45

Although both weapons employed the same components, 46 the design of the two bombs was mm radically different, and most of their components in turn had to be separately custom made. Also, from time to time, important changes were made in the way the fissionable material was to be used. For instance, early plans called for the employment of U-235 and Pu-239 in both the THIN MAN and the FAT MAN. But in June 1944, for technical reasons, the plutonium was ruled out for the THIN MAN. It then became strictly a uranium bomb, and its name was changed to LITTLE BOY. However, U-235 and Pu-239 were both used in the FAT MAN.[44]

There were unique problems to be solved in providing the weapons with a sure means of detonating at the right moment and the right altitude of their trajectories. Conventional weapons exploded on impact or, if controlled by timers, after intervals of delayed re-action; and fragmentation bombs were geared to detonate at low altitudes above the target. In each instance the method was simple, but atomic bombs would have to be detonated differently. No one at Los Alamos claimed to know what the yield of an atomic bomb would be, and the tendency was toward under-estimation. But it was common knowledge that if the new weapons worked at all they would detonate with a force far in excess of anything that high explosives could give. That of course was the whole reason for the program, and if the weapons were to be used with their maximum effects, they should detonate high above their targets. Assuming a possible yield of 10-15 KT, it was calculated that the bomb should burst above a city at more than 1,000 feet to utilize the full lethal radius of the blast.

To insure selectivity for detonation points the weapons had to be equipped with a system of electronics, and for this work Parsons chose R.B.Brode of the Ordnance Division, to be assisted by E.B. Doll and S.J. Ratner. Their job was to transform the bomb into a complex, self-sufficient, and sensitive machine. In a split second after toggling the weapon had to recognize and adjust itself to the external factors of its flight toward the target. To this end the electronics of the bomb was organized into a system of four assemblies for power, arming, fuzing, and firing. Each of them had shortcomings that had to be reconciled with the temperamentalities of its three partners. Batteries were installed as the source of power but, as an example of the difficulties encountered, their operational life was less than 100 hours. After that they had to be recharged or replaced, and this was an awkward and time-consuming chore. The arming system kept the bomb immune to detonation for the first few seconds of its fall. It was a welcome safeguard for the carrier plane and crew, and it depended upon barometric switches to close the circuits at preset altitudes.[49] The arming system was then ready to activate the firing system. This in turn detonated the high explosive components of the inner weapon which, in complicated ways, set off the fissionable material.[50]

The four-fold system of assemblies depended upon exacting subtleties and simultaneities for successful operation.[51] In view of these intricacies Parsons concluded that a specially trained weaponeer should accompany each bombing mission to arm and test the bomb while en route to the target. As a precaution against accidental detonation at the home base, the gap between the fuzing and firing systems was bridged by a removable plug in the nose of the bomb.* Without the plug the firing system could not be actuated. One duty of the weaponeer was to insert the plug at a safe distance from friendly lands.

The weapon components, comprising the whole complex of them--fissionable material, high explosives, the dam to accumulate energy, and the power, arming, fuzing, and firing systems--meant weight and size. In addition it was necessary, of course, to armor the bombs in outer casings, and

*Even the absence of the red plug would not have prevented a detonation of some magnitude if the plane had crashed on take-off and burned. The fire would then almost certainly have resulted in an explosion of the high explosives which in turn would have have resulted in a detonation of the nuclear components.

these too would contribute to weight and size. Almost from the beginning of the atomic program it was evident that the new weapons would have to be delivered by air, and this meant that the sum total of bomb ingredients would have to be integrated and tailored to match the bomb bay of a chosen carrier.

Very slowly indeed, or so it must have seemed to the workers at Los Alamos, the puzzle was put together. And then, at the end of the endeavor, there came another problem created by the program's security. In their final form the bombs had to be streamlined without the aid of America's best experts in aerodynamics.[42] As a consequence the bombs, especially the FAT MAN, lacked one essential of good weapons, namely the high ballistic coefficient of scientific design.

Outwardly the bombs reflected their inner dissimilarities. The LITTLE BOY was 30 inches in diameter and 128 inches long, and weighed nearly 9,000 pounds. The FAT MAN resembled a conventional bomb, but was more bulbous or egg shaped. Eventually, its square box-type tail was equipped with baffles or drag plates, sometimes thought to be a serious strain upon the structural stability of the weapon. The FAT MAN was 60 inches in diameter and, in this case like the LITTLE BOY, 128 inches long. It weighed somewhat more than 10,000 pounds.

In the course of two hectic years, 1943-1945, Oppenheimer kept the group of physicists working steadily on the design and construction of fission bombs. To do so he had frequently to reject various and spontaneous suggestions that the program move into the thermonuclear field.[41] Oppenheimer's patience and persistence were not the least of his contributions to America's war effort.

As the bombs neared completion the confidence of Los Alamos declined, perhaps a normal reaction to the strain of responsibility. Early in 1944 some of the scientists believed that an implosion weapon might be more efficient than the gun-type. But faith in the theory was not strong, and enthusiasm often slumped. There were some who feared, or possibly for humanitarian reasons they hoped, that neither weapon would detonate. Others, conceding a 10 KT yield from the LITTLE BOY, would admit no more than a TNT equivalent of 200 or at most 500 tons from the FAT MAN. It was this pessimism that prompted Groves' report to Marshall in December 1944 with possibly disastrous consequences at Yalta.[45]

In the spring optimism revived. Estimates of the gun-type remained unchanged, but there was a strong belief that implosion, if it worked at all, would be more efficient and would give the greater yield.

By May or early June 1945 both weapons were structurally complete, but the fissionable components were not ready until 6 July. Even at this late date the efficiency and yield of the gun-type weapon could not be estimated with confidence. On the other hand, it was scientifically certain that the bomb would detonate, and no one at Los Alamos felt it necessary to test the mechanism. It was different with the FAT MAN. The theory of implosion could only be established by testing, and much of the real effectiveness of atomic weapons would depend upon the outcome.

Operation TRINITY

Long before the fissionable components were ready, Groves selected the desert range of Alamagordo, N.M., as location for the FAT MAN test. The operation was code-named TRINITY, and it would be the first atomic detonation in history. The chosen site, a solitary place, a wilderness within easy transporation reach of Los Alamos, was far beyond the point of danger to the nearest settlement.

During the spring Alamagordo was partly readied for the great event. Additional plans were drawn for the last minute installation of instruments to record blast data. On 12 July about 200 scientists and technicians from Los Alamos began to assemble the FAT MAN in an old ranch house on the range. On 14 July the bomb was hoisted to the top of a hundred foot steel tower. The next day there was installed a mechanism to permit detonation by long distance control; cameras were placed to obtain photographs [redacted] and various instruments were set up to record the temperature, radioactivity and shock waves. The data was to be transmitted to a central recording room by radio. Additional instruments were to be dropped by two B-29 aircraft. A timer and earth shelter were built six miles south of the tower as the forward observation point, and a second and safer observation post was located four miles further away. [redacted].

It was intended to fire the bomb the morning of 16 July, at 0400 hours which, under summer war time, was really 0200. A terrific thunder storm, however, necessitated delay and zero hour was postponed to 0530. To those who participated in the test, the moment seemed to be a critical instant in the history of the world. Brigadier General Thomas Farrell, who was operational deputy for General Groves, has left an interesting account of the last fifteen minutes before detonation.[52]

> For some hectic two hours preceding the blast, General Groves stayed (in the control room) with the Director (Dr. Oppenheimer). Twenty minutes before zero hour, General Groves left his station for the base camp, first because it provided a better observation point and second, because of our rule that he and I must not be together in situations where there was an element of danger which existed at both points.
>
> Just after General Groves left, announcements began to be broadcast of the interval remaining before the blast to the other groups participating in and observing the test. As the time intervals grew smaller and changed from minutes to seconds, the tension increased by leaps and bounds. Everyone in the room knew the awful potentialities of the thing that they thought was about to happen. The scientists felt that their figuring must be right and that the bomb had to go off, but there was in everyone's mind a strong measure of doubt.

We were reaching into the unknown and we did not know what might come of it. Dr. Oppenheimer, on whom had rested a very heavy burden, grew tenser as the last seconds ticked off....He held on to a post to steady himself. For the last few seconds he stared directly ahead, and then (at 0530) when the announcer shouted "Now!" and there came this tremendous burst of light followed shortly thereafter by the deep growling roar of the explosion, his face relaxed into an expression of tremendous relief....

The effects could well be called unprecedented, magnificent, beautiful, stupendous and terrifying. No man-made phenomenon of such tremendous power had ever occurred before....The whole country was lighted by a searing light with the intensity many times that of the midday sun. It was golden, purple, violet, gray and blue.

After the light and heat came ~~the~~ pressure and ~~tremendous roar~~ thunder. Two men were knocked down in the control center. As the mushroom cloud reached 40,000 feet and began to disperse, it was seen that the steel tower had been vaporized, and later it was found that the sand within a radius of 1200 feet ~~was~~ had fuzed into a green glass-like substance. All life, vegetable and animal, within a radius of one mile was totally destroyed. The estimated yield was more than 20KT. 53

The detonation was not unnoticed by the outside world. The flash was seen in Amarillo, 450 miles away. At El Paso, 150 miles to the south, people saw the burst of light and heard the blast. At Silver City, New Mexico, 200 miles to the southwest, and at Gallup, New Mexico, 235 miles to the northwest, windows rattled. Reports of earthquakes, meteors, and airplane crashes came from many localities. At Albuquerque, a blind girl asked her mother: "What was that?" Newspapers at home and abroad reported a great detonation in New Mexico, presumably of "secret ammunition dumps."

Sixty-five miles north of Albuquerque, watchers on the hill at Los Alamos waited impatiently through the night to see the distant fine. Not knowing of the storm at Alamogordo, they were fearful of failure when the 0400 zero hour passed without a burst of light along the horizon. Then, one and a half hours later, there was the sudden flash that gave pragmatic sanction to the theory of nuclear physics and proved the practicality of implosion.

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Chapter III

SILVERPLATE, THE INITIAL AAF PRO

In June 1943, three months after Dr. J. R. Oppenheimer went to Los Alamos, Captain W. S. Parsons, USN, became Head of the Laboratory's Ordnance Division. His work was twofold—to direct the engineering of the bomb and to determine the vehicle of delivery. He delegated his second responsibility to Dr. Norman ~~E.~~ F. Ramsey who became head of the Delivery Group.

In the early summer the scientists at Los Alamos were thinking mostly of only one kind of atomic bomb, the gun-type. It was estimated that its weight would be 8-10,000 pounds, its length ~~about seventeen~~ more than ten feet, and its yield 10-25 KT.[1] Obviously such a weapon had to be delivered by air, and no more than two aircraft models could qualify in size and range to meet the delivery requirements—the British Lancaster and the American B-29.[2] The Lancaster had some advantages but its use would complicate maintenance, and Ramsey therefore chose the B-29 although it had but recently reached the production stage and had never been tried in combat.[3]

The superfortress, as the B-29 was called, was a four-engine aircraft with 8,800 horsepower. It was ninety-nine feet long, its wingspread 141 feet three inches, and its over tail height thirty-four feet seven inches. The plane's maximum weight was 140,000 pounds, though its optimum weight was less. Each of its two bomb bays was 150 inches long and sixty-four inches wide. The service ceiling was 38,000 feet and maximum speed was between 360 and 400 miles per hour at 33,000 feet. The range of the aircraft was between 3,000 and

4,000 miles depending upon the bomb load.[4] On 1 June 1943 AAF activated at Marietta, Georgia, the 58th Bombardment Wing to test the giant bombers as they came in from the Boeing factory in Wichita, and to train their crews.* The first shipment left Wichita for Marietta on 15 July.[5] By coincidence the development of the B-29 was perfectly timed to meet the needs of the atomic energy program.

After Parsons approved the selection of the B-29 he and Ramsey explained their selection to Brigadier General Leslie R. Groves, head of the Washington Liaison Office of MANHATTAN District. In July Groves told General H. H. Arnold, Commanding General AAF, of the secret bomb, and requested that he test the ballistics of the weapon as soon as possible.[6] Arnold arranged for the tests to be held at the Dahlgren Naval Proving Ground, in Virginia, during the month of August. The available models were crude. They were built to a scale of 14/23, and consisted of a long fourteen inch pipe welded into the middle of a standard 500 pound bomb. The ballistics was so poor that the testing ended after a few drops. Arnold wanted more accurate models.[7]

It was at this point that Dr. John von Neumann, at Los Alamos, proposed an implosion bomb that would be fifty-nine inches in diameter and weigh 9,000 pounds. In September Groves saw Arnold again, informed him of the differences between the THIN MAN and the FAT MAN, especially the differences in their dimensions. Groves requested Arnold:[8]

1. To continue the tests at Dahlgren for the time being.
2. To modify a small number of B-29's, not more than three, for the accommodation of the weapons.

*In November 1943 the 58th Wing was moved from Marietta to Salina, Kansas.

3. To organize and train a special AAF combat element to deliver the bomb under the control of an AAF field commander.

The continuation of the Dahlgren tests imposed no new responsibility, but the modification of the B-29's and the organization of the combat element, then mentioned for the first time, implied unique liabilities.

Fortunately for the Air Force, and for Los Alamos, it was possible to correlate in detail the AAF modification-organization program with the day-to-day work being performed by the Laboratory. Arnold and Groves both knew that the weapons would not be ready for delivery for another eighteen months or two years. Since it seemed improbable that Germany could survive that long, it was assumed that the bombs would be employed against the Japanese whose strong military position argued against an early surrender.*[9] There appears to have been some immediate talk of specific targets in the Empire,[10] but no choice was made before the end of 1944 or the early months of 1945. In the meantime Arnold set in motion the many activities that were needed to modify

*In 1943, the situation in the Far East was anything but encouraging. Maj Gen Joseph W. Stilwell, Commanding General, China-Burma-India Theater, continued to champion a strategy based upon the reconquest of North Burma, the establishment of land communications between India and China, and the training and equipping of vast Chinese armies to defeat the main Japanese armies on the continent of Asia. This strategy pointed to another ten years of war, at least. In the Southwest Pacific Area, Gen Douglas MacArthur's island hopping campaign was thousands of miles from Japan and promised no quick victory. True, MacArthur adopted island hopping because he had no intention "of becoming involved in the land mass of Asia", but the Pentagon does not seem to have thought of bypassing China for at least another year. Although Maj Gen Claire L. Chennault lashed out against the proponents of "trench warfare" his defense of air transportation and the effectiveness of a strategic air attack on Japanese LOC in China and Southeast Asia was slighted in Washington military circles. The United States was all set for a long, tedious and costly war, and the atomic bomb, if it could be made to work, was regarded by those who knew of the program as the one means of saving countless American lives.

B-29's for the accommodation of two bombs that differed not only from conventional weapons but from one another.[11]

General Arnold's first problem was to reconcile national security with the type of action that would insure the readiness of AAF for its new mission. The difficulty was to obtain from MANHATTAN District and pass on to the Air Force such technical information concerning the atomic bombs as would permit an efficient and skillful modification program without violating the greatest secret in history. In a conference with Marshall, Arnold worked out a plan whereby a few carefully selected AAF officers would be told about the bomb. These key figures in turn would be responsible for designing and executing the B-29 modifications in such a manner that others employed on the project would not suspect the purpose of their work.[12]

Obviously Arnold could not supervise the undertaking himself,[13] and he delegated to Major General Oliver P. Echols, AC/AS-4, responsibility for additional ballistic tests, for modification of the B-29's and for organizing the atomic combat element. Echols chose from his own staff Colonel Roscoe C. Wilson as Project Officer.[14] The latter had orders to protect the over-riding priority of the modifications, as well as his own authority, by referring all objections to Arnold.[15]

Wilson reported at once to the Washington Liaison Office of MANHATTAN District and received from Groves a resume of the atomic energy program, but in general terms only.[16] In October 1943 Parsons and Ramsey came to see Wilson in Washington. It was then that he learned for the first time that there would be two different bomb types, and details of their designs. The B-29 modifications, of course, would have to provide for the carriage of either weapon with equal facility.

Once he saw the full import of his work, Wilson kept Arnold, Echols and Groves constantly informed of the progress made.[17]

Following their first conference, Parsons, Ramsey and Wilson met frequently--generally in Los Alamos or the Pentagon but occasionally elsewhere. In the course of his discussions Wilson became familiar with what MANHATTAN scientists and engineers had done and were doing, and he quickly delineated in his own mind what the Air Force tasks would be.[18] Even before he could undertake the organization of a combat element, Wilson would need technical specifications, special equipment, transportation and many other miscellaneous services, and all of these had to be kept current with a constantly changing situation. As quickly as possible Wilson created a small group of efficient assistants upon whom he could rely for accurate information, sound advice and prompt action. His chief assistant, who was actually his deputy, was Colonel M. C. Demler; his unfailing contact with MANHATTAN District was the latter's AAF liaison officer, Captin John Derry, USA; his representative in the Materiel Command was the Bombardment Project Officer at Wright Field, Colonel Donald L. Putt, who was made responsible for the actual modification of the B-29 aircraft. Putt in turn called his own deputy, Captain R. L. Roark, into the program.*[19]

*It should be mentioned at this point that there were three changes in designation of the Materiel Command between the summer of 1944 and the spring of 1946 which lead to confusion unless explicitly explained. On 17 July 1945 the Materiel Command was replaced by Materiel and Services. Within Materiel and Services there were the Materiel Command and the Air Service Command. On 1 September 1944 Materiel and Services was inactivated and the Materiel Command and the Air Service Command became the Air Technical Service Command. In March 1946 the Air Technical Service Command became the Air Materiel Command.

The original change from Materiel Command to Materiel and Services was brought about because General Knutson did not want to be known as a Commanding General but as a Director. The arrangement was so unsatisfactory to the military that in six weeks the change was made from Materiel and Services to the Air Technical Service Command.

Modification of Aircraft and Further Testing of Weapon Models (December 1943-October 1944)

Straight away Wilson arranged for the most highly qualified among the carefully selected members of his group to visit Oppenheimer and Parsons at the Laboratory and acquire first hand knowledge of the program. Then Wilson set about to implement the basic principles of security that Marshall and Arnold had agreed upon a few weeks earlier. A code was his chief concern because from time to time he had to discuss, by 'phone and correspondence, the modification requirements and the two weapon types. As a first step Wilson and Putt agreed to call the modification project SILVER PLATED but they soon shortened it to SILVERPLATE. The Los Alamos THIN MAN and FAT MAN served excellently as designations for the gun-type and implosion weapons, but some form of explanation was necessary for those who in one way or another were brought in touch with the project without being initiated into its real significance. For this latter purpose Wilson and Putt defined SILVERPLATE as a pullman car to be used by the President, THIN MAN, and the Prime Minister, FAT MAN, in a secret tour of the United States.* #20

With policies of security agreed upon, Headquarters AAF gave Wilson and Putt every support and authorized them to proceed in their

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*Due to the problem of security Wilson could not request an official authorization for SILVERPLATE. By mere coincidence the War Department selected the same word for another purpose and there followed a brief period of confusion. Without explanation, Gen Arnold's office ordered the agency using SILVERPLATE to select another code, and Wilson continued to employ the term. It outlasted the war and Operation CROSSROADS in 1946, and was not discarded until the spring of 1947.

work without interference. On 1 December 1943 Arnold's office informed the Commanding General, Materiel Command, that SILVERPLATE modification of B-29's must be given "the greatest possible priority", that Putt was to be the Project Officer, and that he could not reveal the nature of his task.[21] In Ohio, Wright Field too, once instructions came through from Washington, gave Putt the support he needed, and when a B-29 flew in from the 58th Bombardment Wing, SILVERPLATE personnel and facilities were available for the prototype modifications.[#22] Ramsey and Wilson kept Putt informed of the many changes in detail that emanated from Los Alamos. Also, from time to time Los Alamos sent corrected models of the two bombs to Wright Field. Using all the information supplied him, Roark designed the modifications and kept them current with the weapon developments. The installations were made by hand.[23]

At the time that Putt and Roark began modifications, Wilson arranged for the resumption of drop tests of the bomb models, but moved from Dahlgren to Muroc Army Air Base, California, a satellite of Wright Field. On 24 December 1943 Wilson and Putt prepared a detailed plan of operations,[24] and scheduled the first mission of the modified B-29 for mid-February 1944.[25] The Commanding Officer of Muroc received scant information about the tests. A B-29 airplane and crew, three ground observation stations and crews, and a party of twenty

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#At Wright Field SILVERPLATE was listed as PULLMAN on the Command's notices on Classified Projects and it was given MX-469 as a project number.

observers would be involved.* Muroc was responsible only for the coordination of the tests with other flights from the field and in the general area.[26]

On 20 February the first SILVERPLATE aircraft was flown to Muroc.[27] Captain Clyde S. Shields was pilot and commanding officer of its crew, and First Lieutenant David Semple was the bombardier. Since both these officers were key personnel in the test program, due to the roles they were to play, both were admitted to a general knowledge of the atomic program. Simultaneously models of the THIN MAN and the FAT MAN arrived at Muroc. Testing began 28 February.[28] After twenty-four drops the tests were discontinued for revision of the suspension mechanism and for further improvements in THIN MAN models.[29] The tests were resumed in June by which time the B-29 included an adaptation of the British bomb suspension and release device. The THIN MAN models had been redesigned and re-designated as the LITTLE BOY. Both the aircraft and the gun-type model functioned well, but there was trouble with the FAT MAN which exhibited a hitherto unnoticed yaw. Semple introduced some simple modifications which were satisfactory in correcting the weapon's shortcomings.[30]

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*The representatives or observers from MANHATTAN and Wright were:

From MANHATTAN		For Wright Field
Capt W.S. Parsons, USN, in charge	Mr. Julian Mack	Capt R.L. Roark
Lt Cmdr A.F. Birch, USN	Mr. S. J. Katner	1st Lt D.L. Semple, AAF
Maj W.A. Stevens, CE, USA	Mr. D. L. Anderson	Mr. I.R. Holland
Mr. R.B. Brode	Mr. L.T.E. Thompson	
Mr. K.T. Bainbridge	Mr. L.S. Skaggs	
Mr. Norma Ramsey	Mr. Sheldon Dike	
Mr. H. R. Crane	Mr. Gordon Voorhies	
Mr. Arthur Breslow	Mr. Berlyn Brizner or	
Mr. E. B. Doll	Mr. Roger White	

As a result of the tests, the SILVERPLATE requirements seemed to be sufficiently firm to request an industrial contractor to manufacture the designed items. On 23 August 1944 the Glenn L. Martin-Nebraska Company received the contract to modify the first three B-29's, and selected its Fort Crook Modification Center in Omaha as the program site.*[31] The Muroc SILVERPLATE aircraft served as model, and Wright Field supplied the drawings and specifications.[32] The changes, limited entirely to the bomb bay and its area, included the installation of a new H-frame, C-6 hoist, sway braces, carrier assembly, antenna equipment, junction box, and the British Type F release unit and Type G Shackle assembly.[33] In addition the latest changes made in B-29's in general were incorporated in the SILVERPLATE planes, and the Winker Type bomb bay doors were installed.[34] The Materiel Command saw to it that Martin accorded high priority to the project.[35]

The major problems that the Center encountered in SILVERPLATE came from the frequent changes in specification as the Los Alamos scientists continued to improve their own designs for the weapons. For example, on 29 September 1944 word reached Martin to install FAT MAN equipment on all modified B-29's,[36] but to discontinue the LITTLE BOY installations.[37] Within a matter of weeks Los Alamos wanted LITTLE BOY adapters on all SILVERPLATE planes.[38] By the end of 1944 refinements in the Laboratory's design for the

*The contract under which Glenn L Martin-Nebraska operated for the SILVERPLATE project was that designated as W 535 ac-25848 as approved by the Commanding General, Materiel Command, 6 Nov 1942. Actually, therefore, the Fort Crook Modification Center was already working for AAF on other projects, and the SILVERPLATE work was simply another modification requirement that came from Wright Field. No explanation was necessary as far as the contractor was concerned, and no new contract appears to have been drawn up especially for the SILVERPLATE work.

the implosion weapon meant that there had to be a relocation of the FAT MAN suspension hook, as well as alterations in the sway braces to permit greater freedom in hoisting.[39] Then, as the AAF personnel became fully aware of the operation problems, it was necessary for Roark's group to call for other rectifications.[40] Some changes came as late as January 1945 when the Americans were producing a release and shackle that were better suited for the atomic bombs than the British built Type F and Type G.[41]

Meanwhile the extent of the SILVERPLATE Project had widened. Training proved to be more demanding than had been expected, and Wilson concluded that the combat element should be supplied with enough planes to meet emergencies. In July 1944 the number of modified B-29's was increased from the original three to fourteen, and on 22 August the total was again lifted, this time to twenty-four which, combined with the one plane hand-modified by Wright Field, would give a grand total of twenty-five.* A schedule was set up for the delivery of the modified aircraft by the civilian contractors. It was Roark's responsibility to guide the Engineering and Production divisions of the Materiel Command in applying the experience gained in the Muroc tests, and to see that the civilian contractors observed the schedule.[42] The next increase occurred six months later, in February 1945 at the same time that the last SILVERPLATE modifications

*The order to modify twenty-four B-29's came through to the Production Division, Materiel Command, from the Chief, Modification Division, AC/AS, Materiel and Services, Hq AAF. As a concession to security, the normal channels for approval of engineering requirements were by-passed and the Materiel Command's SILVERPLATE Project Officer dealt directly with the Command's Production Division.

were settled. The Army Air Forces decided that instead of twenty-four modified aircraft there should be forty-eight, which with the hand modified model totalled forty-nine.[43] On 18 April the number was raised by five. Thus when it was almost time to plan specific operations, SILVERPLATE included fifty-four B-29's, twenty-nine of which had been modified in 1944 and twenty-five of which were either being modified or were to be modified within a year.* Actually, only forty-six were completed before the end of the war, but even that was a far cry from the three planes originally requested by Groves.[44]

The Combat Element

It was not until late June or early July 1944, six months or more after the beginning of the modification and test programs, that Wilson moved to organize a combat element. He went first to

*The schedules of Aug 1944 and Feb and Apr 1945 have been put in the following tabular form:

Aug 1944 Schedule No A/C	Del. Date	Feb 1945 Schedule No A/C	Del. Date	Apr 1945 Schedule No A/C	Del. Date
3	30 Sep 44	1	mod by hand	1	Mar 45
11	31 Dec 44	24	under Aug sch	13	Apr
10	Jan 45	1	31 Mar 45 proto.	2	May
		13	Apr 45	2	Jun
Total 24	to be mod.	2	May 45	2	Jul
1	mod. by hand	2	Jun 45	2	Aug
		2	Jul 45	4	Sep
G.T 25	by Jan 45	2	Aug 45	2	Oct
		2	Sep 45	1	Nov
	Grand Total	49	Grand T	29	Mar-Nov 1945

Of the twenty-five aircraft called for in the Aug 1944 schedule, fourteen were to be used for training and ten were to be assigned to the combat unit. The hand-modified aircraft, apparently, was to be kept as a permanent model.

Brigadier General Mervin Gross, Chief, Operations, Commitment and Requirements (OC&R), about the new outfit. It was in the course of the ensuing discussions that Wilson saw for the first time the inadequacy of having only three B-29's modified, one to carry the weapon and two to serve as spares. Such a combat unit would be too small to become self-supporting. Gross and Wilson therefore decided for security reasons to organize a special squadron. This decision meant that the unit would be too large to be located at Muroc. The next step was to select a commanding officer for the squadron, indoctrinate him in the secrets of the atomic energy program, choose a new field for training personnel and testing weapon models, and make the move by mid-autumn.[45]

Colonel Paul W. Tibbets was an outstandingly efficient officer in charge of Eglin Field's testing of machine guns for B-29's. Gross and Wilson agreed that he would be an excellent CO for the atomic bomb squadron. Tibbets, therefore, was relieved of his duty at Eglin and ordered to Muroc in July. There he was told what his mission would be, and he, with Gross and Wilson, made the preliminary plans for the organization of SILVERPLATE's combat element.[46]

In July Wilson, Tibbets, Parsons, and Ramsey sought the advice of Major General U.G.Ent, Commanding General, Second Air Force, in selecting a field for the program. There were many factors to be considered, and after some delay Wendover Air Force Base, Utah, became the logical choice, largely because its isolation aided security. The field was given the code name of KINGMAN or Site K. Its "training and test center" had the symbol W-45, thus initiating an agency that continued through many vicissitudes until August 1948 when it became the USAF (3170th) Special Weapons Group.[47]

A selection had still to be made of the best qualified squadron for the job. After long consideration, the 393rd Bombardment Squadron which had completed two-thirds of its training at Fairmont Army Air Field, Geneva, Nebraska, as part of the 504th Bombardment Group, was chosen for the special work.[48] The squadron had a personnel strength of approximately 700 officers and men, headed by Lieutenant Colonel T. J. Classen.

To carry through the assignment it was necessary to reorganize Wendover Field which, up to that time, had been used as a base for training fighters. Henry L. McClanahan was appointed by MANHATTAN District as its Wendover Project Officer. Colonel Charles Trobridge was made the new CO, but he reached his headquarters without knowledge of his mission, and he was not enlightened for sometime to come.[49]

The situation in which the CO found himself was by no means unique. Captain C.F.H. Bogg arrived as Ordnance Officer, and for quite a while remained mystified concerning the purpose of his work. After ten days or two weeks in which he learned nothing and had little to do, Bogg was informed that he should be prepared for the arrival and unloading of three box cars bringing equipment for testing the accuracy of machine guns. The need for unusual security precautions was emphasized. Within a few days thirty-five airmen arrived, each with an armament speciality. Through individual interviews, Bogg selected eighteen of them for the work of unloading and taking care of the expected equipment, the nature of which still remained a mystery. When the cars arrived, the accompanying guards would allow no one inside except McClanahan and Bogg. Still ignorant that the cars contained bomb models, Bogg acted according to his instructions and unloaded under cover of darkness. Ten models of the FAT MAN and four half-scale models and two full-scale models of the THIN MAN were transferred to a restricted area of the field.[50]

At the same time that the box cars arrived the 393rd Bombardment Squadron left Fairmont, 1 October 1944, and went by troop train to Wendover. Soon after reaching their new station, the officers and men were assembled and Colonel Tibbets was introduced to them. No mention was made of an atomic bomb, but the colonel said that the squadron would engage in a highly secret project which, if successful, was expected to end the war at least twelve months sooner than could be otherwise anticipated. The officers and men were warned that as their work unfolded absolute security would be the responsibility of everyone within the squadron. Later on, when some form of explanation was necessary, officers and enlisted men were told that they were preparing for an aerial mining attack on the deep ravines of Formosa. How much of this story was believed it is impossible to say, but in all probability the ordnance personnel and the aircraft crews were skeptical since they saw the weapon models and must have sensed that the real secret was not the mission to be performed but the type of bomb that was being developed and tested.[51]

The decision made in the late autumn of 1944 to modify fifteen rather than three B-29's necessarily increased the size of the combat element.[52] It was to be a self-supporting unit known as the 509th Composite Group[53] with the 393rd Squadron serving as the tactical force. Other units were added at the same time: the 390th Air Service Group, composed of the 603rd Engineering Squadron and the 1027th Air Materiel Squadron;* the 320th Troop Carrier Squadron

*Hqs and Hqs Squadron of the 509th was placed under the Base Service Squadron of the 390th Air Service Group for administration, quarters and rations.

soon to be known as the GREEN HORNET, to transport personnel and materiel within the United States and between the United States and the overseas base;* and the 1395th MP Company.[54]

On 17 December 1944 Headquarters AAF activated the 509th. It was commanded by Colonel Tibbets and assigned to the 315th Bombardment Wing (VH) which was at Colorado Springs. That same day Major General Lauris Norstad succeeded Colonel Wilson as Headquarters AAF Project Officer for MANHATTAN District Activities, and Wilson became Norstad's liaison officer at Headquarters 315th Wing.[55]

There was yet another addition to be made to the 509th--an ordnance squadron, the requirements for which increased steadily. In the late autumn of 1944 Bogg went to Los Alamos, accompanied by Ramsey, and learned the secret of the atomic program. In the light of this knowledge, of course, Bogg had a much better understanding of his own work. Upon returning to Wendover he asked for and obtained an increase of fifty men.[56] At first the ordnance personnel were assigned to the various squadrons within the 509th,[57] but administrative difficulties led to the activation of the 1st Ordnance Squadron, Special, Aviation, on 22 February 1945, thereby completing the

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*The 320th Troop Carrier Squadron possessed hard worn C-45's, C-47's and B-17's, but these were soon replaced with ten new C-46's, five "trans-Pacific" C-54's and a few C-45's for more limited flights. The GREEN HORNET did much to overcome the shortcomings of Wendover in the matter of transporation and communications with the outside world.

organization of the 509th.*58 However there was still the problem of bringing the Group to full strength in personnel, and this was not achieved until 24 May, two days before the overseas movement of the ground echelon began.**59

The Ordnance Squadron did great work, and between February and July 1945 its workshops were the busiest part of Wendover. It was not uncommon for 50,000 pounds of equipment to arrive in one shipment. Such freightage imposed a serious strain on field facilities, and it was necessary for the Squadron to establish its own

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*The units of the 509th Composite Group, their activation dates and strength:

Unit	Activation	Officers	EM
393rd Bomb Sq.	1 October 1944 #	62	157
15 crews		6	231
393 Engineering & Arm. Dept		7	164
393 other Departments		27	59
Hq & Hq Sq, 509th Composite Gp	17 December 1944	18	176
390th Air Service Gp Hq	17 December 1944 #	8	234
603rd Engineering Sq	17 December 1944 #	8	126
1027th Materiel Sq	17 December 1944 #	37	122
320th Troop Carrier Sq	17 December 1944 #	4	130
1395th MP Company	17 December 1944 #	14(28)	228
1st Ordnance Sq	22 February 1945		
	Total	191(205)	1624

#This is not the date of the 393rd's activation, but of its arrival at Wendover.

**The Ordnance Sq had a particularly difficult time reaching full strength. Of its 228 authorized EM, only eighty-six were present at Wendover on 22 Feb 1945. That meant that 160 others had to be obtained. There followed a long process of selection by interviews which rejected four out of every five candidates. At least 800 men were interviewed in the course of chosing 160, and this was at a time when the Armed Forces were scraping the bottom of the barrel for manpower. Between 25 Apr and 7 May the actual strength of the Ordnance Sq rose to 167, leaving fifty-five vacancies. The next day two officers of the squadron went to Kearns Overseas Replacement Depot and selected forty-three men. The remaining twelve vacancies were not filled until 24 May.

Transporation Section.[*60] The Squadron also set up a Production Department where ordnance specialists and technicians assisted Los Alamos in the development of the arming, fuzing and firing systems, and the ballistics of the weapons. One weapon model after another was turned out, some built in scale and some in full size.[61] In a short time Production was divided into two sections--Prefabrication and Final Assembly.[**62] It was in Production that Squadron personnel acquired a working familiarity with both the LITTLE BOY and FAT MAN. Once overseas there were 1st Ordnance officers and enlisted men who [redacted] in ~~the~~ them skill of assembly, were superior to most of the Los Alamos representatives. Although it had been decided at an early date to send a Navy weaponeer on each atomic mission, there were some members of the Ordnance Squadron who could have done the job equally well.[***]

The prospect of accumulating usable amounts of fissionable material at Hanford and Oak Ridge, the progress made by Los Alamos in designing two types of atomic weapons, the successful modification of B-29's at Wright Field, and the activation and organization of the

*The unit performed its tasks with C-2 wreckers, the 25' and 40' AAF semi-trailers, and 3,500 and 6,000 ton fork lift trucks and special bomb trailers and cranes.

**The Prefabrication Section was responsible for assembling all the components of the bomb to see that the parts fitted properly. The bomb model was then disassembled and turned over to the assembly crews for final assembly. The first HE unit was not put together until late March 1945 and was dropped for test purposes in the Great Salt Lake Desert near Knowles, Utah. In all the test drops the model bombs frequently veered off to one side, an erratic behavior probably due to loss of parts of the tail fins.

***It is worth noting at this point, though it will be mentioned later in the text, that both Parsons and Ashworth, the Navy weaponeers, were assisted on the Hiroshima and Nagasaki bombings by an officer selected from the 1st Ordnance Squadron.

509th at Wendover all showed that within a few months atomic combat operations would begin. As 1944 drew to a close, much thought at the highest levels of the Government was given to the selection of tentative targets. Events by that time had ruled out the last possibility of employing the weapons against Germany, but Japan still gave no indication of admitting defeat. Evidently the blow would be delivered against the Mikado's Empire. It is not clear when the choice was made of possible targets,*[63] but there is some evidence to indicate that the date was either December 1944 or January 1945.[64] General Arnold, in his Global Mission, has explained the policy which led eventually to the destruction of Hiroshima and Nagasaki:[65]

> To test the bomb's real destructiveness, three or four cities must be saved intact from the B-29's regular operations as unspoiled targets for the new weapon. Which cities should be spared was a problem. I talked the matter over with Secretary Stimson, and gave him a list of the target cities we planned to attack with the B-29's in any case.
>
> Mr. Stimson struck off my list the city of Kyoto. Kyoto had a population of 792,000 and was an important manufacturing center. In my opinion it should have been destroyed. But the Secretary said it was one of the holy cities of the world, and of outstanding religious significance. So Kyoto was removed from the regular B-29 target file, and also eliminated as a possible target for the atomic bomb.

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*It is impossible to obtain exact dates for many of the important decisions and events of this 1943-1945 period of the atomic program. Very little was reduced to written form and often what was written was soon destroyed. Consequently, much of the record can be recalled only through personal and frequently undocumented reminiscences. Such material is not always reliable history. Despite the best intentions of those who participated in the events, inaccuracies and contradictions creep in. What one person recalls as certain, another will refute as unfounded. The question of when the four Japanese cities were selected as targets for the atom bomb is an excellent example. It is impossible to determine from available evidence and from personal memoirs when the decision was made. However, the fact that Hiroshima, Niigata, Nagasaki, and Kokura were not destroyed by the B-29's in their fire raids between January and August 1945, is strongly indicative that the decision was made in the very early part of 1945 at the latest.

We selected four other cities for atomic attack, because of their size and manufacturing or industrial significance. Hiroshima, with a population of 218,000; Niigata, 119,000; Nagasaki, 197,000; and Kokura, a smaller city of approximately 51,600. These four were industrial centers and were of great importance to the Japanese production effort. Kokura was at the south end of a tunnel connecting the island of Honshu with the island of Kyushu. I was anxious to see what effect the atomic bomb would have on the tunnel; whether it would fill it up with water; how badly it would spring a leak; or whether any of the effects of the bomb would be carried through the tunnel to the northern entrance.

Regardless of the exact date on which the tentative targets were selected, the time had come by January 1945 to inform the American authorities in the Pacific of the atomic weapons. The time had also come to determine the base from which SILVERPLATE aircraft could attack Japan.[66] In February Commander A. L. Ashworth, USN, was delegated to deliver a personal letter from Fleet Admiral Ernest King, CNO, to Admiral Chester W. Nimitz, Commander-in-Chief, Pacific Ocean Areas (POA). The letter informed Nimitz of the research being done in nuclear physics and of the probability that the bomb would be ready by August.[67]

In addition to delivering the letter, Ashworth was expected to arrange for the location of the 509th overseas. At the direction of Nimitz, Ashworth discussed his problems with Vice Admiral Charles H. McMorris, Chief of Staff, POA, and Lieutenant General Millard F. Harmon, Commanding General, AAFPOA. Harmon strongly recommended Tinian* as the base of operations. Its North Field, still under construction, would be finished by June, and would be well within B-29 range of Japan.** Less than a week later

*Tinian was captured by the Americans in the summer of 1944.

**Gen Harmon was lost, with his plane and its crew, somewhere between Kwajalein and Johnston, a few days after his conversation with Ashworth.

Ashworth visited the island and reserved sufficient areas in the vicinity of the field for assembly buildings, laboratories, warehouses, and storage space for high explosives. In March, after Ashworth's report had been approved, Colonel E. E. Kirkpatrick went to Tinian, with a battalion of Sea Bees, to undertake the requisite construction. In June 1945 the facilities could accommodate the first technical personnel from Los Alamos. They operated as Project A under the command of Captain Parsons or his deputy Dr. Ramsey.*68

The new self-confidence on the part of MANHATTAN and the steps taken to prepare for the overseas base of operations indicated the atomic energy program was fast approaching climax. The point had been reached where no mistakes were permissible, and the 509th Composite Group intensified its own preparation and training. An elaborate schedule was worked out at Wendover for the ordnance personnel and the combat crews of the B-29's. A bombing range, constructed about eight or nine miles west of the airfield, was operated by the Ordnance Squadron and was equipped with cameras, a few instruments, an SCR-584 radar and a small electronics laboratory, the latter being used by Brode. The range, however, was intended only for testing ballistics and fuzes. At a later date some of these tests were made at Salton Sea where there was a more elaborate system of instrumentation. Use was made of two other ranges, one located sixty-five miles from Wendover and the second at Inyokern, California, in testing the models when complete with high explosives. Inyokern was preferred to the range nearer Wendover because better equipped. During that last phase

*Parsons went to Tinian early in June, remained only a few days and returned to the United States. He did not go back to Tinian again until late July and it was during this period that Ramsey was in command of the Los Alamos personnel.

of preparation, the work performed by the Ordnance Squadron consisted of inserting Archie type fuzes in the models, and collecting the ballistics data. The bomb was in a critical stage of its development and still exhibited serious weakness in flight. Partial correction was achieved by baffle plate fins. The device, a box type riveted aluminum alloy construction with a baffle system which entrapped the air flowing through it somewhat like a drogue, was called the "California parachute." It was evident that the failure of any one baffle would cause the bomb to deviate seriously from its target.[69]

When the testing-training program was reaching its full momentum, MANHATTAN sent Wendover a collection of 23/59 scale models of each type bomb with removable tail. Four to six drops were made each day in an attempt to find the most effective alliance of tail and bomb contour. Through a trial and error method it was discovered that the best combination was the California parachute with an ellipsoid. Upon this basis a contract was let for the construction of the prototype of 1560, as the FAT MAN was sometimes called.[70]

During the test operations, which continued through June 1945, much difficulty was experienced in procuring parts and maintaining adequate coordination of related activities. This confusion was unavoidable since the bomb was designed at Los Alamos but manufactured and tested at Wendover. The strict security under which the tests were conducted prevented the free exchange of necessary information. Despite these obstacles, nearly 100 model bombs were drop tested within the period of the first six months of 1945.[71]

As the bomb models came nearer to their final form and exact dimensions, the SILVERPLATE aircraft were of course adjusted to the changing requirements. Early in 1945 the B-29's used for training were withdrawn from the 393rd Squadron and were replaced by fifteen others ready for combat. Additional SILVERPLATE aircraft were held in reserve. All the SILVERPLATE planes were stripped of armament, except for the tail turret, to provide maximum speed and elevation.[72] A new problem of security then emerged and in order not to concentrate suspicion on the 509th Group, all the aircraft of the 315th Wing had to be correspondingly stripped, a matter of grave concern to Brigadier General Frank Armstrong, the Wing Commander. The latter knew nothing of the atomic weapons, and was dismayed to think that his planes were being disarmed just before combat.[73]

To obtain experience in approaching and flying over coast lines, and also to observe the use of radar facilities, the air crews of the 393rd Squadron, like many other AAF units preparing to go overseas, were sent to Batista Field in Cuba. That is where the GYPSY Task Force was located and directed this special training. The crews of the 393rd remained at Batista from January until the latter part of March 1945, a much longer period than was customary for normal organizations.[74]

Soon after the Squadron returned to Wendover, Colonel Classen was relieved of his duties as CO of the 393rd to become Deputy Commander of the 509th. Classen was succeeded as CO of the 393rd by Major Charles Sweeney who had previously commanded the 320th Troop Carrier Squadron—the GREEN HORNETS.

When the ground echelon of the 509th left Wendover for Seattle, the port of embarkation, in early May 1945, there was another problem of security. Familiarity with the bomb demanded that personnel of the 1st Ordnance Squadron be almost completely shut off from contact with those outside their own unit during the trip across the country from Utah to Washington State. The officers and men of the 1st Ordnance Squadron were not permitted to associate with other members of the 509th Group, and on the trains they were restricted to their own pullman cars. When meals were served to the Ordnance Squadron, no other persons were allowed in the diner. The ground echelon sailed 26 May. The air echelon went overseas in several contingents, and by July the 509th Group was installed in Tinian. Wendover Field was maintained as the ZI supporting base and as a continental terminal of GREEN HORNETS.[75]

When the 509th moved overseas it was transferred from the 315th to the 313th Bomb Wing since the latter was stationed on Tinian and the former was sent to Guam. This change occurred in the midst of a far reaching reorganization. In mid-July there was established in the Pacific the United States Army Strategic Air Forces (USASTAF) under command of General Carl Spaatz with headquarters on Guam. Among other units, USASTAF included the XXI Bomber Command headed by Major General Curtis E. LeMay. The XXI Bomber Command, in turn, included the 58th, 73rd, 313th, 314th, and 315th Bomb Wings, all of which were B-29 outfits and were part of the Twentieth Air Force still under the personal command of General Arnold. On 1 August 1945 all this was changed. LeMay became Spaatz' Chief of Staff in USASTAF and the XXI Bomber Command became the Twentieth Air Force under command of Lieutenant General Nathan F. Twining.

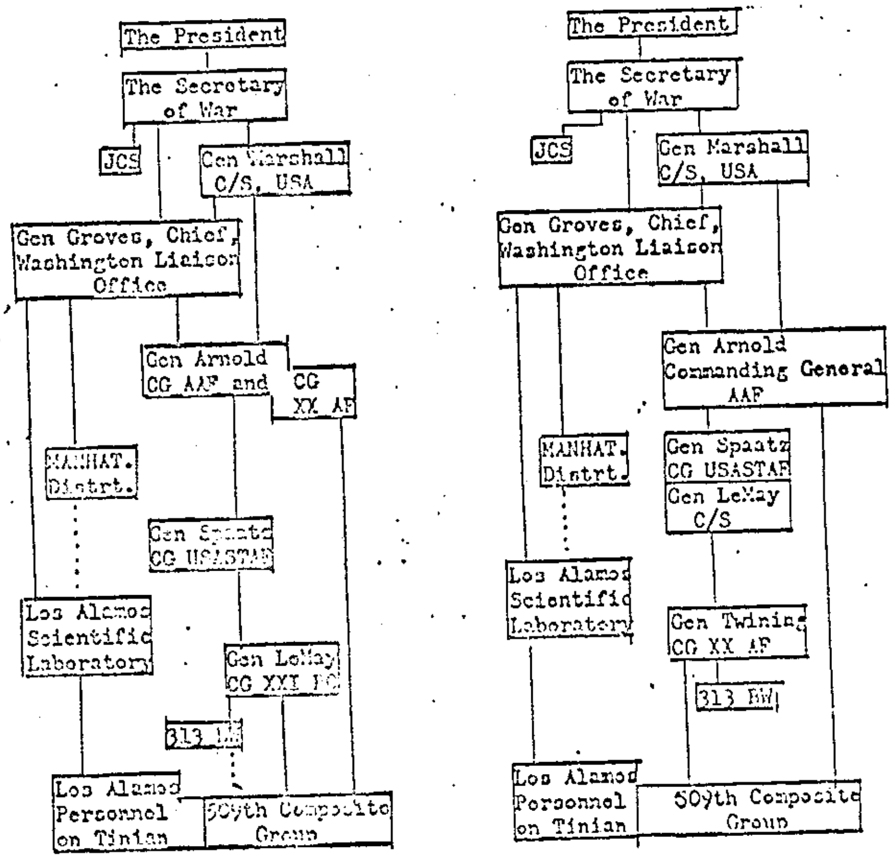
From 15 July until 1 August the 509th chain of command seems to have been from the President through Stimson to either Marshall or Groves to Arnold as CG AAF, and CG Twentieth Air Force, and thence either to the 509th direct or through LeMay as CO XXI Bomber Command. Thus on 29 May 1945, Headquarters, AAF sent the following message to the Commanding General XXI Bomber Command.[76]

> The 509th will be under your command and control, but because of the experimental nature of the project considerable control may be exercised from this headquarters, especially in the initial phases, with regard to the targets for the primary weapons.

Beginning 1 August, however, the chain appears to have been from the President, through Stimson to Marshall or Groves, to Arnold and thence either to the 509th direct or through Spaatz and Twining.[77] As a body, JCS was entirely by-passed and so was the 313th Bomb Wing.*

*Command Channels for the 509th Composite Group and for Los Alamos personnel while on Tinian Island:

For 15-31 July Period For 1 Aug-15 Sep Period



Actual Command channels ______ ; nominal command channels .....

On 16 July—17 July, Tinian time—while the 509th Composite Group was still in the process of settling down on its overseas base, word came from New Mexico that the TRINITY test was a success. The atomic bomb was a practical weapon, and the 509th was capable of delivering it against any one of the four Japanese cities spared by other AAF raids as tentative atomic targets. The time was at hand when the President of the United States, supported by the advice of his top level strategists, and in agreement with the Prime Minister, would have to decide whether and when to use the bomb in a deadly raid against the enemy's homeland.

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Chapter IV

THE FIRST ATOMIC OPERATION

The Alamogordo test began the final phase of the war-time atomic energy program. The last doubt of feasibility vanished and two new weapons were part of the American arsenal. It was certain that if implosion functioned the gun-type bomb would also work, and Hanford and Oak Ridge could guarantee enough plutonium and U-235 to permit the manufacture of the fissionable components for at least one weapon of each type by early August. It remained only for the President to sanction the use of the bombs and for the 509th Composite Group to execute the operation.

The President's Decision

In July 1945 the wisdom of using atomic bombs against the Japanese seemed very clear to the President, and his positive decision, from his point of view, was unavoidable. In the light of information which the President did not and could not have at the time, however, it appears that with only a slight change in circumstances his decision would certainly have been negative.

First of all, it seems now that Japan was much closer to capitulation in the summer of 1945 than was generally believed. As early as the summer of 1944 the Japanese sensed that their military strength was waning. Much more important to them than their current and dramatic success in China was the endless drain upon their resources, the cumulative effects of naval losses, the threat of eventual starvation, and the slow but impressive success of General MacArthur's forces in the island hopping campaign in the Pacific. Each advance brought the Americans nearer the day when they could launch an effective air attack on the Japanese homeland.[1]

The first sign of Japanese uneasiness occurred on 18 July 1944, shortly after the loss of Saipan, when Tojo was succeeded as Prime Minister by Kuniaki Koiso. The change was an attempt to bolster the nation's military strength, and was therefore confession of weakness. The western powers, however, could see Koiso only as a shrill-voiced militarist determined to fight to the death.

The new Prime Minister, despite his best efforts, could not stay the misfortunes of war. In the course of the next ten months there was a perceptible deterioration in the military position of Japan. In March 1945 Mandalay fell to the British. Thereafter Japanese resistance in Burma virtually ceased and in May the Allies reoccupied Rangoon. At the same time the Japanese had to begin a slow withdrawal from east China and the China coast and the way was opened for a naval serverance of all LOC between Japan and her forces in Southeast Asia and in Manchuria.

More important than all else, perhaps, was the steady approach of MacArthur's forces and the increased intensity of the B-29 raids. Moreover, the nature of the raids became more vicious. Precision bombing of specific targets was abandoned in favor of incendiary attacks on Japanese cities which were destroyed, one after another, in horrifying holocausts. In March the Americans struck Tokyo with fire bombs and the resultant casualties exceeded those later inflicted on Hiroshima and Nagasaki by the atomic explosions.[2]

The turn of events had already done much to strengthen the peace party in Japan when the Americans landed on Okinawa on 1 April 1945. From the point of view of many highly placed officials the situation was desperate and within a matter of days the Koiso cabinet fell. Kantaro Suzuki then became Prime Minister with imperial instructions to end the war as soon as possible. Unfortunately the Emperor's order could not be obeyed without first appeasing the militarists. Suzuki had to move slowly, and before seeking peace he had had to go through the motions of increasing the war effort. Naturally his attempts to pacify the militarists were mistaken by the Allies as a genuine attempt to continue the war.

The Prime Minister's intentions were the best, but the fall of Germany on 8 May and continued adversities in Asia seemed to confuse him. Within two months he made two mistakes of disastrous consequences.

His first error was in late May when he determined to approach the Russians secretly and request their mediation between Japan and the Anglo-American Allies. Suzuki, of course, did not know that Russia was already committed at the price of rich spoils to enter the war within three months; but in view of long years of unfriendly relations between Moscow and Tokyo, the Prime Minister should have guessed the Kremlin's intentions. Had Suzuki approached Washington and London through Switzerland or Sweden the war might have terminated before the Potsdam Conference, before the Russian intervention and before the use of atomic bombs. As it was the Russians greedily sabotaged the Japanese peace efforts, and the following account of Suzuki's pathetic failure is interesting:[3]

> On June 3 former Prime Minister Hirota, one-time ambassador to Moscow called on the Russian ambassador Jacob Malik at the hot spring resort of Hakone, where they talked in the utmost secrecy to prevent reprisals by the Japanese secret police. Malik was cool toward the proposals and when Hirota later attempted to renew the conversation the Soviet ambassador pleaded illness and refused to see him....(But later on) Hirota conferred twice more with Malik, who remained cold to the proposals. "If Russia agrees to mediate, what will Japan do for Russia?" demanded the Soviet ambassador. The Russians continued to stall.

On July 7 the Emperor urged Premier Suzuki to more haste in peace negotiations and said: "We may miss a precious opportunity while we are trying to ascertain the attitude of the Soviet Union." He suggested that a peace envoy be dispatched at once to Moscow. The Supreme War Council agreed and on July 12 the Emperor entrusted Prince Konoye with the peace mission. Konoye's instructions were to end the war at any cost*....(When the Japanese embassy in Moscow requested the Kremlin to receive Konoye) Premier Stalin and Foreign Commissar Molotov begged off, saying they were too busy preparing for the trip to Potsdam.

Evidently the Russians, who were informed by their embassy in Tokyo of the crisis in Japan, did not want the war in the Far East to end until the Soviets could claim the victors' spoils.[4] The Japanese Ambassador to Moscow, Naotake Sato, was doubtless disappointed when his request was rejected but he patiently awaited the return of Molotov from Potsdam to reopen the question.

Meanwhile, on 12 April 1945, less than two weeks after the Americans landed on Okinawa, President Roosevelt died.** He was succeeded by Harry S. Truman who came to the presidency ignorant of the atomic

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*This is doubtless an exaggeration. As far as can be ascertained, the Japanese never considered, in planning for a negotiated peace, to sacrifice the Emperor.

**According to Dr Alexander Sachs, President Roosevelt agreed in Dec 1944 to the following plan for the use of the first atomic bomb:

> Following a successful test, there should be arranged (a) a rehearsal demonstration before a body including internationally recognized scientists from all Allied countries and, in addition, neutral countries, supplemented by representatives of the major (religious) faiths; (b) that a report on the nature and the portent of the atomic weapon be prepared by the scientists and other representative figures; (c) that thereafter, a warning be issued by the United States and its allies in the Project to our major enemies in the war, Germany and Japan, that atomic bombing would be applied to a selected area within a designated time limit for the evacuation of human and animal life, and finally (d) in the wake of such realization of the efficacy of atomic bombing, an ultimatum demand for immediate surrender by the enemies be issued, in the certainty that failure to comply would subject their countries and peoples to atomic annihilation.

Nat S. Finney, "How F.D.R. Planned to use the A-Bomb", Look, 14 Mar 1950.

energy program and ~~ill-informed~~ not cognizant of the internal situation in Japan. It was relatively simple for him to acquire a working knowledge of MANHATTAN District, Los Alamos Scientific Laboratory and the 509th Composite Group. It was much less simple for him to learn the intricacies of Japanese internal affairs because no one in Washington had accurate information on the subject.

Soon after Mr. Truman's emergency inauguration, Secretary Stimson organized an Interim Committee* to instruct the new President in atomic matters. Not only did the Committee review the purpose and work of MANHATTAN District but it kept the President currently briefed on the progress being made at Los Alamos. The Committee also undertook to advise the President on matters of atomic policy, and in this connection considered the advisability of employing the weapons against the Japanese in accordance with plans of the Military Policy Committee which went back to 1942 and 1943.[5]

Even in the spring of 1945 there were some scientists, employed by MANHATTAN in one capacity or another, who protested that the bombs should never be used against any nation. Their objections led the Committee to weigh two alternatives to the actual employment of the weapons in combat. It would be possible to inform the Japanese that the bombs had been developed and warn that they would be used unless Tokyo came to terms; it would also be possible, and perhaps more effective, to stage an open demonstration of the bomb in some uninhabited area. The Committee rejected both suggestions. A warning would compromise the atomic secret, increase the difficulty of

*The Committee, chairmanned by Secretary Stimson, included Vannevar Bush, Karl T. Compton, and James B. Conant. The Committee in turn was assisted by a Scientific Panel of A.H. Compton, Enrico Fermi, E.O. Lawrence and J.R.Oppenheimer.

delivery, and give the enemy an opportunity to concentrate American prisoners of war in the threatened cities. A demonstration of the weapon would likewise compromise the secret, with the added risk that a dud would remove the sting from the threat. Moreover there was the matter of fissionable material. Although Hanford and Oak Ridge were successful in making plutonium and in separating U-235 from U-238, the amount on hand would not be more than enough for two or three bombs at most. One bomb would have to be fired secretly to prove the practicability of the weapons. If a second were fired at an international demonstration the United States might have only one other weapon to use against the Japanese if they chose to ignore the warning. The effectiveness of the weapon might well depend upon the apparent ability of the United States to employ several bombs in quick succession as though coming from an ample stockpile. On 1 June 1945 the Committee unanimously recommended that the bomb be used against the Japanese as soon as possible and without warning of any kind that would reveal the nature of the weapon.[6]

Less than three weeks later, on 18 June, a meeting was held at the White House to consider plans that had been prepared for the November invasion of Japan. No one doubted that the campaign would lead to victory, but no one doubted that the cost in human life would be appalling. The President insistently asked whether there was not some other course open to the Allies. He was assured that there was no other way to end the war without an unacceptable compromise. No one in Washington knew at that time the state of Japanese morale, the fear in Tokyo of a naval blockade, the devastating effects of the incendiary raids, or the attempts of Suzuki to enlist Russian mediation. The invasion plans were therefore formally approved by the

Commander-in-Chief.

Joseph C. Grew, former American ambassador to Japan and in the spring of 1945 Acting Secretary of State, disagreed with the decision. He and a few others, who were familiar with Japanese psychology, believed that Tokyo was no longer adamant. Vague and unofficial reports of unrest in Japan came through to the Department of State, and Grew argued that Tokyo might accept Allied peace terms if assured that the Emperor would be spared.[7] During the afternoon of 18 June Grew met Stimson and Secretary of the Navy James Forrestal. Grew insisted that an attempt should be made to negotiate with the Japanese by promising immunity to the Emperor. Stimson remained convinced that force was necessary but he incorporated Grew's suggestion in a memorandum to the President on 2 July. Stimson pointed out that though Japan could doubtless offer strong resistance in case of invasion, it should be obvious that the nation could not win the war. Therefore Tokyo might accept peace terms if assured that:[8]

1. The Allies possessed overwhelming force which could and would be used—including the Soviet armies though this could not be mentioned.
2. Japan would be destroyed if this force should be used.
3. The Allies were determined to destroy the power of the Japanese militarists but not the people and not the sovereignty of the Japanese Government within its own islands.
4. The Allies would permit the existing dynasty to continue its rule, but as a constitutional monarchy.

A few days after the Stimson memorandum, the President and his party of advisers left for Potsdam. The thinking which prevailed among them at the time of their departure had been described by Stimson:[9]

As we understood it in July, there was a very strong possibility that the Japanese Government might determine upon resistance to the end, in all the areas of the Far East under its control. In such an event the Allies would be faced with the enormous task of destroying an armed force of five million men and five thousand suicide aircraft, belonging to a race which had already amply demonstrated its ability to fight literally to the death.

The strategic plans of our armed forces for the defeat of Japan, as they stood in July, had been prepared without reliance upon the atomic bomb, which had not yet been tested in New Mexico. We were planning an intensified sea and air blockade, and greatly intensified strategic air bombing, through the summer and early fall, to be followed on November 1 by an invasion of the southern island of Kyushu. This would be followed in turn by an invasion of the main island of Honshu in the spring of 1946. The total U. S. military and naval force involved in this grand design was of the order of 5,000,000 men; if all those indirectly concerned are included, it was larger still....We estimated that if we should be forced to carry this plan to its conclusion, the major fighting would not end until the latter part of 1946, at the earliest. I was informed that such operations might be expected to cost over a million casualties, to American forces alone. Additional large losses might be expected among our allies and, of course, if our campaign were successful and if we could judge by previous experience, enemy casualties would be much larger than our own.

Soon after the Conference opened, Stalin casually remarked in a conversation with Truman that the Japanese had broached the subject of peace. The Soviet leader added that the Russians had brushed aside these suggestions as insincere. Because of Stalin's off-hand account of the conversations in Tokyo, the Americans attached little importance to Suzuki's efforts toward negotiations.[10] During the next few days the President attempted to get the exact date for the Russian attack in Manchuria. Then came the news from Alamogordo on 16 July. The Americans were no longer interested in when the Russians would intervene, or whether they ever intervened. It was evident that Japan could be defeated without assistance from Moscow and without the bloody costliness of the November invasion. The changed situation was very welcome but it meant that the President was faced with a "terrible decision."[11]

The President and the Prime Minister and their advisers had serious discussions. They reviewed the advisability of warning the Japanese of the existence of the bomb and also of staging a demonstration of the weapons devastating power. In the end they sustained the recommendations made to the President on 1 June by the Interim Committee—the bomb would be dropped. However they hoped that the threat of overwhelming force, as mentioned by Stimson in his memorandum of 2 July, might suffice to bring the Japanese to their senses and so avoid the necessity of an atomic strike. After informing Stalin of the atomic program and the successful test at Alamogordo the Allies began the preparation of a formal Declaration calling on the Japanese to surrender.[12]

Before the Declaration was ready for issuance, Truman met his advisors--Stimson, Marshall, and Arnold--and together they made the plans for the 509th Composite Group to drop the bomb on Japan as soon as practicable after 1 August, provided that the Japanese had not in the meantime sued for peace. Later on, when he wrote his memoirs of these historic moments, Truman said:[13]

> The final decision of where and when to use the atomic bomb was up to me. Let there be no mistake about it. I regarded the bomb as a military weapon....The top military advisors...recommended its use, and when I talked to Churchill he unhesitatingly told me that he favored the use of the atomic bomb if it might aid to end the war.
>
> In deciding to use this bomb I wanted to make sure that it would be used as a weapon of war in the manner prescribed by the laws of war. That meant that I wanted it dropped on a military target....
>
> Stimson's staff had prepared a list of cities in Japan that might serve....as targets: Hiroshima, Kokura, Niigata, and Nagasaki....The order...was in accordance with the military importance of the cities but....General Spaatz, who commanded the Strategic Air Force....was given some latitude as to when and on which of the four targets the bomb would be dropped. That was

necessary because of weather and other operational considerations.*

Word of the President's decision was flashed to Washington on 24 July, with instructions to give Spaatz--then in the capital preparatory to his assumption of command of the Strategic Air Forces on Guam—as much latitude as possible in executing the atomic mission.[14] The next day General Thomas T. Handy, Acting Chief of Staff in Marshall's absence, personally gave Spaatz the following directive:[15]

WAR DEPARTMENT
OFFICE OF THE CHIEF OF STAFF
Washington, D. C.

25 July 1945

TO: General Carl Spaatz
Commanding General
United States Army Strategic Air Forces

1. The 509th Composite Group, 20th Air Force will deliver its first special bomb as soon as weather will permit visual bombing after about 3 August 1945 on one of the targets: Hiroshima, Kokura, Niigata and Nagasaki. To carry military and civilian scientific personnel from the War Department to observe and record the effects of the explosion of the bomb, additional aircraft will accompany the airplane carrying the bomb. The observing planes will stay several miles distant from the point of impact of the bomb.

2. Additional bombs will be delivered on the above targets as soon as made ready by the project staff. Further instructions will be issued concerning targets other than those listed above.

3. Dissemination of any and all information concerning the use of the weapon against Japan is reserved to the Secretary of War and the President of the United States. No communiques on the subject or releases of information will be issued by commanders in the field without specific prior authority. Any news stories will be sent to the War Department for special clearance.

*In the early part of 1958 Tsukasa Nitoguri, Chairman of the Hiroshima City Council, challenged the wisdom and justice of Mr. Truman's decision. In reply the former president said that the question of dropping the bomb "never would have arisen had we not been shot in the back by Japan at Pearl Harbor." He added that even then the bomb was not dropped until after Japan rejected the Allied ultimatum from Potsdam, and he pointed out that its use probably saved 500,000 Japanese lives. Facts on File, 1958, p. 86. Truman made his statement on 4 Mar 1958.

4. The foregoing directive is issued to you by direction and with the approval of the Secretary of War and of the Chief of Staff, USA. It is desired that you personally deliver one copy of this directive to General MacArthur and one copy to Admiral Nimitz for their information.

/s/ Thos. T. Handy
/t/ Thos. T. Handy
General, G.S.C.
Acting Chief of Staff.

The next day, 26 July, the Declaration of Potsdam was issued in the name of the United States, the United Kingdom and China—although the Generalissimo Chiang Kai-Shek knew nothing of the atomic bomb. The Declaration was based on Stimson's memorandum of 2 July, and demanded the unconditional surrender of the Japanese armed forces rather than of the Japanese Government.[16] The Tokyo peace party was pleased with the proffered terms. Despite strong opposition on the part of the militarists, the Emperor and the cabinet agreed that the Declaration was most encouraging and could not be rejected. On 27 July a modified version of the document was released by the Japanese Foreign Office which made the Allied conditions seem even more favorable in the eyes of the people. The Declaration, however, had been received via radio and not through the normal channels of a neutral embassy or legation, and the cabinet concluded that, for the time being, the Government should avoid a definite commitment. The Emperor, Suzuki and the cabinet decided simply "to wait and see", but their hopes were high.

It was then that Suzuki made his second great mistake. He permitted the Japanese press to state on 28 July that the Government would pursue a policy of mokusatu. The word is very ambiguous, and the Prime Minister may have intended to convey the impression that he had "no comment". But the term could also mean "to kill with silence" or "to ignore", and it was so translated by Domei and broadcast by Radio Tokyo as the official reply to the Allies.[17]

In Tokyo Suzuki's blunder cost him the victory he had recently gained over the militarists and before he could make another move for peace he had to reacquire his ascendency over his domestic enemies. In Potsdam the Domei report was accepted as final,[18] and the President radioed Washington that the bomb should be dropped as provided in the directive to Spaatz. Thereafter the atomic operation, code-named CENTERBOARD, moved on with the relentlessness of destiny.[19]

Operation CENTERBOARD: Strike One and Two

As the final decisions were being shaped at Potsdam, it was concluded at Tinian, where the 509th Composite Group had assembled in full, that it would be unwise to keep the air crews of the 393rd Bomb Squadron inactive while awaiting the word to drop the bombs. Tibbets therefore decided that the crews could be used operationally and to their own advantage by raiding enemy targets with PUMPKINS, which were FAT MAN cases equipped only with the HE components. On 20 July ten aircraft divided into small formations of three to four planes were dispatched against several individual targets despite a forecast of 6/10 to 9/10 clouds. All these planes, except one, bombed either primary or secondary targets, and all but one bombed by radar. On 24 July another force of ten aircraft, organized into small formations, was again dispatched against Japan. In this case, nine planes bombed visually and one by radar. Results were reported as excellent. Then on 26 and 29 July two other forces of ten aircraft were sent out. These forty sorties gave ten crews of the 509th four missions each over Japan, and the enemy became accustomed to formations of three or four bombers and regarded the attacks as little more than nuisance raids.[20]

In the pre-atomic practice missions, the 509th suffered no losses as a result of enemy action. Indeed, the enemy did not rise to offer opposition in the air, and the anti-aircraft fire was ineffectual. However, because several B-29's belonging to other units crashed in take-offs, it was decided to provide extra precautions to avoid a possible detonation of the first atomic bomb on the home field. Originally it was intended to complete the bomb assembly before the weapon was loaded, but, on Captain Parson's suggestion, plans were changed to perform final assembly after take-off. This late decision necessitated a field modification of the bomb bay to provide a place for the weaponeer to stand while completing the assembly.[21]*

In 1945 the nuclear components of an atomic bomb represented an appreciable item in the economy of the nation, and it was imperative that every precaution be taken to deliver the material to the 509th Composite Group. For the sake of safety and to minimize the loss, if loss there should be, the fissionable material to be used in the first LITTLE BOY weapon was sent to Tinian in four shipments. One part went by cruiser, the USS *Indianapolis* which slipped quietly into the Tinian port on 24 July. Relieved of its mysterious cargo the *Indianapolis* put to sea at once, only to be torpedoed and sunk by the Japanese.** The remaining three section of U-235 were flown

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*This precaution was in addition to the use of the red plug, and wasa special protection against a fire-ignited detonation in case of a crash and conflagration at take-off. See asterisk footnote, p. 77.

**The sinking of the *Indianapolis* has been told by R.J. Newcomb, *Abandon Ship* (New York, 19[illegible]).

[redacted] to Tinian in three otherwise empty Air Transport Command C-54's, which arrived 28 and 29 July. The nuclear components of the implosion-type weapon plus several FAT MAN non-nuclears were transported from Sacramento to Tinian by three of the 509th's SILVERPLATE B-29's. One of these aircraft, Captain Edward M. Costello's Laggin' Dragon, was almost lost at take-off when the life-raft door blew open and became entangled with the right elevator.[22]

On 30 July, Brigadier General Thomas Farrell, the operational deputy for General Groves, reached the island and the 509th was ready for its history making missions. The first bomb could have been dropped 31 July as far as the Composite Group was concerned. But the Potsdam decisions were not delivered to the 509th until 1 August, being transmitted by the Twentieth Air Force in the form of a directive. The next day, 2 August, Field Order No. 13 for the 509th Group was signed "by command" of General Twining. After that, because it was considered essential that both bombs be dropped visually, it was merely a matter of waiting for good weather.[23]

The Field Order named the cities of Hiroshima, Kokura, and Nagasaki as the primary, secondary, and tertiary targets, respectively, of the first atomic mission, CENTERBOARD Strike One. Plans called for the use of seven B-29's. Three weather planes were to be dispatched in advance of the attack, one to each of the three cities. In the strike force there were also to be three planes—the bomb carrier, the Enola Gay* with Tibbets as pilot; the instruments plane, The Great Artiste** with Major Charles Sweeney as pilot; and the photography plane with

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*The plane was named for Col Tibbets' mother.

**Named for Capt Kermit K. Beahan, the bombardier.

Field No. 91 and with Captain George Marquart as pilot.* A seventh B-29 was a stand-by at Iwo Jima where there were pit facilities for unloading and reloading the bomb in case of an abort. All other planes were excluded from the target area from four hours before until six hours after the blast at which time, it was hoped, two F-13's might approach the destroyed city to photograph the damage.[24]

Although Tibbets had long understood the significance of his assignment he still faced the uncertainties of delivering a weapon of unimaginable power without having seen the proto-detonation. It had been planned for Tibbets and Begg to witness the blast at Alamogordo, but the late postponement of TRINITY to 16 July made it necessary for them to go to Tinian before the shot. Immediately after TRINITY, movies and still photographs of the blast were flown to 509th Headquarters. Lack of space in the Briefing Room precluded proper focusing for the movies, but the stills were carefully studied.[25]

Even after the move to Tinian few members of the 509th knew the real purpose of their work, so a special briefing was held 4 August for the officers and enlisted men of the aircraft in the strike force. The nature of the bomb was not mentioned, but the crews were shocked to learn that the weapon would have a force equivalent to 20,000 tons of TNT. Another briefing was held at midnight 5-6 August. Iwo Jima was established as the rendezvous point for the Enola Gay, The Great Artiste, and Aircraft No. 91. [redacted] There were Last minute details ~~were given~~ of weather

*No. 88, later named UP AN' ATOM, was Capt Marquart's regular plane. Marquart and his crew were transferred to a/c No. 91 for Strike One.

and arrangements for air-sea rescue.[26] In an effort to concentrate attention upon the safety of crews, no provision was made to photograph the actual detonation.

The final briefing was followed by breakfast and the customary pre-mission activities. The weather planes took off about 0130 in the morning of 6 August. At 0245 the Enola Gay was airborne and began the flight of more than 1600 miles to its target. With Tibbets was Major Thomas W. Ferebee as bombardier. Captain Parsons was weaponeer, assisted by Lieutenant Morris R. Jeppson, AAF, of the 1st Ordnance Squadron. Through long work with the practice bombs, Jeppson was technically competent to serve as weaponeer despite his lack of years and rank. First Lieutenant Jacob Beser, AAF, of the 393rd Squadron, served as the radar-countermeasure officer.[*] At take-off the Enola Gay was followed at two minute intervals by The Great Artiste and Aircraft No. 91.[27]

The flight was uneventful and perfectly timed.[**]

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*Beser was the only one who flew in the Bomb Carrying Aircraft for both of the atomic raids on Japan.

**The progress of the CENTERBOARD Strike One mission is succinctly described as follows in the log kept by Parsons during the flight:

August 6, 1945

0245 Take Off
0300 Started final loading of gun
0315 Finished loading
0605 Headed for Empire from Iwo Jima
0730 Red plugs in
0741 Started Climb
Weather Report received that weather over primary and tertiary targets was good but not over secondary target.
0838 Leveled off at 32,700 feet
0847 All Archies (electronic fuzes) tested to be O.K.
0904 Course West
0909 Target (Hiroshima) in sight
0915 Dropped bomb (originally scheduled time was 0915)
Flash followed by two slaps on plane. Huge cloud.

(Cont'd on following page)

[redacted] At 0740 Parsons announced that the bomb was ready. The rendezvous point was reached on schedule and the flight continued to the Empire. At 0815 a weather plane reported from Hiroshima "2/10 lower and middle, and 2/10 at 15,000 feet." On the basis of this report Tibbets decided to drop on Hiroshima. The bomb was given a final check at 0905. The initial point was reached at 0911 and at 0915 Ferebee toggled the weapon. Altitude was 31,600 feet and ground speed was 328 miles per hour. Tibbets turned 150 degrees and nosed down to gain speed. When the *Enola Gay* was fifteen miles from the target, slant range, the bomb detonated at an altitude of 2,000 feet and with a force of 15 KT according to the parachuting condenser gauges. [redacted] The flash was followed by shock waves distinctly felt on the plane, and the crew observed the awesome ball of fire. As the mushroom cloud was surging upward to an altitude of 50,000 feet,[28] it was "unofficially" photographed from the tail of the *Enola Gay*.

Having ascertained the safety of *The Great Artiste* and No. 91, Tibbets reported the success of the mission to a few interested persons at Tinian and began the long flight home leaving behind him the fiercely burning city. Six hours later the two F-13's found the

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**(Cont'd from preceding page)

1000 Still in sight of cloud which must be over 40,000 high
1003 Fighter reported
1041 Lost sight of cloud 363 miles from Hiroshima with the aircraft being 26,000 feet high.

The quotation from the log is taken from the Los Alamos Laboratory, *Nuclear Weapons Engineering and Delivery*, LA 1161, Jul 1946, p. 152.

smoke still too dense for photographic work,*

At 1500 that afternoon, twelve hours and fifteen minutes after take-off, the Enola Gay reached Tinian. There were a few soldiers near the tower, but the number grew as General Spaatz drove up and walked across the field to the B-29. As Tibbets left the plane "Attention to Orders" was called and Spaatz awarded the Distinguished Service Cross to the pilot. Few of those who witnessed the ceremony understood its significance.[29] Indeed, most of the personnel on Tinian got their first knowledge of the bomb while listening to later radio programs from the United States. Nothing could more clearly demonstrate the success with which the secret had been kept.[30]

Despite the fact that Japan had already suffered a loss of 50 per cent of its war making potential through previous bombings of the Twentieth Air Force, the first atomic bomb did not appear to daunt the determination of Tokyo to continue the struggle. It was, therefore, decided to execute a second atomic mission, designated CENTERBOARD Strike Two, using a FAT MAN weapon, and scheduled for 13 August. Plans duplicated those of the Hiroshima raid and called for three weather B-29's to precede the bomb carrier which was to be accompanied by two other planes for instruments and photography. Sweeney, as CO of the 393rd, was chosen by Tibbets to deliver the bomb. Captain Kermit K. Beahan was bombardier and Commander F. L. Ashworth, USN, was weaponeer. Lieutenant Philip Barnes, of the 1st Ordnance Squadron, was assistant weaponeer, and Beser again served as radar-countermeasure officer.

On 8 August there was a sudden change in plans. The weather at the time was good but the forecast was for several days of bad

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*Pictures of the damage were not taken for five days.

weather over Japan beginning 10 August. The decision was made to stage Strike Two for 9 August and take-off time was set for the hours of early dawn. Even then the weather was deteriorating and the original plans for a rendezvous of the bomb carrier with the instrument and photography planes at Iwo Jima were cancelled. The route would be from Tinian direct to Yakoshima on Kyushu for rendezvous, and thence to Kokura or Nagasaki as the primary and secondary targets. Visual bombing was prescribed.[31]

Because their plane, The Great Artiste, had been modified to drop blast gauges, Sweeney and his crew were transferred to Bock's Car, and Captain F. C. Bock, and his crew, flew The Great Artiste as the instrument plane.* The Full House served as the photography plane, but it was not piloted by Major Ralph Taylor. He was replaced on that one flight by Major J. I. Hopkins who was the

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*This shift in crews, of no importance, resulted in considerable comment because of an inexplicable reluctance to admit that the bomb was dropped by BOCK'S CAR. The mistake may have originated in press releases prepared as soon as Sweeney was selected to pilot the bomber for Strike Two. Interviews by H. L. Bowen with Lt Col K. K. Beahan, 9 May 1953; Mr. Jacob Beser, 1 Jun 1953; and Mr. J. D. Buscher, former Intelligence Officer, 509th, 8 Jun 1953. Why the error was perpetuated has never been explained. W. D. Laurence rode as a passenger in THE GREAT ARTISTE with Bock, but in his Dawn Over Zero (New York, 1946, p. 230) he wrote that the bomb was being carried in THE GREAT ARTISTE whose number was 77. But 77 was the number of BOCK'S CAR. The number of THE GREAT ARTISTE was 89. (Prints A-59474 AC, 35571 AC, and 39807, Photo Service Hq ACIC) The Photographic Album of the 509th had its text written by personnel of the Group before they left Tinian. Certainly some of these writers knew that the drop was made by BOCK'S CAR, yet it was specifically stated that the bomb was dropped by THE GREAT ARTISTE. Capt F. L. Ashworth did not mention the names or numbers of participating aircraft in his address at Ft. Belvoir, "The Atomic Bomb at Nagasaki," 23 Sep 1946. But on 1 May 1953 Capt Ashworth said he knew the bomb was dropped by BOCK'S CAR. In official dispatches it was said that the bomb was dropped by the a/c with the Serial Number 44-27297 which was BOCK'S CAR and in one instance the plane was mentioned by name. Moreover, the ENOLA GAY and BOCK'S CAR were sent to the AF Museum at David-Monthan Field as the planes which dropped the first two atomic bombs.

Operations Officer of the 509th. Taylor's crew served with Hopkins.

At midnight the three weather planes, the bomb carrier, and its two accompanying aircraft were fueled and checked. Everything seemed in order, but once underway the CENTERBOARD Strike Two mission suffered a series of bad breaks.*

The three weather planes took off at 0230 A.M. They reached Japan

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*These misfortunes are indicated though not elaborated in Ashworth's log which is taken from LA 1161, p. 154-155, and quoted in full:

August 9, 1945.

0347 Take Off
0400 Changed green plugs to red prior to presurrizing
0900 Arrived rendezvous point at Yakoshima and circled awaiting accompanying aircraft.
0920 One B-29 sighted and joined formation.
0950 Departed from Yakoshima proceeding to primary target Kokura having failed to rendezvous with second B-29. The weather reports received by radio indicated good weather at Kokura (3/10 low clouds, no intermediate or high clouds, and forecast of improving conditions). The weather reports for Nagasaki were good but increasing cloudiness was forecast. For this reason the primary target was selected.
1044 Arrived initial point and started run on target. Target was obscurred by heavy ground haze and smoke. Two additional runs were made hoping that the target might be picked up after closer observation. However, at no time was the aiming point seen. It was then decided to proceed to Nagasaki; approximately 45 minutes spent in the primary target areas.

1150 Arrived in Nagasaki target area. Approach to target was entirely by radar. At 1158 the bomb was dropped after a twenty second visual bombing run. The bomb functioned normally in all respects.

1205 Departed for Okinawa after having circled smoke column. Lack of available gasoline caused by an inoperative bomb bay tank booster pump forced decision to land at Okinawa before returning to Tinian.

1351 Landed at Yontan Field, Okinawa
1706 Departed Okinawa for Tinian
2245 Landed at Tinian

about an hour before the bomber but they were of little assistance since their reports were inaccurate. By 0349 when Bock's Car took off--followed at two minute intervals by The Great Artiste and Full House--there were thunderstorms at Tinian. These conditions continued and the flight to Yakoshima had to be kept at an altitude of 17,000 feet. While the carrier flew through considerable turbulence, the bomb's internal inverter failed and for a short time threatened the success of the mission. Sweeney reached rendezvous point at 0900, which was prompt. Five minutes later another B-29 was seen but it could not be identified immediately either as The Great Artiste or Full House. Particularly desirous of having the instruments plane with him but unwilling to break radio silence, Sweeney circled the rendezvous point until The Great Artiste was recognized by observation. The Full House was never sighted from Bock's Car. Hopkins may have missed the rendezvous point altogether or he may have been circling Yakoshima at an altitude too high to be seen by Sweeney. Because of the drain on his fuel supply, Sweeney decided at 0945 to resume course without the missing Full House,[32] and five minutes later headed for Kokura.

Major Sweeney's concern for fuel as early as 0945 brings up an interesting point. Somewhere in the course of the Strike Two mission there was a failure of the fuel booster pump on Bock's Car, and it precluded the use of 800 gallons of 'gas in the aircraft's auxiliary tanks. Ashworth's log makes no mention of this handicap until 1205 after the bomb had been dropped. On the other hand, some members of the crew have said that the faulty pump was discovered before take-off and that the flight was deliberately begun as a calculated risk. Other members of the crew have been equally positive that the plane was circling the primary target when it was found that the pump would not work.[33] Whatever the truth may be, it is certain that Sweeney was worried about fuel by the time that the Full House failed to meet its rendezvous schedule at Yakoshima. Thereafter Sweeney's concern increased with every delay,

Shortly after leaving point rendezvous, the first of the reports came from the weather observation planes. It was indicated that Kokura, the primary target, was generally clear with 3/10 low cloud cover which was expected to dissipate. A little later the report came through the Nagasaki was and probably would remain clear. In view of this information, Sweeney decided to attack Kokura. However, upon arrival, the city was found to be largely obscured by haze and smoke from Yawata which had been fire bombed the night before. A run over the target failed to find an opening in the smog. Since it had been directed that the bomb sight cross hairs had to be on the target before a drop was made, Beahan could not toggle. The flight engineer recommended that the aircraft be taken to another target, but Sweeney felt obligated to make two other runs over Kokura, thereby consuming forty-five minutes with engines set at full war power. By that time some flack was reaching the level of Bock's Car and Japanese fighters began to climb toward the bomber. After more discussion, Sweeney decided with Ashworth's approval to abandon Kokura and attack Nagasaki.[34]

When Bock's Car left Kokura there were only 1200 usable gallons of fuel in the tanks—enough to get the bomber to Nagasaki and on to Okinawa, provided that the aircraft could be freed of the weight of the bomb. Since the weapon was much too valuable to be wasted in an abort it was essential to make a drop on the secondary target. To save distance Sweeney flew straight across Kyushu. Even so fuel became dangerously low. On the bombing run to the target, radio silence was broken twice. A last-minute effort was made to locate Full House, and air-sea rescue was alerted to the possibility of ditching in the vicinity of a surface vessel whose position had been given during the last briefing at Tinian.[35]

During the run from initial point to the target, Nagasaki appeared to be closed in with low lying clouds. Although orders had been to bomb visually for greater accuracy, Ashworth feared the bombing would have to be by radar. The initial portion of the bomb run was then set up by the radar team, but twenty seconds from the release point the bombardier found he could see the target. He then took over the bombing run from the radar operator and used the Norden bombsight. The weapon was toggled at an altitude of 28,900 feet. Detonation occurred at 1102 with a brilliant white flash. The yield was erroneously estimated by condenser gauges, as 42 KT, The muchroom rose to 30,000 feet within five minutes and then went on up to 50,000 feet. As soon as the shock wave passed, Bock's Car turned back and circled the cloud twice in an effort to evaluate the damage done, but low level clouds shut out all sight of the burning city. Sweeney's crew, which had flown The Great Artiste as instrument plane on the Hiroshima raid, considered the second blast the greater of the two.[36]

The trip from Nagasaki to Okinawa was uneventful. When he approached Yontan Field, however, Sweeney was unable to cont[illegible] control tower by radio, and Bock's Car [illegible] pattern without permission. Although Sweeney [illegible] all of the pyrotechnics on board his aircraft, the control tower remained silent. Without guidance, Sweeney landed half-way up the 7,000-foot runway and avoided a crash at the end of the field by using the electrical reverse pitch propellers. The big bomber refuelled as quickly as possible, took off for Tinian without further delay, and landed there at 2230, nineteen hours after departure.*[37]

Shortly after Sweeney made his landing at Okinawa, Hopkins also brought in Full House. He explained that after his failure to effect rendezvous at Yakoshima he proceeded to the Empire on his own. It appears that while Sweeney was making his runs at Kokura, Hopkins sighted an unidentified explosion elsewhere and used most of his film on this unimportant blast. Later Hopkins saw the cloud at Nagasaki but arrived there after Sweeney left. However, from the data

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*The Japanese had seemed so determined after the Strike One mission to continue the war that at the same time plans were made for Strike Two it was decided to prepare for a Strike Three mission as well. About the same time that Sweeney took off in BOCK'S CAR for the Kokura-Nagasaki targets Col Classen and Maj J. A. Wilson left Tinian for ZI to get the nuclear components for additional bombs. Plans called for Strike Three to be directed against Tokyo in darkness. Certainly greater destruction could be wrought against a clean target but it was hoped that the psychological effects of the light as well as the blast of an atomic bomb would bring the Japanese Government to its senses. (Telecon 11-14, from Norstad to Spaatz, 11 Aug 1945) After the difficulties encountered in the rendezvous of the Strike Two aircraft, Parsons and Farrell argued that in the future photography should be on a catch-as-catch-can basis. If there had been a Strike Three it is probable that the bomb carrier would have made the trip with the instrument and photography planes. Of course, before Classen and Wilson could return, the Japanese surrendered and thereby precluded the need for the third mission. (Msg No. 5788 from CG 20th AF, Guam, for War Department, CM-IN-19362, 20 Aug 1945; Msg No APCOM 5909 from CG 313 Bomb Wing, Tinian, to War Department, 26 Aug 1945; Msg No APCOM 5722 from CG 313th Bomb Wing, Tinian, to War Department (Farrell to Groves), 17 Aug 1945.

collected by Hopkins it became clear that Bock's Car approached the target about two miles off course. The error shifted the point of detonation toward the suburbs, and left the city behind a semi-protective shield of encircling hills. [38]

Of course the novelty of the weapons and their significance for the future aroused an intense curiosity about effects. Even before the end of hostilities attempts were made to evaluate the damage done at Hiroshima and Nagasaki. The first estimate was based on photographs from an F-13 on 11 August. The second estimate was made by an inspection party which General Farrell took to Japan as soon as the military situation permitted.* [39] There followed a number of American and Allied commissions for more thorough studies. The most valuable reports were made by the United States Strategic Bombing Survey (USSBS) and the British Mission.** [40]

At Hiroshima the gun-type weapon devastated 4.1 square miles, demolished 40,000 out of 50,000 buildings, killed 80,000 inhabitants, and wounded an equal number. [41] The implosion bomb was a more powerful weapon but was less destructive at Nagasaki because of the topographical factors. Here the area of complete destruction was restricted to 1.8 square miles, and casualties were limited to 40,000 dead and 40,000 wounded. [42]

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*An account of Gen Farrell's visit to the bombed cities, written by Maj Gen R.C. Wilson, is attached as an appendix to this chapter.

**Both surveys began in Oct 1945 and continued for approximately ten weeks. The investigations had the the cooperation of the Japanese.

Postscript to CENTERBOARD *

The war-time effort to master atomic energy was the greatest intellectual venture ever attempted up to that time. In its tragic climax the program shared the "mingled yarn, good and ill together,"** that is human history.

The President received word of the successful attack on Hiroshima while on board the USS *Augusta* returning to the United States after the Conference of Potsdam. At once he authorized the War Department to release a statement prepared by him before he left for Germany. He explained that the bomb used an "explosive" 20,000 times as powerful as a ton of TNT. The "greatest marvel...is the achievement of scientific brains in putting together infinitely complex pieces of knowledge held by many men in different fields of science." Once more he called on Japan to surrender or face destruction.[43]

For the first time the world appreciated the real significance of the Potsdam Declaration. Nowhere was the greatness of the scientific achievement underestimated, and there was thankfulness that the war would have to end at once. But men and women everywhere were shocked. Even when dulled by time the disaster of Hiroshima remains disturbing though morally it cannot be worse to kill 80,000 people

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*For the sake of the record Appendix II of this Chapter contains a list of the fifteen airplane commanders of 393rd Squadron and, whenever possible, the names, field numbers and full serial numbers of the fifteen SILVERPLATE aircraft on Tinian, with the names of the air and ground crews. There is also a list, as complete and authentic as could be made with available sources, of those who flew on the Strike One and Two bombers.

***All's Well that Ends Well*, Act IV, sc 3.1.82.

with one blast than it is to kill the same number in twenty raids using high explosive bombs. It was the power of the weapon, and its unpredictable impact upon the future that was frightening.[44]

In Japan the Government's reaction, and that of the people, was considerably less accute than in other nations, due, no doubt, to the strange fact that the Japanese did not understand what had happened.

So great was the disaster at Hiroshima that only meagre accounts reached Tokyo for nearly twenty-four hours. It was not until the morning of 7 August that a telegram came through stating that the whole city had been destroyed by a single bomb. By that time, of course, Tokyo also had radio transcriptions of the President's statement, but most Japanese authorities remained incredulous and dismissed the whole thing as American propaganda. The political situation remained under the control of the war party, and the militarists spoke of the reports from Hiroshima as most exaggerative. Even those few who had a realistic knowledge of what had happened believed that the United States did not have sufficient fissionable material for a second bomb.[45] Hence, to the disappointment of the Allies the Japanese Government did not immediately capitulate, and it was necessary to prepare for the Strike Two mission.

During the succeeding two days the peace party continued to base its hopes for a negotiated settlement on the good graces of Moscow. On 7 August, after the return of the Russian delegation from Potsdam, the Japanese Ambassador was summoned to see Molotov at 1700 on 8 August. Sato was stunned when the Soviet Foreign Minister read the Russian declaration of war, to be effective at midnight. Two hours later, 0100 of 9 August Tokyo time, the Russians struck in Manchuria.

They were met only by the depleted Kwantung Army whose strength had already been withdrawn to Japan to defend the homeland against the anticipated invasion of Anglo-American armies.[46] At approximately the same time that hostilities began in Manchuria, Sweeney took off from Tinian on the Strike Two mission. Although there was no direct connection between the Russian invasion and the attack on Nagasaki, the two events were made known to the Japanese public as twin disasters.* It was quite clear to every reasonable person that the last chance had passed for anything less drastic than surrender. It could be only a matter of days before all of Manchuria would be lost, and apparently the Americans had a commanding stockpile of atomic weapons which could turn Japan itself into ruins.

On 10 August the Japanese Government agreed to accept the Potsdam Declaration if the Emperor could remain chief of state. The Allies gave the assurances that Tokyo desired and on 14 August hostilities

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*There is one point in connection with the Russian intervention that should be made here. On 29 July Molotov went to the Secretary of State, James Byrnes, and said that the Soviet-Japanese Neutrality Pact, signed 13 Apr 1941 and to be effective until 13 Apr 1946, stood in the way of a Russian declaration of war even though on 13 Apr 1944 Moscow had warned that the agreement would not be renewed. Molotov suggested it would be helpful if the United Kingdom and the United States formally requested the Soviet Government to intervene. This placed the United States Government in the position of asking another nation to violate its agreement with a third power. After involved consultations, the President approved a letter to Stalin asking the Soviets to enter the war. The President pointed out that under Article 103 of the Charter of the United Nations a conflict in obligations between the Charter and any other agreements, the obligations under the UN Charter would prevail. The letter concluded: "Though the Charter has not been formally ratified, at San Francisco, it was agreed to by the Representative of the Union of Soviet Socialist Republics and the Soviet Government will be one of the permanent members of the Security Council." This somewhat strained logic permitted the Kremlin to declare war despite its treaty obligations not to do so. (James F. Byrnes, Speaking Frankly (New York, 1947), p. 207-09.)

ceased. Formal surrender occured in Tokyo harbor, on board the USS *Missouri*, on 2 September 1945.

The role of atomic weapons in bringing about the Japanese surrender remains disputable. It seems reasonable to assume that without the bombs, and even without Russian intervention, the Japanese would have come to ~~the same~~ a military end within a ~~few~~ months. On the other hand, but for Suzuki's two blunders--the pursuit of peace through Russia and the *mokusatu* policy toward the Declaration of Potsdam--the war's end ~~war~~ could have ~~terminated~~ negotiated in July without either the atomic bombs or the invasion of Manchuria. Once Suzuki let the control of the situation revert to the militarists, however, only something as apocalyptic as atomic fire and as overwhelming as the Russian attack could have saved mankind from the bloody invasion set for November.*47

More important than the effect of the bombs on the already defeated Japanese was the effect which atomic energy would have upon the future course of military and social history. Scarcity of fissionable material in 1945 precluded an abrupt and revolutionary break with the past in any field. Even so it would never be possible thereafter to ignore atomic weapons and the Air Force had constantly to adjust its own plans for offense and defense to the changing prospects of the atomic energy program.

*This same point was effectively made by a very distinguished Japanese, Toshikazu: (*Eclipse of the Rising Sun* (London), 1951, p. 217)

"One of the first questions asked me by the American war correspondents who swarmed into Tokyo with the vanguard of the occupation forces in September 1945 was, "Was it the atomic bomb or Russian participation in the war that was responsible for the surrender?" That is a difficult question to answer. It will probably always remain a debatable point. But to us who knew the inner development it seems that neither of the two basically changed the course of the war. It is certain that we would have surrendered in due time even without the terrific chastisement of the bomb or the terrible shock of the Russian attack. However, it cannot also be denied that both the bombs and the Russians facilitated our surrender. Without them the Army might still have tried to prolong resistance."

References for Chapter IV

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APPENDIX I TO CHAPTER IV

The following selection is a passage taken from the letter from Maj Gen R. C. Wilson to Col W. J. Paul, subject: Personal Recollections of Air Force Participation in Atomic Energy, 1944-1951, 5 Mar 1953:

When the first bomb was dropped, I received orders by phone (I was on TDY in the US from Okinawa) to find one Brig General Newman, somewhere in the Pacific, and to accompany him to Japan as soon as that became a possibility. I searched for General Newman in Hawaii, Guam, and the Mariannas, and found him eventually with the Army Headquarters on Okinawa.

I landed with him with the 11th Airborne Division at Yokohama. There we met Brig General Farrell, who was assembling a group of military and scientific people to examine the A-bomb effects on Hiroshima and Nagasaki.

We landed at Atsugi in late afternoon amid a scene of tremendous activity which gave the false impression of confusion. Aircraft were pouring troops and supplies into the airdrome. The troops were marshalled and marched away with great rapidity. Our party was promptly placed in jeeps and headed for Yokohama.

I was impressed by the orderliness of the population. Few civilian men were in evidence along the road. Most of the men we encountered were marching, unarmed, apparently en route to demobilization points. They passed us in dignified silence without looking our way. The women we met for the most part silently turned their backs; but the children waved and cheered and held up the Churchillian "V" sign.

My first sight of Yokohama was shocking. The outskirts through which we entered were literally burned to the ground. The populace was living in dugouts or shanties built of all sorts of scraps, rags and metal. Sanitary facilities appeared to be totally lacking.

The main part of the city appeared relatively undamaged. We secured lodging in an apartment house which obviously had been abandoned in haste. Night had fallen before General Newman and I went to look for General Farrell, who was in a waterfront hotel just requistioned for General MacArthur. .

The streets of Yokohama were pitch black and we had to feel our way on foot along an alley to reach the hotel. This we did with pistols prudently (if self-consciously) drawn.

Turning out of the alley we came suddenly upon MacArthur's hotel. A platoon of guards with fixed bayonets was lined up in front. The scene was lighted by two great flaming torches, one on either side of the door. Their flickering light gave a dramatic and ominous appearance to the armed guards. It was an awesome spectacle reminiscent of the Dark Ages. They came to present arms as we entered the circle of light, the captain's command and the crashing arms ringing in the silence. Few sights or sounds of war impressed me as did that pointedly theatrical guard in a newly fallen city.

Just prior to the surrender, I accompanied Generals Farrel and Newman in a part of some eight people, including a professor from the University of Tokyo, to Hiroshima. We landed at a badly damaged airdrome some 20 miles south of the city where we requisitioned a bus to take us north. In spite of the assurances of our Japanese professor, notice of our arrival had not been sent to the local Japanese commander at Hiroshima. When we arrived it was to find that we were unexpected; that the commander misunderstood the purpose of our visit as a demand for his surrender and that he was extremely hostile. While we treated with this tiasan (sic), our professor appealed to the local priests for protection. The priests came to the headquarters where our two generals were having a most difficult and unfriendly interview, and spirited us away. We were taken to the sacred island of Myshima where word of our coming had been sent before us. The town was absolutely still, with all the windows shuttered and no people except the gendarmes in evidence. These stood at every street corner between us and the temple, and fell in to form a rear guard behind us as we passed.

Having gained the Temple, we were relieved of all our clothing and equipment, except our pistols which we insisted upon retaining, and after receiving a ceremonial bath and being supplied with kimonas, we were allowed the freedom of the Temple. There we remained for two nights and a day, until our status with the Japanese commander had been straightened out.

We then proceeded to Hiroshima, the physical damage of which had been adequately described. It was a hot August day with rain impending, but we were forced to keep the windows of our requisitioned automobiles closed because of the overpowering smell and the incredible swarms of blue bottle flies.

We returned to Yokohoma in time for the surrender ceremony on the Missouri, and left shortly thereafter for an inspection of the damage at Nagasaki.

The visit to Nagasaki involved a flight by Green Hornet C-54 from Atsugi to Omura. Admiral Byrd had been invited to come with us. The weather was bad and navigational aids few. We flew south of Kyushu and let down over the water to approach Omura at a few hundred feet, beneath the overcast. Omura, when located, was badly shot up and pitted with bomb craters. Wrecked and burned-out aircraft littered the field. The safest landing appeared to be across the hangar line apron. We got down but blew all four tires in breaking to a stop.

We radioed into the blue for help, describing our trouble and hoping that someone would pick up our message. Then we decided to continue into Nagasaki on our mission and to get through a message for help from there. (Later, when we returned to Amura we found that Okinawa had heard us, had sent up a crew, had changed our tires and departed!)

We requisitioned a bus which took us to Nagasaki through rice paddy districts elaborately organized for defense. We arrived in the street before the governor's office and summoned him to appear. The governor refused to meet us, sending word that he would receive us somewhat later at his convenience. Meanwhile we obviously were expected to stand humbly in the street. At this point, Admiral Byrd put on his most pompous manner and announced to the governor's functionary that he was the personal representative of the President of the United States (he was, too--but for the surrender ceremony) and that the governor would report to him immediately. The governor did, and we stated our mission and required his cooperation. He offered us full cooperation except that he said that he had no transportation. Japanese officers passed us now and then in Buicks but he seemed afraid to requisition their cars. However, after we stated that we would seize the next cars that passed, he produced what we needed.

Nagasaki was only partially destroyed and consequently better organized for recovery when we saw it. Shinto priests were still conducting cremation ceremonies at many points in the open. But the dead had been recovered and the wounded placed in hospitals.

The day after our arrival, Col D. C. Doubleday and I went down to the docks to watch the Marines land and seize the city. It was an impressive sight, but it was an error on our part to welcome the first landing craft. It spoiled the show and hurt the commander's feelings. Fortunately we returned to Omura that evening to look over the airplane; for the rest of our party, which went to a Geisha house to attend the now tamed governor's reception, was arrested by the Marines and charged with disorderly conduct (i.e., entering a house of ill-repute!)

I do not know how General Newman talked himself out of that charge but he must have had some difficulty for he returned to Omura next morning in a bitter mood.

Col Doubleday and I witnessed the arrival of the first liberated PW's at the docks in Nagasaki. They were Austrialians. Their condition was pitiful--emaciated, frail, wan and stooped, they could hardly shuffle to the boats which were to carry them to a hospital ship. My impression was that the stories of Japanese barbarity toward PW's could not have been exaggerated..

In September 1945 the party returned to the United States and after rendering its report to General Groves, it was disbanded and I was assigned as Deputy to General LeMay, then the newly assigned Deputy Chief of Staff for Research and Development.

APPENDIX II TO CHAPTER IV

A list of the fifteen bomber commanders of the 393rd Squadron, the names, field number, and full serial numbers of the fifteen SILVERPLATE aircraft on Tinian, the names of their air and ground crews, and a complete list of those who flew in the Strike One and Strike Two missions of the weapon carriers, THE ENOLA GAY and BOCK'S CAR.

1. Maj Ralph R. Taylor, Jr., Airplane Commander
   FULL HOUSE
   Field Number 83
   Serial Number
   1st Lt Michael Angelich, 1st Lt Fred A. Hoey, 2nd Lt Raymond P. Biel

   S/Sgt Theodore M. Slife, Cpl Richard B. Anselme, T/Sgt Robert J. Valley, M/Sgt Frank M. Briese, Cpl Nathaniel T. R. Burgwyn, Pfc Donald D. Fockler, Cpl William B. Reedy, Pfc Mario A. Litterio, S/Sgt Glen Mahugh, Jr., Sgt Chester A. Hammond, Sgt Steve J. Kinosh, Jr.

2. Capt Joseph E. Westover, Airplane Commander
   STRANGE CARGO
   Field Number 73
   Serial Number 44-27300
   1st Lt Robert M. Donnell, 2nd Lt John W. Dulin, 2nd Lt Louis B. Allen, 2nd Lt William J. Desmond

   Sgt Samuel R. Wheeler, S/Sgt William J. Spradlin, S/Sgt James H. Doiron, S/Sgt William J. Cotter, Cpl Dorward A. Stevens, Sgt Cleo E. Harter, Pfc Francis J. Merry, Pfc John H. Hubeny, Jr., Sgt Clyde R. Beecher, Cpl Filbert Reynolds, M/Sgt Robert E. Smithson.

3. Capt James N. Price, Jr., Airplane Commander

   Field Number 90
   Serial Number
   1st Lt William Collinson, 2nd Lt Thomas F. Costa, 2nd Lt Everist L. Bednorz

   S/Sgt Adam F. Castellitto, S/Sgt Robert H. Byrd, Sgt Fred E. Brown, M/Sgt James A. Adkins, Cpl Joe R. Brown, Cpl Clyde L. Bysom, Cpl Joe M. Madrid, Pfc Edward M. Josefiak, Cpl William R. Crotty, S/Sgt Raymond G. St. Myers, Pfc Donald E. Miller, S/Sgt Russell D. Carrigan, Cpl William R. Compronio.

4. Capt Edward M. Costello, Airplane Commander
LAGGIN' DRAGON
Field Number 95
Serial Number 44-86347
2nd Lt Harry B. David, 2nd Lt Robert J. Petrolli, 2nd Lt
Thomas H. Brumagin, 2nd Lt John L. Downey

Cpl James R. Bryant, M/Sgt Carleton A. McEachern, Sgt
Maurice J. Clark, Sgt David Purdon, Pfc James W. McGlennon,
Sgt Robert E. Holse, S/Sgt Robert J. Dowling, Pfc Fred D.
Butler, Cpl Robert R. Garn, Pfc Charles W. Rich, M/Sgt
John C. Hansen

5. Capt Ralph N. Devore, Airplane Commander
NEXT OBJECTIVE
Field Number 86
Serial Number 44-27299
2nd Lt Leon Cooper, 2nd Lt William J. Easton, 2nd Lt Franlin
B. Wimer, 2nd Lt William T. Hulse

Cpl Glenn S. Allison, Sgt Michael G. Bohon, Sgt Lee E.
Palmert, Cpl Clarence E. Britt, Cpl George F. Robinson
Cpl James R. Womack, Pfc Charles E. Schwab, Sgt Marion C.
Fowler, T/Sgt Forrest C. Anderson, Pfc Jerry Grubaugh, Jr.,
Sgt Mack Newsom.

6. Capt Charles F. McKnight, Airplane Commander

Field Number
Serial Number
1st Lt George H. [illegible]hen, 2nd Lt Franklin MacGregor, 2nd Lt
Jacob Y. Bor[illegible]koe, 2nd Lt Jack Widowsky

Sgt Roderick E. Legg, Sgt Lloyd J. Reeder, T/Sgt William F.
Orren, Jr., Cpl Donald O. Colo, Cpl Oscar J. Thigpen, Pfc
Frank E. Sutton, Sgt Carmine A. Genova, Cpl Chester J.
Krajewski, Pfc Francis J. Schramke, T/Sgt Arnold E. Sleipnes.

7. Capt Robert A. Lewis, Airplane Commander
ENOLA GAY
Field Number 82
Serial Number 44-86292
1st Lt Stewart W. Williams, 2nd Lt Richard McNamara, 2nd Lt
Harold J. Rider

S/Sgt Joe S. Stiborik, T/Sgt George R. Caron, Cpl Richard M.
Nelson, Sgt Robert H. Shumard, T/Sgt Wyatt E. Duzenbury, S/Sgt
Walter F. McCaleb, Pfc Harold R. Olson, Sgt Leonard W. Markley,
Pfc John E. Jackson, Pfc John J. Lesniewski, Sgt Steve C.
Lizak, Cpl Jean S. Cooper, Cpl Winfield C. Kinkade.

8. Capt George W. Marquardt, Airplane Commander
UP AN' ATOM
Field Number 88
Serial Number 44-27304
Capt James W. Strudwick, 2nd Lt James M. Anderson, 2nd Lt Russell Gackenbach

T/Sgt James R. Corliss, Sgt Anthony D. Capua, Jr., Sgt Melvin H. Bierman, Sgt Joseph M. DiJulio, Sgt Warren L. Coble, Cpl George P. Hammons, Pfc Carl C. Mason, Pfc Aram E. Bezdegian, Pfc Frank W. Berzinis, Sgt Mathew W. Huddleston, T/Sgt Joseph I. Gulick, Sgt George J. Brown.

9. Capt Herman S. Zahn, Jr., Airplane Commander
BIG STINK
Field Number 89
Serial Number 44-86346
1st Lt Henry Deutsch, 2nd Lt Gilbert B. Dickman, F/O Francis R. Ormond

S/Sgt Leander J. Baur, T/Sgt James K. Elder, Jr., Sgt Neil R. Corey, Sgt Gerald F. Clapso, Sgt Raymond E. Allen, Sgt Francis A. Pellegrino, Sgt Gerald J. Corcoran, M/Sgt Elbert E. Owens, S/Sgt Carl W. Rein, Cpl Lavern L. Holmes.

10. Capt Norman W. Ray, Airplane Commander

Field Number 91
Serial Number
2nd Lt Myron Faryna, 2nd Lt Stanley G. Steinke, 2nd Lt John E. Cantlon

Sgt Martin G. Murray, Sgt Thomas A. Bunting, M/Sgt George L. Brabenec, Cpl Richard F. Cannon, Sgt Francis X. Dolan, Pfc Edgar A. Poe, Jr., Pfc Troy D. Scott, Cpl Woitto T. Laine, Pfc Barton B. Crespin, Cpl Richard E. Blouse, S/Sgt William E. Egger, Cpl Paul C. Schafhauser.

11. Maj Claude R. Eatherly, Airplane Commander
STRAIGHT FLUSH
Field Number 85
Serial Number 44-27302
Capt Francis D. Thornhill, 2nd Lt Ira J. Weatherly, 2nd Lt Franklin Wey, 2nd Lt Thomas Grennon

Sgt Jack Bivans, Sgt Gillon T. Niceley, S/Sgt Pasquale Baldasaro, Sgt Albert Barsumian, Cpl Yivo J. H. Ping, Pfc Harold E. Knisley, Pfc Chester S. Chudy, Sgt Howard A. Thompson, T/Sgt Donald D. Beaudette, Cpl William E. Smith.

12. Capt Frederick C. Bock, Airplane Commander
BOCK'S CAR
Field Number 77
Serial Number 44-27297
1st Lt Charles Levy, 2nd Lt Hugh C. Ferguson, 2nd Lt Leonard A. Godfrey

Sgt Ralph D. Curry, Sgt William C. Barney, Sgt Ralph D. Belanger, M/Sgt Roderick F. Arnold, Sgt Robert J. Stock, Sgt Robert L. McNamee, Sgt John L. Willoughby, S/Sgt Frederic D. Clayton, Pfc Rudolph H. Gerken, Cpl Robert M. Haider.

13. Maj Charles W. Sweeney, Airplane Commander
THE GREAT ARTISTE
Field Number 89
Serial Number 44-27353
Capt Charles D. Albury, Capt Kermit K. Beahan, Capt James F. Van Pelt, Jr., 2nd Lt Fred J. Olivi

Sgt Abe M. Spitzer, S/Sgt Edward K. Budkley, M/Sgt John D. Kuharek, S/Sgt Albert T. Dehart, Sgt Raymond G. Gallagher Cpl Claude C. Gilliam, Pfc Robert E. Davenport, Cpl Allan L. Moore, S/Sgt Chester V. Pawiak, Pfc Theron L. Blaisdell, Cpl James J. Reilly, S/Sgt Charles B. Rinard.

14. Lt Col Thomas J. Classen, Airplane Commander

Field Number
Serial Number
2nd Lt W. M. Rowe, Capt W. E. Wright, Capt Bobby J. Chapman, 1st Lt Floyd W. Kemner

Cpl George A. Weller, Cpl Lee E. Caylor, S/Sgt Alfred A. Lewandowski, T/Sgt Omar G. Strickland (Ground crew not included.)

15. Major John A. Wilson, Airplane Commander

Field Number
Serial Number
2nd Lt James S. Duva, 2nd Lt E. T. Carrington, 2nd Lt Paul W. Gruning

M/Sgt J. W. Davis, Sgt V. J. Rowley, Cpl D. L. Rowe, Cpl C. A. Rogalski, S/Sgt G. H. Florence (Ground crew not included.)

A Complete List of Those Who Flew on the Hiroshima Mission of the ENOLA GAY:

Col Paul Tibbets, Pilot
Capt W. S. Parsons, USN, Weaponeer
Maj Thomas W. Ferebee, Bombardier
Capt Robert A. Lewis, Co-Pilot
Capt Theodore J. Van Kirk, Navigator
1st Lt Jacob Beser, Radar-Countermeasure Officer
2nd Lt Morris R. Jeppson, Assistant Weaponeer
S/Sgt W. E. Dusenbury, Flight Engineer
S/Sgt Robert H. Shumard, Airplane Mechanic-Gunner
S/Sgt G. R. Caron, Central Fire Control Gunner
Sgt Joe S. Stiborik, Radio Operator
Pfc R. H. Nelson, Radar Operator

A Complete List of Those Who Flew on the Nagasaki Mission of BOCK'S CAR:

Maj Charles Sweeney, Pilot
Cmdr F. L. Ashworth, USN, Weaponerr
Capt James F. Van Polt, Navigator
Capt Kermit K. Beahon, Bombardier
1st Lt Charles D. Albury, Co-Pilot
1st Lt Jacob Beser, Radar-Countermeasure Officer
2nd Lt Phillip M. Barnes, Assistant Weaponeer
2nd Lt F. J. Olivi, Assistant Co-Pilot
M/Sgt John D. Kuharek, Flight Engineer
S/Sgt Edward K. Buckley, Radar Operator
S/Sgt Albert T. DeHart, Central Fire Control Gunner
S/Sgt Raymond G. Gallagher, Assistant Flight Engineer
Sgt Abe M. Spitzer, Radio Operator

The British were represented on the mission by Group Capt G. Leonard Cheshire, British Military Mission to the United States, and Dr. William G. Penny, Professor of Applied Mathematics, University of London, and a member of the British group at Los Alamos. Whether they were present as observers on the Strike One Mission has not been definitely ascertained, but they certainly went on the Strike Two Mission, on Maj Hopkins' aircraft.

These lists were derived, partly from Army Telecon Msg 97155 to Washington, and Telecn Msg No 130001Z, subject: Atomic Bomb Message to Japan, 13 Aug 45, fr CG AAF 20 GUAM to CGUSTAF (Rear) Washington.

Chapter V

THE SHAPE OF OPERATION CROSSROADS

On 28 August, five days before the capitulation ceremony on board USS *Missouri*, Fleet Admiral Chester Nimitz, Commander-in-Chief, Pacific (CINCPAC), suggested in a dispatch to Washington that the surviving ships of the Japanese Navy be inspected and sunk. Of course any such action would be of international significance since it would involve British, Russian and Chinese interests as well as American. Before the Chief of Naval Operations, Fleet Admiral Ernest King, submitted the Nimitz proposal to the Joint Chiefs of Staff, James F. Byrnes, Secretary of State, left for London to attend the first post-war Conference of Foreign Ministers. He was away from 5 September until 4 October,* and JCS felt obligated to postpone action until Byrnes' return.[1]

Postponement of decision, however, did not preclude discussion. On 14 September Major General Curtis E. LeMay, AAF, the JCS Officer for the Atomic Bomb Project, informed General Ira Eaker, Deputy Commander and Chief of Staff AAF, of the plan.[2] That same day, seemingly by coincidence, Lieutenant General Barney Giles—Acting CG, United States Army Strategic Air Forces (USASTAF), in the absence of General Carl Spaatz who had left Guam for Washington—made the following recommendation to General of the Army H. H. Arnold, CG AAF:[3]

> We now have full information on the atomic bomb on land targets.** Strongly recommend that we use at least two more atomic bombs in the destruction of remnants of the Japanese fleet. One

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*The Conference opened 11 Sep and adjourned 2 Oct.

**This widespread opinion was changed by the two shots of CROSSROADS. Even though they were not used against land targets, they showed that there was much about atomic bombs still not understood

> atomic bomb should be statically discharged below the surface. I have discussed the matter with General MacArthur and he is in full agreement.

Four days later, 18 September, Arnold took this suggestion to JCS.[4] Although formal approval again had to be delayed because of Byrnes' absence,[5] the Joint Chiefs decreed that certain Japanese combat ships be preserved for experimental purposes, and directed General of the Army Douglas MacArthur, Supreme Allied Commander in Japan, to inventory the vessels and report on their condition.[6] Thus the Nimitz idea that the remaining ships of the Japanese Navy be sunk became one with the Giles recommendation that some Japanese vessels be used as atomic targets. The time had come to plan for the first formal atomic test.

Apparently JCS informed the Secretary of State of the Nimitz-Giles suggestion as soon as he came back to Washington from London. Byrnes must have given his tentative approval because, on 16 October, CNO declared in a statement to JCS that the "threat of atomic explosives is producing radical thinking about future warfare, which will influence the size and nature of the Army and Navy." He urged that the atomic test be enlarged by the use of surplus United States combat ships as part of the general target, and pointed to the Caroline Islands as an appropriate site.[7]

Two weeks later, 31 October, the Department of the State officially announced that the American, British, Chinese and Russian governments had agreed to destroy the major ships of the Japanese Navy and to divide among themselves the remaining thirty-eight destroyers. The agreement removed the diplomatic barrier to the atomic test. That same day Arnold gave his support to King's move of 16 October, and recommended that the Joint Staff Planners be instructed:[8]

1. To prepare, as a matter of priority, an outline of the type of tests to be conducted, the general requirements, and a listing of the desired information.

2. To recommend the agency to be selected for the implementation of the test.

3. To draft a directive to the implementing agency.

4. To prepare a written statement of these plans for submission to the President for his approval.

The JCS sanction was routine,[9] and on 9 November the Joint Staff Planners turned over their work to a sub-committee.*[10] The report, completed 21 December[11] and approved by JCS 28 December,[12] specified three types of tests. First, a bomb should be detonated in the air over a naval target of ships disposed to give a gradation of damage from negligible to maximum. Second, a bomb should be detonated either at the surface or under the surface at a moderate depth, also intended to give a gradation of damage to ships from negligible shock to sinkings. And third, a bomb should be detonated under the surface at a depth of several thousand feet.**[13]

*The sub-committee consisted of Maj Gen Curtis E. LeMay, as steering member, Col R. C. Wilson, as alternate, Col C. H. Bonesteel, USA, Capt G. W. Anderson, Jr., USN, and Capt V. L. Pottel, USN. A third Navy member was to be appointed later, but his identification has not been ascertained.

**The air burst was expected to demonstrate the range at which target ships of various types were made militarily ineffective by surface and underwater damage, and by the fission products in the form of radioactivity with complete photographic description of all damage. The underwater test near the surface, as well as that at great depth, was intended to show that the range and time required to sink ships or render them inoperable. Description of damage was to be obtained by diver inspection, normal inspection for vessels remaining afloat, and final inspection of the surviving ships in drydock. It was also hoped to determine by the underwater blasts the range at which ships were made inoperable by fission products.

On 29 December JCS appointed Vice Admiral W. H. P. Blandy, USN, Commander of the Joint Task Force, to serve "under the direct supervision of the Joint Chiefs of Staff."[14] At the same time JCS chose Commodore William S. Parsons, USN,* and Colonel Paul Tibbets, Jr., AAF, as Blandy's technical advisers.[15] On 4 January 1946 JCS augmented the Task Force Staff by the appointment of Brigadier General William E. Kepner and Brigadier General Thomas E. Power, respectively, as Deputy Commander and Assistant Deputy Commander for Aviation.[16]

Although the tests at that time were still without Presidential approval, Blandy began his work at once. On 5 January 1946 he submitted to JCS a "Proposed Plan for the Atomic Bomb Test Against Naval Vessels." He also suggested the nomenclature of Joint Task Force ONE and Operation CROSSROADS. He selected the latter term to signify the historical importance of atomic energy. He recommended, after much thought, that the tests be held in the Marshall Islands. They were a trust territory of the United States and hundreds of miles from thickly populated areas. As a site for atomic operations the Marshalls would obviate as far as possible international incidents and reduce the danger of radioactivity to a minimum. Blandy chose Bikini Atoll as the point of detonation. The population of 200 could easily be moved to neighboring islands for safety, and the lagoon could amply harbor all the ships of the Task Force. Equally important, Bikini, though too small to provide landing fields, was the apex of an obtuse-angled triangle with Kwajalein and Eniwetok. Kwajalein could accomodate a large number of aircraft including B-29's, and Eniwetok eventually came to be an excellent base for B-17 mother-drone airplanes used to collect samples of the atomic cloud and the contaminated atmosphere above Bikini. The distances between the three atolls seemed almost "custom made" for the needs of CROSSROADS--200 miles between Eniwetok and Bikini; 250 miles between Bikini and Kwajalein; and 400 miles between Kwajalein and Eniwetok. It was this entire triangular area that Blandy foresaw as the best possible location for the atomic operations.[17]

Admiral Blandy proposed that the air burst bomb be dropped from a B-29 at an

*Parsons had only recently been promoted from captain to commodore in recognition of his work with MANHATTAN District.

altitude of 30,000 feet, as in the Japanese raids, and with the fuze set to explode at 600 feet. The surface or near surface bomb should be attached to the bottom of an LST located in the center of the target array. For both the air burst and the shallow water burst the target fleet should be arranged in radial formation from the center, the latter to be occupied by an aircraft carrier with closely adjacent positions assigned to battleships or cruisers in order to have the bomb detonate near major ships. Vessels of lighter construction--destroyers, tank and infantry landing craft, and ships with merchant type hulls--should be stationed at various distances from the center. For the deep underwater test the arrangement was less simple. There were three possibilities: anchor the ships by special ground tackle; secure them to the outer reef of the atoll; or attach them to towlines and allow them to drift in the open sea. In the third alternative, the bomb could be suspended from a barge some distance to windward. The three shots were labeled ABLE, BAKER, and CHARLIE, with ABLE Day set tentatively for 15 May.[18]

It was evident that both the Army Air Forces and the Navy would play important roles in the operation, and that they would also have the opportunity to test various types of equipment. The Army Ground Forces, however, appeared to have little part in the enterprise. In his "Proposed Plan" of 5 January, Blandy suggested that Army Ground Forces equipment be placed on the decks of the target ships to guarantee close exposure to the blast, with additional equipment, supplies and installations on the beaches of the atoll islands.[19]

Recognizing that public interest would be great, Blandy also recommended that some civilian personnel be permitted to observe the detonations from designated ships and aircraft.[20]

On 10 January 1946 President Truman sanctioned the tests. The next day the Joint Chiefs of Staff officially approved Blandy's Proposed Plan, and directed him as Task Force Commander to organize a joint staff to include civilian scientists as well as adequate representation of land, sea, and air forces.

The Work of Headquarters JTF-1

Joint Task Force ONE was activated 11 January 1946, with headquarters in the Main Navy Building, Washington, D. C. The officers who had assisted Blandy in preparing his "Proposed Plan," took their places as members of his Staff. Kepner and Parsons* became respectively the Deputy Commander Aviation and the Deputy Commander for Technical Direction, and somewhat later Major General A. C. McAuliffe joined the Task Force as Deputy Commander for Ground Forces. The three deputies acted through the Chief of Staff, Commodore A. J. Snackenberg, USN. The latter's principal assistants were known as J-1, J-2, J-3 and J-4 because of the "joint" nature of the Task Force. Captain Robert Brodie, Jr., USN, was Assistant Chief of Staff, Personnel, and Brigadier General T. J. Betts, USA, was Intelligence. Captain C. H. Lyman, USN, was Operations, and Brigadier General D. H. Blakelock, USA, was Logistics.**/21

Operation CROSSROADS was originally conceived solely as a test of tactical effects of an atomic bomb on a fleet of naval vessels. As such, the primary question was the target array and its status, and this subject was already well advanced before the activation of the Task Force. By January the simplicity of the operation had been challenged. Many tests were called for that would gauge the wider significance of the weapon.

*Commodore Parsons was promoted to rear admiral after his assignment to JTF-1.

**JTF-1 Organization Charts may be found in Appendix I of this Chapter.

These additional experiments in one way or another broadened the responsibilities of all the members of Blandy's Staff.

The Target Array

The disposition of ships in the Target Array for the air drop was much more important than for the shallow or deep underwater shots. Although some thought was given to the advisability of locating the air burst bomb in a balloon to avoid the possibility of a bombing error, the proposal was soon discarded. It was always assumed at highest levels that a B-29 would drop the bomb, an operation that led to different Navy and Air Force philosophies.[22] The Navy propounded the doctrine that the ships should be regarded primarily as complex pressure instruments to record the blast effects of the bomb.[23] Therefore the lethal range of the blast could be determined only by saving the ships.[24] The Air Force, faced with the task of delivering the weapon, contended that the ships should be within the 1000-yard circle of the bull's eye. Otherwise a miss of 300 yards—a possibility in any drop from 30,000 feet—would do little damage, and the entire purpose of the test might well be defeated.[25]

The Navy and the Air Force reached their impasse early in the discussions, and the problem was turned over to the Military Advisory Board, the successor of the war-time Military Policy Committee.[26]

The Military Advisory Board first considered the target layout on 20 December 1945. The Bureau of Ships submitted ~~a plan~~ Plan I that expressed the Navy's point of view. There was so much opposition from AAF and MANHATTAN District that the Board requested the Navy to revise the pattern and place the target ship, the USS Nevada, within 500 feet of the expected surface zero, rather than 4,000 feet away.[27] The Joint Chiefs supported the change.[28] During most of January 1946 JTF-1 Headquarters was preoccupied with the organizational details, but toward the end of the month, when Blandy again opened the subject of target array, the Military Advisory Board went on record as supporting the Navy's position that the ships should be regarded as pressure gauges.[29] Consequently ~~the second plan~~ Plan II from the Bureau of Ships, submitted 4 February, ~~remained~~ was, like Plan I, unrealistic for an air drop. The ships were still widely scattered.[30]

~~The plan~~ Plan II was so radically ineffective from an Air Force point of view that Headquarters AAF appointed a Committee, under the direction of Colonel Kenneth H. Gibson, to recommend suitable action.* On 5 February the Committee unanimously recommended a tight pattern,[31] and wisely wrote that there were ballistic weaknesses in the bomb that might cause a serious error.[32] The Committee's recommendations served as the basis of the letter that Headquarters AAF sent to the Commander JTF-1 on 6 February. The Air Force proposed that a battleship should serve

*Col Gibson "directed" the Committee but he was not a member. The nine members were:

Colonel Cecil Cooms, Chairman	Elgin Field
Colonel H. G. Montgomery	Aeronautical Board
Colonel P. W. Tibbets	CO 509th Composite Group
Lt. Colonel K. M. Sowers	509th Composite Group
Major Kermit Lerebee	509th Composite Group
Captain Thomas Beahan	509th Composite Group
Dr. H. K. Van Trump	USSBS
Dr. Roger Wilkinson	Operations Analyst
Mr. Robert Dorfman	Operations Analyst

as the aiming point, and that ships of each class should be exposed systematically at distances of 320, 375, 450, 500, 600, 700, 850, 940, 1000, 1100, 1250, 1400, 1600, and 2000 yards from the aiming point.[33]

In view of the AAF letter, the Task Force Commander prepared ~~a re-~~ Plan III ~~vised plan~~ "based on a general compromise of the suggestions made by the Commanding General and civilian scientists of MANHATTAN District, the Military Advisory Board, the Army Air Forces, several deputy chiefs of Naval Operations, and various officers and civilians on the staff of the Task Force." Blandy warned that the arrangement did not represent a normal disposition of ships at anchorage or a tactical disposition at sea. The damage therefore would be greater than might be expected under combat conditions. An erroneous impression might be created among the public, and to counteract such eventuality the admiral wanted to warn the press "that the technical requirements of the test require a closer grouping of the ships than is customary in war or peace."[34]

The Air Force felt that Blandy's layout, though an improvement, still did not adequately meet the standards of a target from a bombardier's point of view or fulfill the test requirements of damage gradation from maximum to minimum. The Commanding General AAF appealed to JCS for further rectification.[35] The Joint Chiefs supported the AAF contentions and on 15 February ~~informed~~ instructed Blandy ~~that he would have~~ to revise the plan again ~~[illegible]~~ better for gradation of damage.*[36]

*The JTF and AAF Plans are presented below:

BATTLESHIPS	JTF PLAN	AAF PLAN
Aiming Point	1	1
0-500 yards	1	1
500-1000 yards	1	1
1000-1500 yards	2	1

(Cont'd on following page)

On 21 February Blandy submitted his Plan IV ~~revised~~ plan to the Air Force. Under the new pattern, the target fleet was an armada of ninety-three vessels, of which twenty-three were located within the 1,000 yard radius. This arrangement certainly permitted a gradation of damage values, and LeMay [redacted] recommended that CG AAF approve the plan as a satisfactory compromise.[37]

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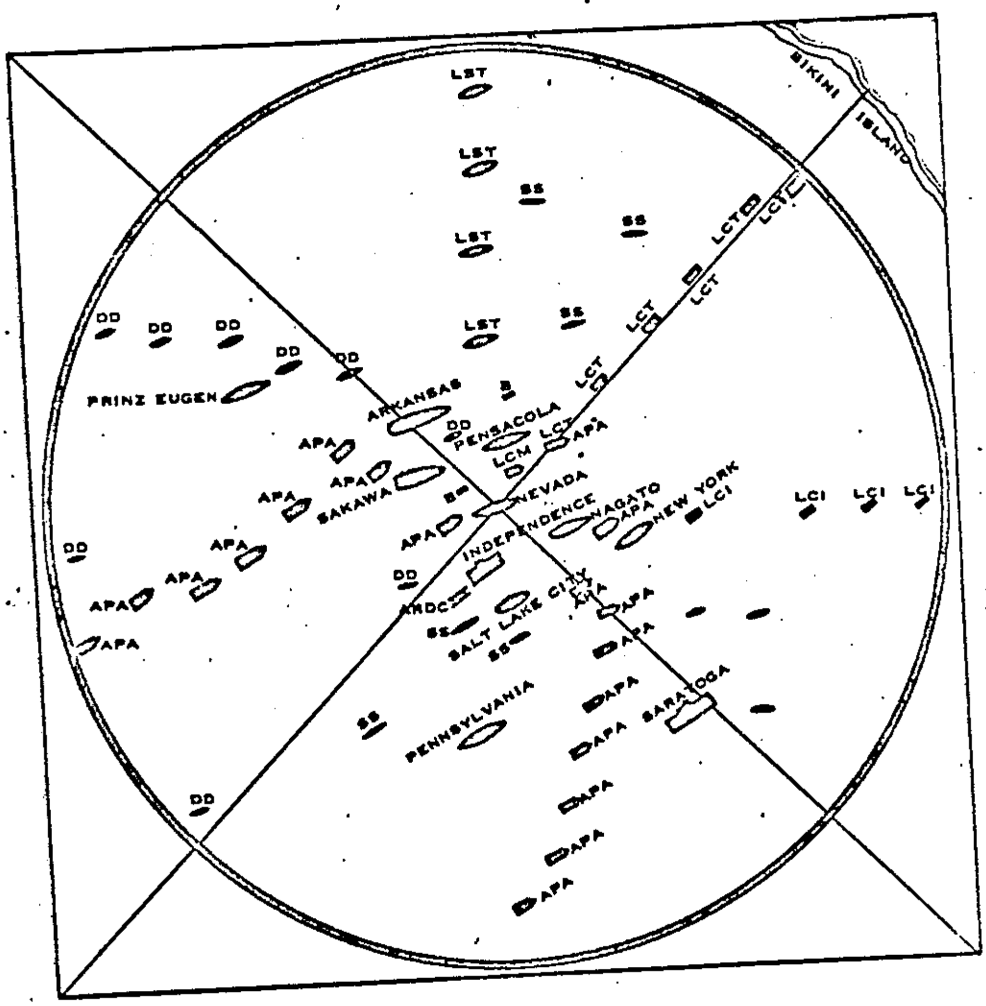
*(Cont'd from previous page)

	JTF PLAN	AAF PLAN
CARRIERS		
0-500 yards	1	1
1900 yards	1	0
CRUISERS		
0-500 yards	2	2
500-1000 yards	1	1
1000-1500 yards	1	1
DESTROYERS		
0-500 yards	1	4
500-1000 yards	1	5
1000-1500 yards	2	3
1500-2000 yards	2	2
2000-2500 yards	1	0
2500-3000 yards	2	0
3000-3500 yards	2	0
4000 yards	3	0
SUBMARINES		
0-500 yards	1	4
500-1000 yards	2	3
1000-1500 yards	3	1
1500-2000 yards	2	0
APA's (TRANSPORTS)		
0-500 yards	0	5
500-1000 yards	3	8
1000-1500 yards	14	3
1500-2000 yards	0	1
3000 yards	0	1
4000 yards	1	1
Total number of ships	51	50



The ABLE Day Target Array of Ships

The Air Force acceptance permitted Blandy to submit his final revision to JCS on 26 February, and on 8 March the Joint Chiefs gave ~~final~~ approval.[38]

The Navy and Air Force disagreed again in trying to determine the quantities of fuel and ammunition to be carried by the target ships. The Navy argued against a full load because secondary explosions and resultant fires would nullify the vessels as instruments. The Air Force wanted the ships fully loaded to test the effects of an atomic bomb on many types of material.[39] The arguments paralleled in time as well as thought those pertaining to the target layout.[40] In mid-February the Military Advisory Board recommended a compromise which was approved at a conference on 19 February between the Navy, Air Force and JTF-1 representatives. They agreed that in Test ABLE the aircraft carrier USS Independence would carry a one-third load of gasoline, and that other ships in the Target Array would be loaded with fuel and ammunition as follows:[41]

Location	Ships	Fuel Load	Ammunition Load
Within 500 yd radius	All types	10-35%	66%
Beyond 500 yd radius	1/3 all types	10%	10%
	1/3 all types	50%	50%
	1/3 all types	90%	90%

Blandy presented the plan to JCS on 26 February, and the Joint Chiefs gave their approval on 8 March,[42] at the same time that they approved the target layout.

A third major problem involved in setting up the Target Array was that of marking the target ship in such a way as to be easily distinguishable by the bombardier when approaching the area on the live run at an altitude of 30,000 feet. The scientific requirements of the tests demanded precision bombing, and the nature of the atom bomb explosion required that the release be made from great height. From an altitude of 30,000 feet the USS *Nevada*, the "target center", would tend to blend with the sea making it difficult to spot. The first idea was to have a Radar Beacon Type AN/CPNC installed as a guide to the pilot.[43] Early in February the plan was changed and JTF-1 decided to paint the ship orange although some feared that the color would be ineffective if the sun was in an unfavorable position at the time of bombing.[44]

Toward the end of February, Kepner asked for the recognition of a definite point at which the bomb should be aimed.[45] A battleship nearly 550 feet long, although not easily identified from the air, was entirely too large to be considered a bull's eye.[46] Two methods of pin-point marking were suggested--the use of a smoke pot and the use of a searchlight.[47] The latter seemed the more desirable, and AAF personnel recommended that trials be held by making dry runs over any naval anchorage at a time when the position of the sun would approximate that at Bikini.[48] After long testing, AAF and Navy representatives decided to keep the ship painted orange but with large white areas and a searchlight.[49] The combination proved to be very effective.*

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*The effectiveness of identification was shown during the rehearsals of 14 June in the Forward Area when the bomb carrier reported: (Memo from Col W. D. Ganey, J-3, To All Concerned, sub.: Visibility Tests, 15 Jun 1946.)

First Run

Altitude, base plus 2000 feet, at 1140, 050°;
NEVADA spotted by position in target array at 27 NM;
White turret seen at 25.6 NM;
Yellow turret seen at 14.6 NM;
Searchlight seen at 12.0 NM.

Second Run

Altitude, base plus 2000 feet, at 1210, 040°;
NEVADA spotted by position in target array at 30.5 NM.
White turret seen at 26.8 NM;

(Cont'd on following page.)

The Military-Scientific Tests, and the Office of Technical Director

Simultaneously with discussions relative to the layout of the Target Array and the loading of the ships, plans went forward for extensive additions to the tests. In September 1945 both the Navy and AAF advanced programs to expose various types of equipment, and thereafter MANHATTAN District, and especially Los Alamos Scientifc Laboratory, came forward with a program of scientific tests. When Blandy drew up his "Proposed Plan" he assumed that the tests would far exceed the generalities laid down ~~in~~ the previous August, and his own directive of 10 January 1946 provided for effects of the bombs against ships, ground and air targets, and for the acquisition of scientific data of general value. The latter would include tests to determine the efficiency of the bomb, and blast yield in terms of kilotons, and pressure and the impulse of the detonation and the extent of various radiations.

*(Cont'd from previous page)

Searchlight seen at 20.5 NM;
Yellow turret seen at 5 NM

Kepner was very much impressed by the fact that the white turret tended to show better than the searchlight. He suggested the possibility of painting a white and yellow area from the turret to the deck edge on each side of the turret for both fore and aft turrets. (Memo for Record by Col W. R. Large, J-3, 15 Jun 1946.) The next day a message was sent to the NEVADA requesting that the white painted area be extended from both port and starboard sides of number three turrets to within three feet of the deck's edge, to include all gear and equipment secured in the area. (Memo from Col J. J. Preston and Robert Dorfman to Col W. D. Cancy, sub.: Visibility Study of NEVADA, 15 Jun 1946.) When this was done, it was felt that the bombardier had a target adequately marked to make the sighting certain. It was believed also that the target array was assembled around an aiming point sufficiently definite to render possible an exact calculation of any bombing error on ABLE Day.

In order to guide the development of the military-scientific tests, Parsons, who, as Deputy Task Force Commander for Technical Direction, was immediately below Blandy and above Snackenberg, expanded the organization of his office. Parsons asked for and received two deputies—the Director of Ship Material, Rear Admiral T. A. Solberg, USN, and the Technical Director, Dr. R. A. Sawyer. The latter in turn gathered a competent staff of seven assistants, one of whom was a civilian and six of whom were naval officers.*

Even before the activation of JTF-1, it was Sawyer's group with whom military and civilian agencies, such as the sub-contractors of MANHATTAN District, negotiated in an effort to have special requirements included in the tests.

Early in December 1945, the Office of the Technical Director announced that the only permissible tests were those which could be:[50]

1. Useful to designers of ships and ordnance material in assessing damage from and providing protection against atom bombs.
2. Valuable in determining the nature, range, and duration of radiation danger from both the air and under water bursts, and the best means of defense against this threat.
3. Necessary to determine the bomb efficiency, burst location, wave formation, and ship movement.
4. Helpful in devising counter intelligence means.

During the remainder of the month, numerous conferences were held in the Navy Department between representatives of Sawyer's office, the Army Ground Forces, the Army Air Forces, the Navy, MANHATTAN District, and

*Dr. Sawyer's seven assistants were:

1. Dr. E. W. Thatcher
2. Capt F. L. Riddle, USN
3. Cmdr E. D. Gilfillan, USN
4. Cmdr A. W. McReynolds, USN
5. Lt. Cmdr J. K. Debehan, USN
6. Lt (jg) J. A. Young, USN
7. Ens H. M. Archer, USN

other government agencies in an effort to outline the extent and content of the Military-Scientific Tests. Each of the participating agencies appointed its own technical committee to prepare requirements.

On 2 January 1946, after conferences in Sawyer's office had led to general agreements, AAF took action to have its "requirements" drawn up for formal presentation. Eaker directed LeMay, by that time Deputy Chief of Air Staff for Research and Development, to prepare the AAF specific requirements with recommended methods of obtaining results.[51] Pressed for time, LeMay submitted an interim report on 4 January 1952,[52] to be used in the event that either JCS or the Joint Task Force should ask immediate recommendations.[53]

Meanwhile, AC/AS-3, AC/AS-4, and other Air Force agencies had been directed to collaborate with LeMay's office and a definite philosophy of approach emerged from many informal conversations. The Air Force accepted the doctrine that the primary purpose of the test was to demonstrate the effect of the bomb on naval vessels, but that invaluable additional information could be gained by including a number of other experiments in the operation. In general, the Air Force desired to test the effects of the bomb directly on aircraft and their components.

The deadline for the completed study was 14 January. On 7 January a conference was called to meet in LeMay's office 11 January for the purpose of coordinating several drafts into a final plan.[54] The conferees agreed that a paper by Colonel R. E. Jarmon, Chief of the Armament Laboratory, and representing the viewpoint of A-4, was the best of several preliminary papers and though still in need of modification, should be accepted as a satisfactory statement of basic AAF requirements. On 16 January LeMay submitted a revision of Jarmon's draft to the Chief of Air Staff as the "Plan for Army Air Forces Participation in the

Proposed Atomic Tests Against Naval Vessels."[55] Two days later, 18 January, this same plan went to the Commander of Joint Task Force ONE as the official statement of AAF requirements.[56]

In a brief introductory cover letter Eaker stated that the Army Air Forces desired to effect tactical and technical investigations of the effect of the weapon upon aircraft and their equipment. The accumulated data was applicable as a new science to the AAF development program and would result in greater preparedness, both offensively and defensively.[57]

The plan called for the use of a few drones—then known as remote controlled planes—to test aircraft structure by operating within the area of destructive shock waves at the moment of detonation. The drones could dare penetrate the atomic cloud itself to test the effect of intense radioactivity upon electronics equipment. Manned planes, flying at a safe distance from the detonation and the cloud, would operate in three small groups equipped with electronic instruments, radios and cameras. The total number of airplanes to meet the needs of the AAF program was ten,[58] which combined with the bomb carrier and two pressure gauge aircraft gave a total of thirteen.* The plan was elaborated in ten appendices with the following general subjects, each of which was carefully developed in detail:[59]

A. Airplane Flight Characteristics.

B. Airplane Remote Control.

C. Power Plant Tests.

D. Electronics - Radio Control and Telemetering - Infra-Red.

E. Aeromedical.

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*This January estimate was only one-third of the thirty-five Army Air Force aircraft airborne at the moment of Shot ABLE, an indication of how plans grew for AAF participation.

F. Electronics - Radar and Radio Projects.

G. Equipment Tests - General

H. Photographic Equipment

I. Armament Problems

J. Questions to be answered by the Joint Task Force during the tests.

The Army Ground Forces, the Navy, the Air Force and MANHATTAN District all completed the final drafts of their separate requirements at approximately the same time. The several lists were submitted to the Technical Director to be screened for impractical projects and duplications before being organized into the officially approved program.[60] Thus the Office of Technical Director functioned as a joint proof test committee, such as was introduced in the preparatory period of Operation SANDSTONE two years later. By the latter part of February 1946 Sawyer and his assistants completed their screening work and summarized the purpose of the Scientific-Military Tests under thirteen points.* [61]

For administrative and operational purposes the Office of the Technical Director organized the tests into nine Technical Groups. They remained directly under Sawyer's supervision, of course, but

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*The thirteen points were: the determination of radiation, air blast, and underwater pressures as functions of time and distance; the measurements of actual pressures on ship structures; the propagation of water surface waves generated by the blast; the dispersal of radioactivity in the water; effects of the burst and radioactivity on marine life; effects of the shot wave on the atoll; effects of the burst on the propagation of electromagnetic waves; determination of the intensity of of neutron and gamma radiation from the burst; physiological effects of heat, shock, and radiation on animals, and the treatment of injuries; measurements of intensity of infra-red, visible, and ultra violet radiation from the flash; determination of effects of radioactivity on the atmosphere's ionization; methods of long-distance detection of atomic bursts; photographic coverage of visible phenomena accompanying the detonation.

Sawyer's summary became the introduction to the CROSSROADS Instrumentation Plan, and serves to illustrate the fact that CROSSROADS was the greatest scientific test ever held up to that time each had its own numerical designation and its own leader.* 62 The groups in turn were subdivided into thirty-two projects, each with a separate serial number as a means of practical identification. Preliminary reports were called for, to be submitted by the group leaders to the Technical Director as soon as possible after the ABLE and BAKER shots. More complete reports were expected at a later date.** 63

The Military-Scientific Tests indicated that Operation CROSSROADS would be the greatest scientific experiment ever conducted up to that time. The development of atomic energy did not come under the same category because it was actually a number of widely separated, though highly coordinated endeavors. In contrast, there were nearly 42,000 persons concentrated at Bikini, of whom 550 were scientists, brought together in a single laboratorial effort. The military representatives were there to test the effect of the detonation on naval vessels and sundry types of equipment, and the the military and the scientists were equally interested in determining energy

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*The nine Technical Groups, their leaders, and their sponsoring agencies were:

Group	Leader	Agency
1. Bomb Operation	Dr Roger Warner	Los Alamos
2. Blast, Pressure & Shock	Dr W.C. Penney	Los Alamos
3. Wave Motion and Oceanography	Cdr Roger Ravelle	USN
4. Electromagnetic Propagation	Capt C.L.Engleman	USN
5. Radiological Safety	Col S. L. Warren	Army Med Corps
6. Radiometry	Cdr S.S. Ballard	USN
7. Radiation	Dr M.G. Holloway	Los Alamos
8. Remote Measurements	Cdr George Vaux	USN
9. Technical Photography	Capt R.S. Quackenbush	USN

**A more detailed explanation of the Military-Scientific Tests may be found in Appendix II of this chapter.

release of the blast, the pressures created, the impulse, the shock wave, the optical radiation or light, and the nuclear reaction. The facts were sought to explain the behavior of the bomb; lead the way to the perfection of better weapons; demonstrate the tactical and strategical significance of the bomb; and indicate the effect which an atomic detonation would have upon the population of a stricken city. In order to collect all the data needed to interpret the two blasts in terms of tactics, strategy and physical repercussions, it was necessary to equip the ~~the use of an~~ target fleet ~~equipped~~ with nearly 30,000 instruments and devices--many of which had to be specially designed and made for the occasion--and to populate it with nearly 6,000 animals.[64]

Work of the Four J-Divisions at Headquarters JTF-1

It would be impossible, in a text of reasonable length, to recount all the activities of the four J-divisions. As far as the Air Force was concerned, the important functions of J-1 pertained to finance and the acquisition of personnel. There were four aspects of the J-2 work that concerned AAF-security, non-technical photography, public information and observers. Three J-4 sections were vitally important to the Air Force because they pertained to air functions--Aerology, Communications, and Air Operations. The latter section was responsible for drawing up the Air Operations Plan and for providing the Task Force with air transportation in ZI, overseas and intra-atoll. It was within the field of air transportation that the duties of J-3 and J-4 overlapped since they both had a subsection for that work. In addition, J-4 handled all other matters pertaining to logistics.

J-1 Division--Finance and Personnel. It was customary in 1946 for Budget and Fiscal Section to be located in the Personnel Division. In principle the same arrangement was kept in JTF-1, but because the Task Force was a joint organization there were differences in detail. Instead of a single Budget and Fiscal Section, there were various sections in J-1, such as the Army Finance Unit, which took care of the normal expenses of assigned personnel. Funds for the operation were made available to the Task Force by the War Department—which acted for both the Army Ground Forces and the Army Air Forces—the Navy Department, MANHATTAN District, and other government agencies. In every instance the sums transferred to the Joint Task Force were taken from the agency's current maintenance appropriations.[65]

The J-1 Division had also the usual responsibilities for personnel.[66] The joint nature of the Task Force did much to overcome the difficulties imposed by national demobilization. In round numbers The Navy supplied 38,000 officers and men or 90 per cent of the total 42,000 officers, men and civilians required by the operation.* Of the 4,000 remaining officers and men needed, 3,500 were obtained from the Army Air Forces. Consequently J-1 had to procure ~~less than~~ approximately 600 persons from other military organizations and from civilians. The point is that J-1 could pass on the problem of personnel procurement to the Naval Bureau of Personnel and to the AAF Continental Air Force.[67]

<u>J-2 Division--Security, Public Information, and Photography.</u> The work of intelligence was complicated by the fact that security had to be maintained in order to safeguard America's most secret weapon at the same time that the Government publicized the tests and even invited a number of foreign observers as special guests. Moreover, Operation

*Most of the Navy enlisted personnel were regular crews, and only a few additional men had to be located and selected with a scientific or mechanical background.

CROSSROADS was held prior to the introduction of RESTRICTED DATA classification and the use of Q-clearance. Consequently, every man who was selected for the CROSSROADS mission had to be checked for loyalty and character, but the investigation was certainly less thorough than that employed later on. The Joint Task Force resorted to the method of supplying personnel with different colored pass cards indicating different levels of work to be done and of areas to be visited. Courier services were set up whereby SECRET messages could be sent between Bikini and Washington. Photographs could be developed only by authorized Task Force personnel, and no print or negative could be released until approved by J-2.[68]

It was also the duty of J-2 to provide the public with accurate information to correct the exaggerations and distortions which appeared in the press or sped through the country as mere rumors. These strange reports went all the way from depicting the tests as an out-and-out Navy-Air struggle, to predictions of vast calamities which were to threaten the Task Force and the nation. There was fear of underwater landslides, of great tidal waves that would sweep the Pacific, of setting the oceans themselves on fire, and of splitting the surface of the earth. Though there was genuine interest in the tests there was also genuine public fear of the consequences, and one of the most important functions of J-2, acting through its Office of Public Information, was to allay these misgivings. From 11 January, when the Task Force was activated, through February, J-2 issued more than forty bulletins which covered every phase of the Operation and offered scientific explanations of the purpose of the tests and the effects of the detonations. Blandy came to the assistance of his J-2 by holding several press conferences in which the other members of his Staff participated. The most searching questions were answered as well as possible, and with full appreciation of the need to alleviate public fears.[69]

On 5 February 1946 the Secretary of War and the Secretary of the Navy approved a suggestion from JCS that public confidence be sought by permitting representatives of the American and foreign press to attend the tests. On 14 March the President approved the following allocations:[70]

	Test A	Test B
American press and radio	114	75
Foreign press	10*	8

However, interest in the operation was so great that press applicants for attendance exceeded the approved spaces. Consequently it was necessary to create a Special Press Committee consisting of representatives of the Task Force and many of the press agencies in the United States. The Committee selected the agencies--chosen to give the broadest possible coverage--and the latter appointed their reporters. The USS Appalachian was designated as Press Headquarters Ship on which living quarters were given to the press representatives according to age. The Task Force arranged for special courses, pamphlets and films on nuclear physics, the origin of CROSSROADS, and the history of the Marshall Islands to insure accurate and interesting reports on what had come to be regarded as the "greatest scientific laboratory in the world."[71]

Another J-2 activity was the preparation of an official film designed for public release and quite independent of the many reels of technical photography ~~which~~ that would have to be highly classified. Betts requested

*One from each nation represented on UN AE Commission, plus two representatives from the United Kingdom.

Captain R. S. Quackenbush, USN, to undertake this program which allowed the public, American and foreign, to see as much of the Operation as was permissable under the rules of security.[72]

J-3 Division--Aerology, Communications, Air Operations and Air Transportation. Certainly the Plans and Operations Division, J-3, had the most complex responsibilities within the Task Force. Acting on directions from Blandy, Lyman and his advisors drew up the Force Organization which provided for eight task groups within JTF-1--Technical, Target Vessel, Transport, Army Ground, Army Air, Navy Air, Surface Patrol, and Service.* The groups, subdivided into thirty-nine task units, can be set forth in

*The purposes and functions of the task groups can be set forth in tabular form as follows:

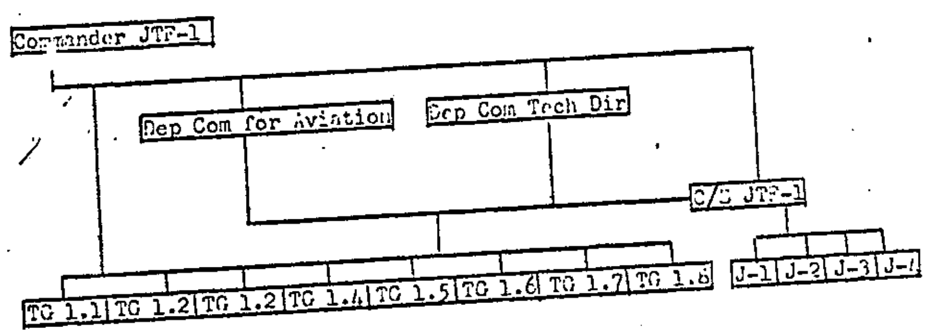
TG No.	Designation	Commander	Function: To Direct	No of Task Units
1.1	Technical	RAdm W.S.Parsons	I-IX S-M Programs	3 (1.1.1 - 3)
1.2	Target Ves.	RAdm F.H.Fahrion	Target Ships	7 (1.2.1 - 7)
1.3	Transport	Capt W.P.Davis, USN	Press Resp, Observers, Crew of Target mships after evacuation	3 (1.3.1 - 3)
1.4	Army Ground	Col J.D.Frederick	Army personnel and equipment	6 (1.4.1 - 6)
1.5	Army Air	Brig Gen R. M. Ramey	AAF Ops, Transport Weather, Rad Recon, Photo, Instrumentation, Drones and observers	8 (1.5.1 - 8)
1.6	Navy Air	RAdm C.A.F. Sprague	Drones, Helicopters, Patrols, Guides for Drone Beast	4 (1.6.1 - 4)
1.7	Surface Patrol	Capt E.N.Parker, USN	Rad Safety	1 (1.7.1)
1.8	Services	Capt H.G.Lyttle USN	Repair, Fueling, Water, Mail, Provisions, Recreation, Hospitalization and Evacuation	7 (1.8.1 - 8) (TU 1.8.2 was never activated.)

were all placed directly under the Task Force Commander and his two deputies for Aviation and Technical Direction in a way that by-passed the Chief of Staff whose authority was limited entirely to the J-divisions.*[73]

When the Task Force came into being, the question of meteorology was of utmost importance. When Blandy chose the Marshall Islands as the test site, and decided that one bomb would be delivered by air, weather loomed as one of his chief problems. Very little was known about the seasonal shift of climatic conditions in that part of the Pacific, and the work of J-3's Aerology Section, under the direction of Colonel Ben Holzman, AAF, was pioneering in its nature.[74]

An aerological plan was drawn up as Annex T to the ComJointTaskFor ONE Plan No 1-46.[75] Organizationally, the Staff Aerological Unit was to be located on the USS *Mt McKinley*, with subordinate units dispersed elsewhere. Task Group 1.5 was given a Weather Central on Kwajalein and there were to be aerological units on all aircraft carriers, escort aircraft carriers and aircraft tenders, but excluding Task Group 1.2, which was the Target Vessel Group. The Aerological Unit on board the *Mt. McKinley* was intended to prepare complete analysis and forecasts for

*The chain of command in JTF-1 was unusual, as shown below:



CROSSROADS operations and coordinate all aerological matters within the Task Force. Special weather forecasts were to be prepared for the Radiological Safety Unit with regard to the anticipated cloud track hazard. The Weather Central of Task Group 1.5 was to serve as the master analysis group. It was to prepare complete surface and upper air forecasts; supply information directly to the Mt. McKinley as requested; and give adequate briefings to the air groups based on Kwajalein. The various ships equipped with aerological units were to supply forecasting and briefing as required.[76]

Of course in an organization as geographically scattered as Joint Task Force ONE would be in the Forward Area, and with the success of the operation of shot days depending upon instant contact between aircraft and surface ships, communications was of prime importance. The Communications Section in J-3, therefore, headed by Captain K. M. Gentry, USN, had to make a well nigh perfect performance or cast Operation CROSSROADS into confusion. The duty of the Section was twofold. First, it had to prepare the Task Force Communications and Electronics Plan to be included in CJTF-1 Operations Plan No 1-46. And second, the Section had to act as the Task Force Communications Office both before and after moving overseas.[77]

The work of preparing the plan went smoothly. Gentry based his concepts on the well-known PAC-70 B which had served the needs of joint operations in the Pacific during the war. By March Communications and Electronics Plan was ready for distribution, and its complexities are indicated by the fact that it called for 203 channels and

348 frequencies.[78] They covered such functions as JTF-1 communications; press radio teletype, radio photography and broadcast; radio signals for remote control of scientific instruments; shipborne and land based radar; control of drone boats; and control of drone aircraft.[79] Twenty channels were used exclusively for air operations.[80] Overall control was to be exercised by the Joint Task Force Fighter Director Office on the Mt McKinley.*[81] To avoid confusion that might result from differences in service language, Kepner proposed that only those messages sent

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*The real test of the Communications and Electronics Plan and the Air Communications Plan came after the move of the Task Force overseas. Many difficulties were experienced which had not been foreseen in Washington. Drone Aircraft and remote control instruments, which required complete freedom from harmonic interference, were sometimes disturbed by frequencies employed elsewhere in the Task Force. A need developed for a continuous wave radio and voice conference net between the DTFC for Aviation and his next subordinate air commanders, and this was difficult to put into effect. After arrival in Bikini, some frequencies chosen in Washington proved to be unsuitable. The Communications Section found it ~~vory~~ very difficult to exclude chatter, which at times became ~~serious~~ disturbing. Gentry denounced with some bitterness "the adolescent brains of the Task Force personnel." He insisted that officers should "catch the juvenile sailors while actually engaged in sending their unmentionable stories over the air." Throughout most of the training period overseas, the Communications Plans and the Communications Section were subjected to harsh criticism, and the comments were deeply resented. It appears that much of the ill temper was nothing more then tension that built up unconsciously throughout the Task Force as the time approached for the first test. After one of the major rehearsals Kepner caused a real upheaval when he stated categorically that communications had failed. However, his complaint undoubtedly accomplished much and improvement became marked thereafter. On 25 June a final full dress rehearsal was held. At the last minute, just as the bomb run was about to begin, it was found necessary to postpone the drop by fifteen minutes. The postponement was properly cleared, communicated to all ships and aircraft, and accomplished without a hitch. This unexpected flexibility in the plan was recorded by one observer "to the undying credit of all concerned, but especially to the communications personnel." When the shot days came, the communications Plans were found to be quite satisfactory. (Paper prepared by Brig Gen T. S. Power, Data to the Incorporated in Maj. Gen W.E. Kepner's Report, 17 Apr 1946; Col D.F.Henry Communications Report to Maj Gen W.E. Kepner, 26 June 1946; Msg, CG TG 1.5 to CJTF-1, 28 Jul 1946; Comments on Msg, CTG 1.5; Memo from Capt Gentry to CJTF-1, 29 Jul 1946; Col J.A.McDavid to CTE-1, Comments on Msg, CTG 1.5, 29 Jul 1946; Air Operations Report Operation CROSSROADS; Robert Dorfman, Journal, 11 Jun 1946; Minutes of Meeting held in Briefing Room of TG 1.5, 12 Jun 1946; Minutes of QUEEN Day Critique held on Mt McKinley 26 Jun 1946; Ltr, Robert Dorfman to Dr. LeRoy Brothers, Kwajalein, 29 Jun 1946.

to the Task Force as a whole should be in Navy form; all other messages should be in Army form.[82]

Probably the finest work done at Headquarters JTF-1, and certainly the finest work done in J-3, was the preparation of the Air Operations Plan. At first it was intended to have the air drop a repetition of the Hiroshima-Nagasaki raids with one bomber serving as the weapon carrier and escorted by two instrument planes. Had this idea prevailed a very simple operational plan would have sufficed,[83] but the number of participating aircraft increased to thirty-three AAF and twenty-nine Navy planes, and it was not a simple matter to devise for them a tight pattern in which they could safely perform their missions on a split second schedule.[84]

The J-3 Air Operations Section, headed by Colonel W.T. Ganey with Captain Paul Foley, USN, as Deputy, was divided into six sub-units—Administration, Operational Intelligence, Photography, Fighter Direction, Tactical and Training and Air Transportation.[85] All of them contributed to the Operations Plan, but the major portion of the work was done by Tactical and Training under the direction of Colonel W. R. Large, AAF.[86]

By late January it was apparent that the Plan would have to be designed so that the participating aircraft could serve as a vast "structure", towering to approximately 30,000 feet, to which innumerable scientific instruments could be attached.[87] The need for this elaborate formation came from the requirements of Sawyer's Nine Technical Groups,[88] the uncertain hazards of radioactivity,[89] and the standards of operational safety.[90]

The Office of the Technical Director forwarded requests for so many new experiments that, after a month of work, Tactical and Training with Blandy's approval decreed a deadline of 28 February beyond which no more

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changes could be tolerated, unless they were of outstanding importance.[91] In March the first draft of the Plan was ready for criticism, and for practical testing by Task Group 1.5 and Task Group 1.6.[92]

After comments came in, Tactical and Training began the first revision. Six principles served as guidance; simplicity, flexibility, safety, maintenance of control of all aircraft by CJTF-1 during the operations, time control of the activation of all instruments at the right moment, and a guarantee--as far as possible--that the bomb could be dropped on the first day chosen for the ABLE Shot.[93]

Simplicity consisted of detailed instructions for every unit[94] which therefore did not have to concern itself with the complexity of the whole operational scheme.[95] Rigidity in shot day activities was avoided by an Instrument of Flexibility for the safety of surface ships of the live fleet,[96] and an Air Operations Plan that effected maneuverability with specific requirements for the air units.[97]

The Air Plan consisted of two parts. First, there was a vertical projection of the Target Center bull's eye which went up to an altitude of 28,000 feet. Around this imaginary line were six circumscribed circles with radii and altitudes that varied from 20 Nautical Miles, Slant Range, at 4,000 feet, to 7 NM SR at 28,000 feet. There were to be seventeen AAF aircraft on these circles, circumnavigating the vertical projection at shot time.*[99] Second, there were to be twelve orbit points located at distances and altitudes between 15 and 20 NM and 2,000 and 30,000 feet around which thirteen AAF and twenty-eight Navy planes would fly prior to detonation. These ~~twenty-eight~~ forty-one aircraft would move in from their orbit points upon the cloud immediately after detonation.[100] Thus the Air Plan permitted a total of fifty-eight aircraft—thirty AAF and twenty-eight Navy planes—to participate in shot operations.** In addition,

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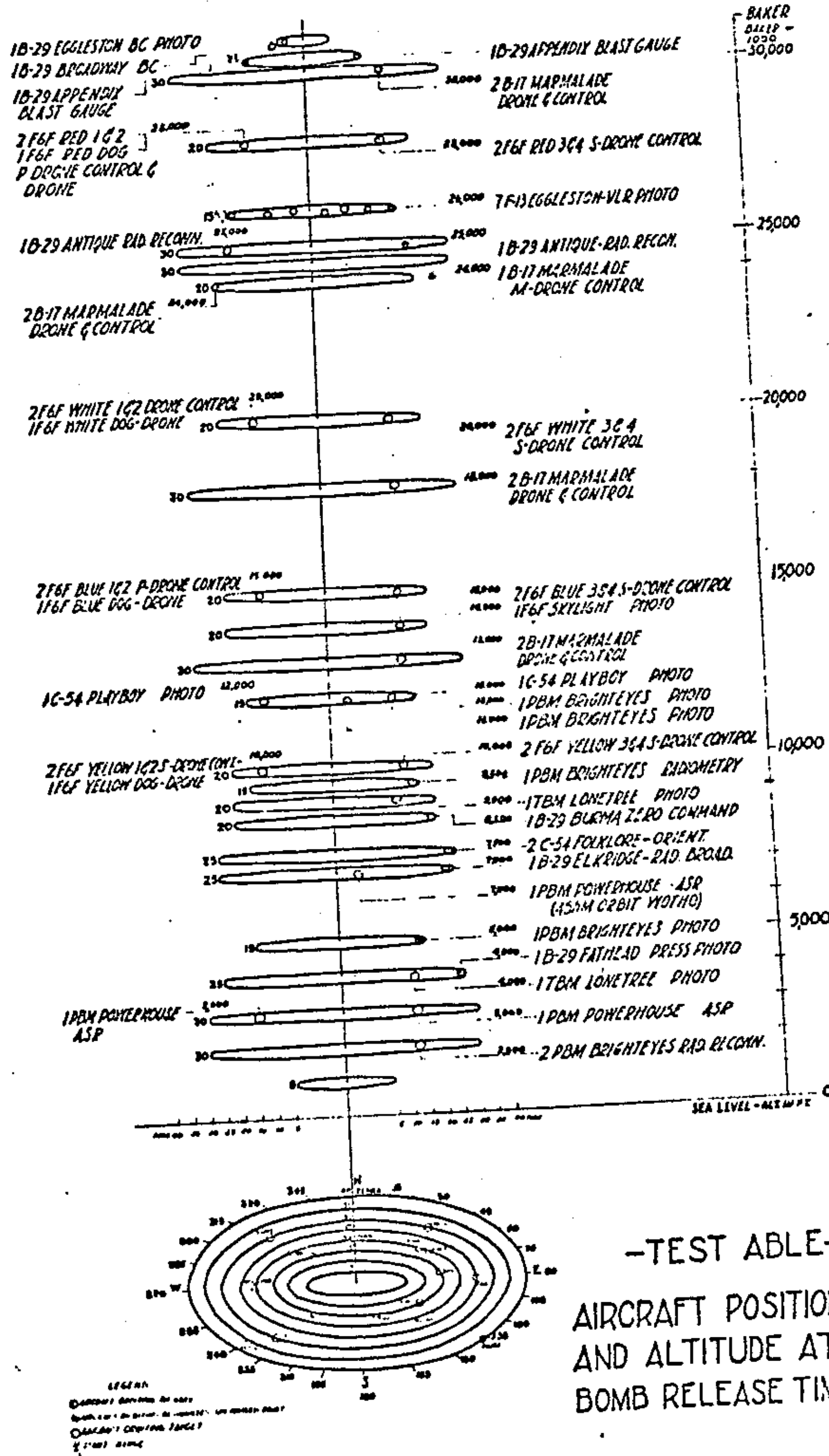
*The positions and functions of aircraft circling Target Center:

RADIUS	ALTITUDE	NO and TYPE of AIRCRAFT		FUNCTION OF AIRCRAFT
7 NM SR	28,000	2	B-29	Pressure Gauge Drop
15 NM SR	26,000	7	F-13	Photography
15 NM SR	12,500	2	C-54	Photography
20 NM SR	7,500	2	C-54	VIP Observers
20 NM SR	7,000	1	B-29	Press Radio Broadcast
20 NM SR	4,000	1	B-29	Press Photography
Total AAF aircraft		15	to circle Target Center before blast	
		1	B-29	Bomb Carrier
		1	F-13	to photograph Bomb Carrier
	Total	17	AAF a/c circling Target Center	

**The position of the aircraft on Orbit Points may be found in Appendix III of this chapter.



-TEST ABLE-

AIRCRAFT POSITION AND ALTITUDE AT BOMB RELEASE TIME there was the Bomb Carrying Aircraft which, at the beginning of the live run, would be on Orbit Point BAKER, 35 NM from the Target Center.[101]

To guarantee control of all aircraft by the Task Force Commander a senior airman was to be designated Airborne Commander. He was to observe the operations from an undefined vantage point of the air, and report directly to Blandy. On the flagship a Combat Intelligence Center (CIC) would supply the Flag Bridge and its Air Plot Room with a detailed picture of the air situation.[102]

Time control was achieved by relating the entire sequence of ABLE Day events to two instants in the operations. The first was XRAY Hour, the moment when the Bomb Carrying Aircraft was scheduled to begin the initial practice run. The second was HOW Hour, the expected moment of detonation, and intended to coincide with MIKE Hour, the moment of actual detonation. All aircraft were instructed to arrive on station a specified number of minutes before XRAY Hour, and to perform specific missions at a stated number of minutes after MIKE Hour.[103]

Technical and Training released the second draft of the Plan on 12 March. There was some criticism, of course, and a third draft appeared on 9 April. After additional suggestions, Technical and Training began a final revision which includeded operations for BAKER Day—the latter being little more than a repetition with minor variations of ABLE Day activities.[104] The fourth draft was completed, printed and ready for distribution by 23 April.[105] Thereafter there was a stream of requests for minor changes up through the eve of each shot day. Technical and Training considered each request for feasibility and in relationship to the operation as a whole.[106]

When the Plan was shown to Major General Leslie R. Groves, MANHATTAN District, and Dr. J. Robert Oppenheimer, Los Alamos Scientific Laboratory, they agreed that "it would be difficult to get it more complicated."[107] To this criticism, Kepner fittingly replied: "It would be difficult to make it more simple."

Another important contribution was made to CROSSROADS by the Air Transportation Unit of J-3 working in cooperation with the Air Transportation Branch of J-4.[107]

From the first it was evident that the success of CROSSROADS would depend upon air transportation, a LOC system which in the days of 1946 was still considered novel. It had been given only one extensive test, namely the Air Transport Command's Hump Route between India and China during World War II. Headquarters JTF-1 saw that for its own needs there would be two phases of air lift—domestic and overseas. The organization of the Task Force provided for the AAF Task Group to have an Air Transport Unit for the transportation of personnel between Washington and Santa Fe as a truck line with a net work spreading out to other crucial points. The overseas air lift was certain to surpass the capabilities of the TG 5 Air Task Unit and would require the assistance of such organizations as ATC and the Naval Air Transport Service. (NATS) It was foreseen that within the Forward Area shuttle service would be between Kwajalein and Eniwetok, and between Kwajalein and Bikini. The TG 5 Air Task Unit could employ some of its C-54 planes on Kwajalein-Eniwetok run since there was a sufficiently large airstrip on each of the islands to accomodate the transports. However, there was no strip at Bikini, and it was necessary to schedule a PBM seaplane flight under the Navy Air Task Group, TG 6, taking off from the Navy Air Base at Ebeye in Kwajalein lagoon and, upon return trip, from the Bikini lagoon. A seaplane tender was required for turn-around service at Bikini. These ideas were organized and implemented by the J-3 Air Transportation Unit and the J-4 Air Transportation Branch to meet the needs of JTF-1 for speedy transportation of some personnel and some supplies across the United States and across the Pacific.*[108]

Additional work of J-4 Division. Besides cooperation with the Air Transportation Unit of J-3, the J-4 Division had the overall problem of logistics which included the preparation of the Forward Area for the Task Force, and the provision of adequate hospital facilities to meet the normal needs of a population of 42,000 people.[109] Implementations came from the Navy Department agencies, and from the Army's Pacific Forces (CINCAFPAC) Mid-Pacific Forces (COMGENAFMIDPAC), Western Defense Command, and the Service Forces.[110] On 9 February CINCPAC proposed to CINCAFPAC a division of logistic

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*The extent of air transportation in CROSSROADS is shown by the following table:

Route	Date (1946)	Personnel Nos.	Personnel Tons	Mail Tons	Freight Tons	Total Tons
ZI-Hickam	Feb-Aug	3089	412.4	181.0	647.4	1240.80
Hickam-Kwaj	Feb-Aug	4366	546.2	99.9	913.7	1559.80
Inter-Atoll	May-Aug	5641	695.5	208.0	437.2	1340.70
Kwaj-Hickam	May-Aug	3074	378.8	94.0	217.2	690.00
Hickam-ZI	May-Aug	2127	265.2	75.7	66.5	407.40
	Totals	18,297	2298.10	658.60	2282.0	5238.70

There are no statistics for the transportation performed by GREEN HORNET within the United States. (Air Transportation Annex, Air Operations Report Operation CROSSROADS).

responsbilities for CROSSROADS. Within a short time a three-point agreement was reached:[111]

1. The Navy should provide complete logistic support to all naval forces.

2. The Navy should provide Army forces with facilities for housing, storage, messing, airfield operation, laundry, medical assistance and hospitalization; with Class I, Class III medical ship service, housekeeping supplies, and other normally used common items; and with local ground transportation.

3. The Army should provide organization equipment and spare parts peculiar to the Army, and resupply of these items as needed; the Army should also supply such operating personnel as were ordinarily attached to participating units, and for a proportionate share in the upkeep and operation of facilities provided by the Navy.

On 2 March, seventeen days after the CINCPAC plan received the concurrence of CINCAFPAC, there was activated at Pearl Harbor, on the suggestion of CINCPAC and with the approval of CNO, Service Division ELEVEN, which JTF-1 designated as Task Group 1.8. Its mission was to serve as an instrument of supply, and there was placed under the group's commander, Captain G. H. Lyttle, USN, a sufficient number of ships to meet the needs of transportation by sea.[112]

Other duties of J-4 included the adjustment of requirements to the ever increasing need of the Task Force,[113] and the removal of the Bikini natives from the islands. The evacuation began 1 March 1946. The entire population of 167 men, women and children was transported without incident to Rongerik Atoll, 109 miles to the east.[114] Finally, before it was possible to conduct the test it was necessary for J-4 to supervise a structures program on Bikini Island, and some of the other nearby atoll sand strips. A few hospital units were needed, as well as some recreational facilities. Also some construction was called for by the scientific tests.*115

The Movement of the Task Force Headquarters to Forward Area

During January and February 1946, Headquarters, JTF-1 expected to fire ABLE Shot on or about 15 May. To meet this schedule, some Task Force units left the United States for the Forward Area on 5 March, and Headquarters was expected to move out toward the end of the month. However, an incident, almost trivial in its nature, led to a postponement of the operation from 15 May to 1 July, and that delayed the departure of JTF-1 Headquarters from late March until mid-May.

At first only 2000 VIP's were invited to join the Task Force as official observers. The guests were to be quartered on some of the assigned combat ships. Blandy felt that such accomodations would not be comfortable, and Nimitz proposed the use of three additional AGO's to house the visitors, thereby doubling the possible space for observers from 200 to 400. Accordingly,

*Most of the construction was done by the Sea Bees. The original group reached Bikini 11 Mar. They were reinforced on 13 Mar and again on 20 Mar when their total reached approximately 1,000. The full extent of their construction, except for that done on Erik Island which is mentioned elsewhere, was:

On Bikini Island

Sea Bee Shops and facilities
Two dispensary buildings
Fourteen heads and urinals
Six pontoon causeways
One Air Coordination Unit
Seaplane landing ramp
Four moorings
Security fence
Shore Patrol building
Trap shooting range
Twenty-six dressing tests
Swimming facilities
Officer's Club 20 x 200 feet
Enlisted Men's Club, 16 x 300 ft
Fleet recreation area for 1,000 civilians and officers, 6,000 enlisted men, including water distillation and distribution systems for 8,000 gals. per day
Three life guard platforms
Officer's concrete athletic court, 100 x 100 feet
Five concrete basketball courts for enlisted men
Ten volley ball courts for enlisted men
Four soft ball diamonds for enlisted men

On Romoen Island
Camp for thirty-five men
Pontoon causeway
Sea Bee shop installations
10 barge evacuation moorings
Ball diamonds

On Enyu Island
A camp for 25 men
Sea Bee shops
Pontoon causeway
Concrete basketball court

On Prayer Island:
One Camp for 25 men and Army Aerological Installation

places allocated to congressmen jumped from thirty to sixty.[116] At the same time the President appointed an Evaluation Board ~~from~~ for CROSSROADS on which four other congressmen would serve, making a grand total of sixty-four congressional spaces for the operation.[117]

When Speaker Sam Rayburn heard of these plans he was deeply concerned. He felt that if sixty-four congressmen went on a junket to the Marshall Islands the administration's legislative program would be delayed—a political inconvenience on a congressional election year.[118] Rayburn took his grievances to the White House, and the President called a cabinet meeting for 22 March. Blandy was present and argued for the May schedule.*[119] Nevertheless, the President postponed the tests for about six weeks, and ABLE Day was set tentatively for 1 July.[120] The decision was a blow to morale, and it led to some amusing speculation on the part of commentators,[121] but the work of Task Force Headquarters went on without pause.

Since the overseas movement of Task Force units ~~were~~ was already under way

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*Adm Blandy warned that an indefinite postponement would endanger the plan. It was not certain that the scientists could be persuaded to remain with the Task Force beyond September. Secretary Henry Wallace said that the tests might be held during the Christmas vacation--an unintentional confession of ignorance on his part of what was involved. Blandy replied that the operation required the scientists to be overseas for more than a few days. He added that a six weeks delay would also cause trouble because of the deterioration in the weather during June and July. But a six weeks delay would not make it impossible to hold the tests during the summer of 1946.

Most of the commentators ignored the obviously honest explanation released by the White House and the War Department. Rumors, purportedly based on "inside information", were used to create a belief that postponement was a prelude to eventual cancellation as appeasement of Russia. Drew Pearsons said that the delay was necessitated by the time required to develop a special machine for use in the deep underwater test. He predicted that the tests would be held in the spring of 1947.

by the time that the postponement was announced,[122] ships and aircraft continued during April and May to transport men and supplies to Bikini, Eniwetok and Kwajalein. Gradually the target fleet gathered, the ships moved to their positions and the eight task groups with their subordinate task units took their places in the Marshall Islands. In early May Headquarters JTF-1 left Washington. By rail or air, personnel crossed the continent and assembled in San Francisco to board the USS Mt McKinley which served as Blandy's flagship. The vessel sailed on 8 May under the command of her own captain, but flying the flag of Snackenberg. Blandy, Kepner, McAuliffe, Parsons and several other high ranking staff officers joined the ship at Pearl Harbor where she arrived on 14 May. The next day, 15 May, Admiral Blandy broke his flag and assumed operational command of the entire Task Force.[123]

A stay of one week in Hawaii gave the personnel of JTF-1 a chance for last minute checks on many items and for a general briefing.[124] The flagship sailed from Pearl Harbor on 22 May and the Pacific crossing was uneventful. Early in the morning of 2 June the Mt McKinley moved to her anchorage in Bikini lagoon and acknowledged the customary naval courtesies from scores of ships already present.*[125]

There was still a month before ABLE Day, but that was little time in which to accomplish all the work yet to be done.

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*The schedule of the MT MCKINLEY in crossing from Pearl Harbor to Bikini was as follows:

Left Pearl Harbor	22 May
Lost one day crossing Int. Date Line	27 May
Arrived Kwajalein	29 May
Left Kwajalein	1 Jun
Arrived Bikini	2 Jun

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94. CJTF-1, Operation Plan No 1-46, Annex F, Air Plan, Appendix II; Air Operations Report Operation CROSSROADS, p. 24.

95. Memo, Maj J. W. O'Neil to Col W. D. Ganey, 16 Aug 1946.

96. Large Interview.

97. CJTF-1, Operation Plan No 1-46, Annex F, Air Plan, Appendix II; Air Operations Report Operation CROSSROADS. p. 24; TG 1.5, Tactical Doctrine History TG 1.5, 21 Jan-7 May 1946, Vol I-H, Annex Nos 61-69.

98. CJTF-1, Operation Plan No 1-46, Annex F, Air Plan.

99. Daily Diary, Air Operations Section I, 11-12 Apr 1946.

100. CJTF-1, Operation Plan No 1-46, Annex F, Air Plan.

101. <u>Ibid</u>.

102. Ltr, J-32 to Col L.L. Kunish, sub.: Summary of JTF-1 Air Operation Staff Training at Bikini, 16 Jun 1946.

103. Air Operation Report, 18 Apr 1946.

104. Minutes of Air Staff Conference, 22 and 25 May 1946.

105. Air Operations Report Operation CROSSROADS, p. 23.

106. <u>Ibid.</u>

107. Memo, RAdm W. S. Parsons to Maj Gen W. E. Kepner, 1 Apr 1946.

108. CJTF-1, Operations Plan No 1-46, Annex R, Logistics, Section II, Transportation, and Appendix XI, Air Transportation Plan: Reports of Air Transportation Officer, JTF-1, 18 Apr 1946: Ltr, Hq CAF to Brig Gen Roger M. Ramey, n.d.; Memo, Col Arno H. Luehman to C/S SAC, sub.: CROSSROADS Project, 25 Jan 1946; Ltr, Hq CAF to CG AAF, sub.: Domestic Air Lift for CROSSROADS Project, 26 Feb 1946; Memo, AAF CROSSROADS Project Office to DC/AS, sub.: Status of CROSSROADS Project, 15 Feb 1946; Hq TG 1.5, Daily Diary, 16-17 Feb 1946; Msg, CJTF-1 to CG AAF, 4 Mar 1946; Msg, CG AAF to CJTF-1, 8 Mar 1946;

Msg, CG AAF to CJTF-1, 8 Mar 1946; Hq SAC, CROSSROADS Weekly Progress Report, 12 Apr 1946; Hq CAF, A-3, Daily Diary, 4 Apr and 15 May 1946; Report of Col J.A. Roberts, Hq TG 1.5 to CG TG 1.5, sub.: Survey on Facilities Available to TG 1.5 at Hamilton Field, Johnston Island, Kwajalein and Eniwetok, 3 Feb 1946; Ltr, Hq CAF to CG TG 1.5, sub.: Air Transportation for CROSSROADS Project, 14 Feb 1946; Ltr, Hq AAF, sub.: Same Sub, 11 Feb 1946.

109. Memo, Brig Gen David N. Blakelock to VAdm W.H.P. Blandy, sub.: Tentative Outline for JTF-1 Logistic Support, 15 Jan 1946.

110. CNO Directive to all Navy Department Agencies, 16 Jan 1946; War Department Directive to CINCAFPAC, COMGENAFMIDPAC, and CG WDC, 26 Jan 1946; Ltr, CINCPAC to CINCAFPAC, and 1st Ind, 9 and 13 Feb 1946; CJTF-1, Report on ...CROSSROADS VII, (Section A).

111. JCS dispatch 112120Z Jan 1946 to CNO, etc., sub.: Activation and Support of JTF-1.

112. CJTF-1, Operation Plan No 1-46, Annex A, Movement Plan.: JTF-1 Staff Organization Chart.

113. Air Operations Report Operation CROSSROADS, Air Transportation Report, p. 4-5.

114. JTF Release No 13, 11 Mar 1946; Memo, L. S. Sabin to CNO, sub.: Removal of Natives, 12 Mar 1946.

115. CJTF-1 Report, VII, (Section A).

116. Maj James Taylor, AAF, Report on Conference with Adm W.H.P. Blandy, 25 May 1946.

117. Ibid.

118. Ibid.

119. Ibid.

120. Ibid.

121. JTF-1 Press Release No 6, 3 Apr 1946.

122. Hq TG 1.5, Daily Diary, 30-31 Jan 1946; History of TG 1.5, 21 Jan-7 May 1946.

123. Section I—Air Operations; Air Operations Daily Diary, 14-15 May 1946.

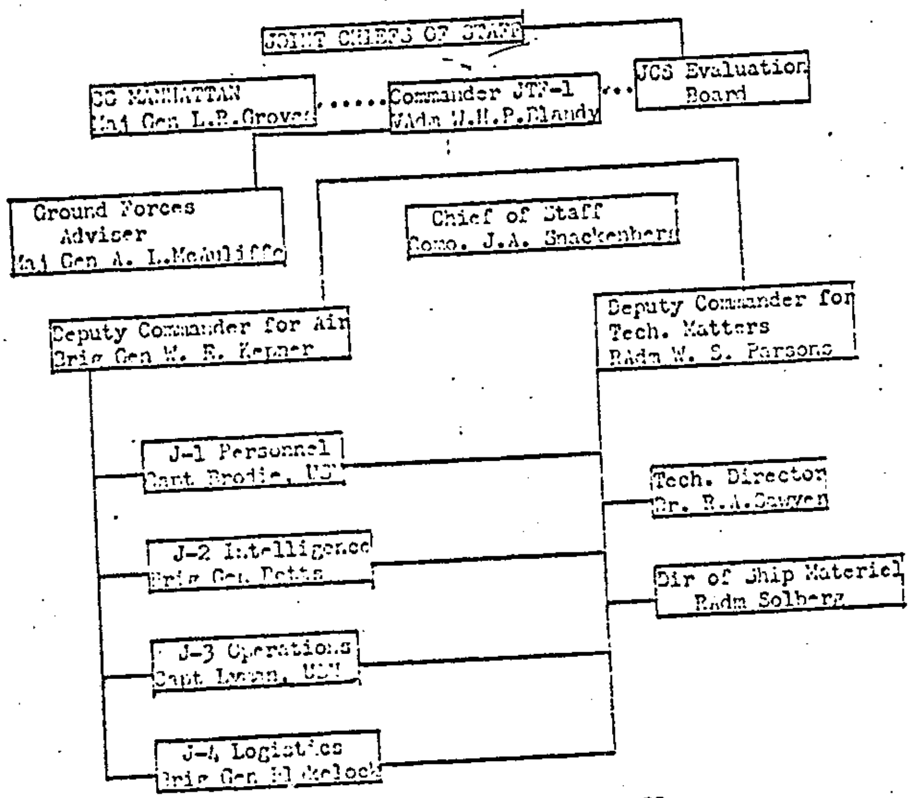
124. Ltr, Maj Gen W. E. Kepner, Hq JTF-1, CG AAF, 30 Jun 1946, sub.: Directive for AAF Participation in Atomic Tests; Dorfman, 20 May 1946.

125. H. L. Bowen, Notes on Stay in Kwajalein, 29 May-15 Jun 1946; Maj James Taylor, Memo for Record, 2 Jan 1946.

Appendix I to Chapter V

Organizational Charts for JTF-1

STAFF ORGANIZATION OF JTF-1



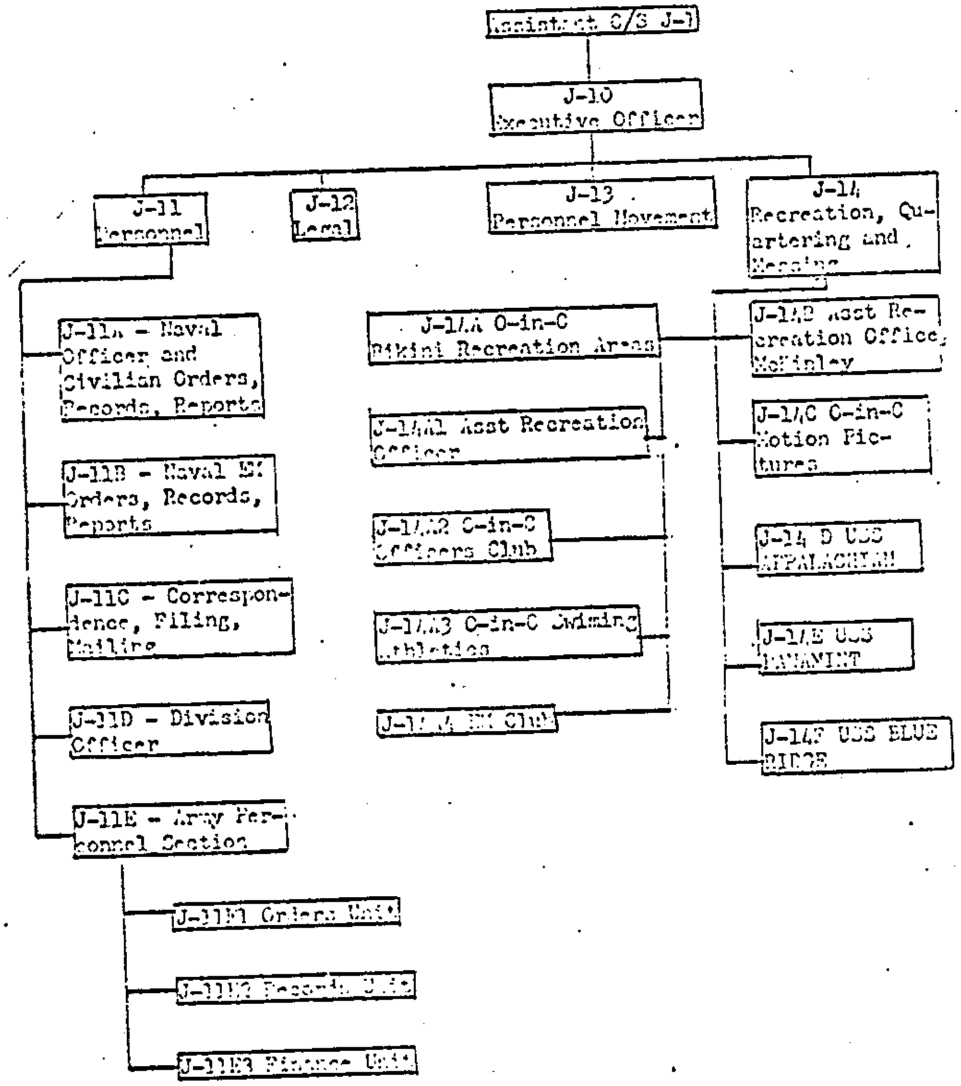
MEMBERS OF THE JCS EVALUATION BOARD

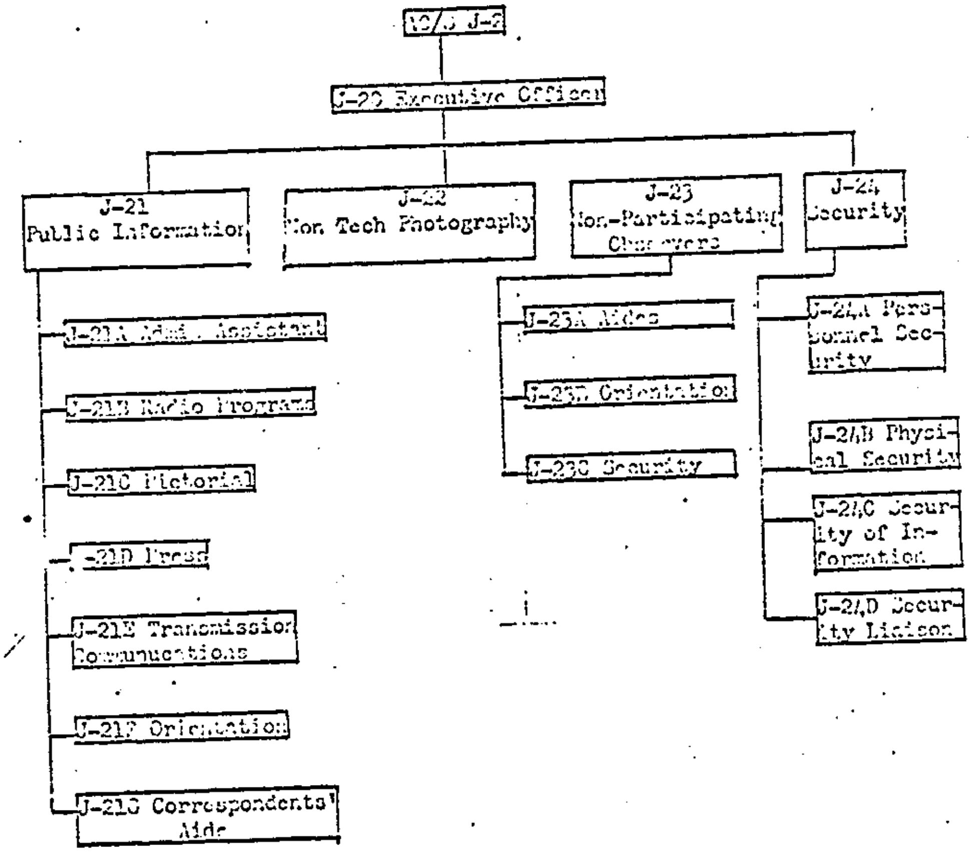
Dr. Carl T. Compton, Chairman
Mr. Bradley Dewey
Mr. J. F. Farrell
Gen. J. T. Stilwell (deceased)
Lt. Gen. A. C. Wedemeyer
(Sub. for Stillwell)
Lt. Gen. L. H. Brereton
V. Adm. John H. Hoover
R. Adm Ralf A. Ofstie

Mr. J. A. Derry, Secretary to Board
Col. Robert C. Butler, Acting Secretary

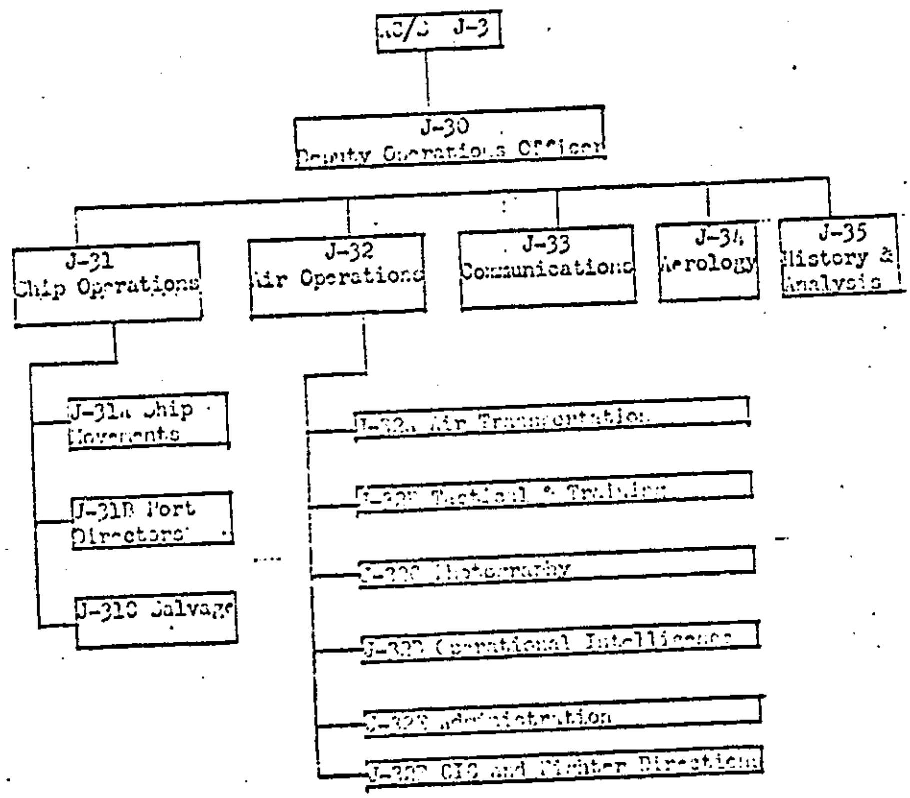
Technical Aids to Board
Mr. Russ Symontowne
Dr. Thornton Page
Col. Robert C. Butler
Major Glen W. Clark

STAFF ORGANIZATION OF J-1

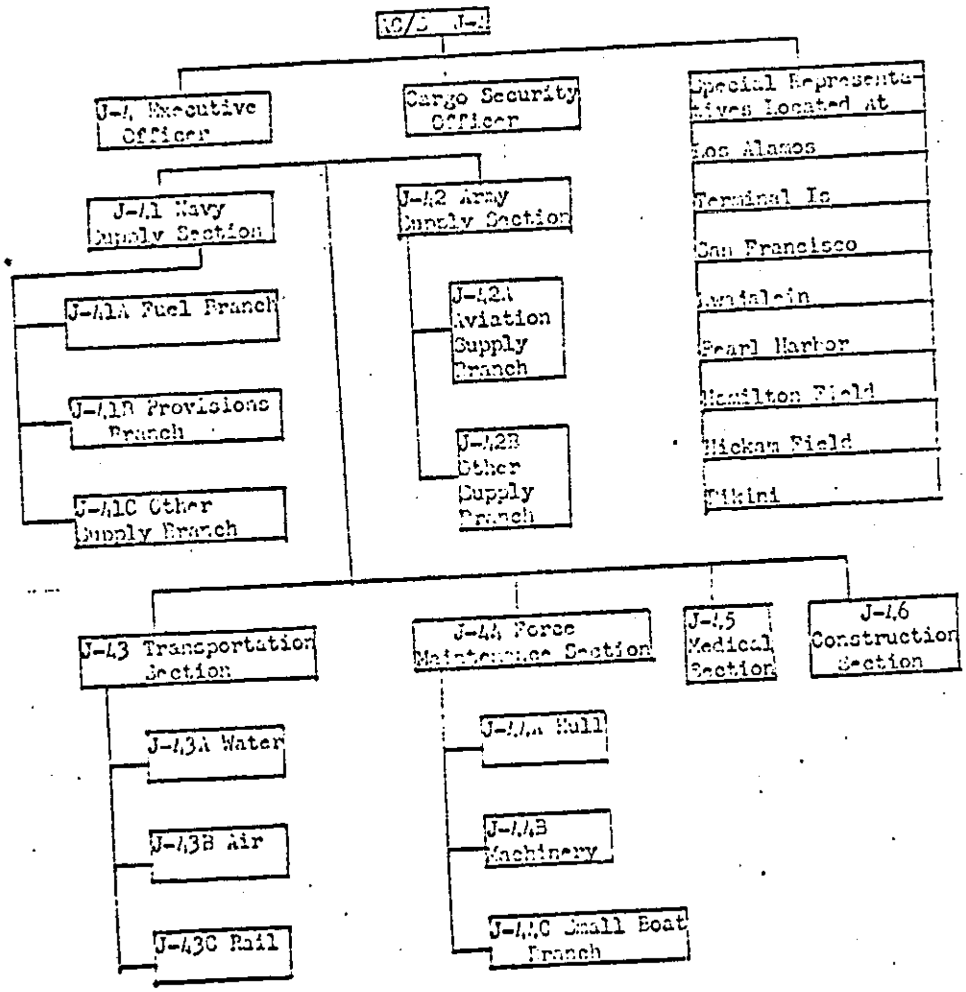



AC/S J-2
J-20 Executive Officer
J-21 Public Information
J-22 Non Tech Photography
J-23 Non-Participating Observers
J-24 Security
J-21A Admin. Assistant
J-21B Radio Programs
J-21C Pictorial
J-21D Press
J-21E Transmission Communications
J-21F Orientation
J-21G Correspondents' Aide
J-23A Aides
J-23B Orientation
J-23C Security
J-24A Personnel Security
J-24B Physical Security
J-24C Security of Information
J-24D Security Liaison

STAFF ORGANIZATION



STAFF ORGANIZATION



Appendix II to Chapter V

A summary of the purpose of the military-scientific tests

Technical Group I, Bomb Operation, included the scientific tests requested by MANHATTAN District, or more specifically, by Los Alamos Scientific Laboratory. The projects of this group included the supply, fusing, assembly, and firing of the bombs for Shot ABLE and Shot BAKER. In 1946, the functioning of an atomic bomb was still universally regarded as something so new, and understood by so few people, that it was quite natural for the work to be considered as a "scientific test". The leader of Group I requested the services of a number of Army Air Force and Navy Units for transportation and construction, and to drop the bomb. Thus, it was planned to have the weapons transported by the Navy from the West Coast to Kwajalein; to employ military personnel and equipment in transferring the weapon from ship to plane on Kwajalein for Shot ABLE; to select an Army Air Force aircraft to carry the bomb from Kwajalein to Bikini; and to transport the second bomb by ship from Kwajalein to Bikini Lagoon where it was to be attached to a Navy LST for the underwater blast. But in these operations MANHATTAN made only the most necessary compromises with its wartime secrecy, and few additional military personnel were to be admitted to a knowledge construction or mechanism. Thus the Army Air Forces, through Task Group 1.5, and especially through Task Unit 1.5.1, was called in to play an important part on ABLE Day in the activities of Technical Group I of the Military-Scientific Tests. Nevertheless only a very few AAF personnel participating in the operational phase of Group I were to be permitted a technological knowledge of the weapon. (CJTF-1, Operations Plan no 1-46, Annex G)

Technical Group II, Blast, Pressure and Shock, was sub-divided into four projects--Underwater Pressures, Air Blast Measurements, Shock Wave Velocity, and Measurements by Condenser Gauges. Underwater Pressure was to be tested by the use of more than 1300 recording gauges. Most of these instruments were to be placed under water at varying depths and distances from the target center, and a few were to be located on the target ships. In Air Blast Measurements, 1300 other instruments were to be placed on board the target ships to obtain data on the air blast wave as a function of distance. Three methods were adopted to record the Shock Wave Velocity. First, fifteen sonobuoys were to be moored in a line at appropriate distances to transmit a radio signal on shock wave arrival. Second, several argon flash units were to be placed along radial lines and photographed by cameras on Aomoen Island. And third, the direct photography of the burst from the Aomoen cameras was designed, among other things, to reveal the velocity of the shock wave. The Measurements by Condenser Gauges were to be achieved by dropping the instruments on parachutes from two B-29's following the bomb carrying aircraft. In this way blast pressure could be telemetered back by frequency modulation. Some of the instruments selected for the Blast Pressure Measurements on Target Ships were very simple—banks of pipes welded on the decks, to reveal pressure by bending; forty 50 gallon empty drums on ship decks to record pressure by deformity; 1,000 empty 50 gallon cans used approximately in the same way. Other instruments were not so simple, such as the diaphragm train pressure gauges, some with magnetic wire recorders, and mechanical piston gauges, all to be placed on the target ships. (Maj F. D. Walker, History of AAF Technological Participation in Operation CROSSROADS, pp. 58-62.)

Technical Group III, Wave Motion and Oceanography, was to study the height, length and propagation of water waves caused both by ABLE and BAKER Shots, but primarily to gather data produced by BAKER Shot. The necessary instrumentation was a family of meters and in addition television sets, cameras for tower photography and aerial photography, and radio sonobuoys were also to be used. Moreover, it was decided to place five seismographs on the coral projections of the reef to obtain data on the structure of the atoll and to record possible submarine landslides. An oceanographic survey of the lagoon was scheduled both before and after the second blast to discover changes in the physical formation of the atoll and to note the effect of the blast and its phenomena upon the fish life of the lagoon and vegetation of Bikini Island. (Report of the Technical Director of Operation CROSSROADS, Encl F.)

Technical Group IV, Electromagnetic Propagation, was broken down into four projects representing the combined interests of the Bureau of Ships, the Army Air Force, and Los Alamos Scientific Laboratory. The Bureau of Ships was permitted to conduct a test of the effects of the atomic bomb explosion on insulators, coaxial lines and Navy cables. It was determined to make the tests on each destroyer of the target group. The Bureau of Ships was also allowed to test other and more intricate equipment. There were technical implementations of these two projects carried out by the Bureau of Ships which were intended to gather additional data, such as catching the radar echo of the bomb burst on Aomoen Island. (Report Tech Div, Encl G)

The Army Air Forces had an equally elaborate program under Technical Group IV, and it was headed by Colonel D. F. Henry. Plans called for AAF ground stations on Eniwetok and Kwajalein islands to transmit and receive signals in the 5-12 MC region. It was decided to have two SCR 299's on Kwajalein transmitting at approximately 6 and 11 MC and two on Eniwetok transmitting at about 7 and 12 MC. It was provided that radio signals from the burst would be transmitted by B-17 drones equipped with automatic tape transmission on 5, 8, 14 and 18 MC and an 1800 MC jammer transmitter. These signals were to be monitored by the control aircraft and the B-29's carrying pressure recording gauges, with one half of these aircraft having communication intercept and analysis equipment and one half having intercept and analysis equipment. It was planned to have radar echoes recorded of the burst by aircraft radar sets equipped with scope cameras. (Report Tech Div. Encl G: Memo from Technical Director CROSSROADS Project to RAdm W. S. Parsons, sub.: Instrumentation, 8 Feb 1946.)

Group IV also contained the Los Alamos project on Electronics, directed by Dr. M. G. Holloway. His responsibility was to arrange transmission of the timing signals sent out during the last thirty minutes prior to detonation. Here was another activity which later task forces regarded as part of routine operations, but in 1946 it was still looked upon as an experiment. It was also Holloway's job to design and supervise the construction of timing signal receivers and relays with the assistance of the Bureau of Ships. (Walker, pp. 89-98.)

Technical Group V, Radiological Safety, was very important from the viewpoint of Joint Task Force ONE. The Group was divided into three units-Safety Precautions, Radiological Surveys, and Radiological Measurements. Of these three units, Safety Precaution became closely interrelated with the Damage Control Section of Ship Material under Admiral Solberg. Both "sections" or projects were concerned with safe-guarding personnel against the hazards of radio-activity, and this led to overlapping activities. (Report Tech Div. Encl C.)

Very little was known about radioactivity in 1946, and Headquarters JTF-1, was certainly justified in considering the subject one to be included in the Military-Scientific Tests. By the first week in February, Group V adopted the following eleven point program as a guide in the work to be done: (CJTF-1, Report on Atomic Bomb Test ABLE and BAKER Operation CROSSROADS, VII (Section C): CJTF-1 Operation Plan 1-46, Annex E, II, Col S. L. Warren, Report on Radiological Sabets. 4 Feb 1946.)

1. Promulgate a set of safety rules for all personnel.
2. Issue a prediction, based on oceanographic and aerological data, of direction of motion of contaminated air and water masses.
3. Establish monitors on destroyers equipped with Geiger counters to observe visually and instrumentally downwind draft of contaminated cloud (probably visible up to 30 minutes) and water currents.
4. Make preliminary survey of lagoon with Geiger counter equipment seaplane or helicopter.
5. Follow up with monitors in small boats carrying portable Geiger counter equipment to check water surface and board target ships to check.
6. Procure seventy-five G-M counters in order to equip all planes airborne between H-2 and H-30 with counters with earphone attachments, or have monitor with portable counter aboard each plane. Personnel were to be equipped with "photographic badges."
7. Maintain a situation chart in the flagship to show status of contaminated areas as reported by monitors.
8. Monitor target ships, returned drones, and other possibly contaminated regions before allowing presence of general personnel.
9. Provide photographic film "casualty badges" for personnel of Radiological Measurement, Navy Drone, USAAF Drone, and Photo units.
10. Mount 5000 photographic films behind lead, silver, and cadmium screens and distribute them throughout working spaces of target ships to measure total radiation exposure in those spaces.
11. Provide suitable protective goggles for all necessary observers of the burst.

Once the eleven point program was announced, it served as the basis for an understanding with the Damage Control Section of Ship Material.

The two units of Technical Group V and Ship Material collaborated so thoroughly that it is necessary to treat their joint work as though it had been done by one organization. But it is also necessary to remember that the two sections were never administratively joined.

Neither the Safety Precautions Project of Radiological Safety nor the Damage Control Section of Ship Material had very much experience in the field when they planned for the protection of Task Force personnel against radioactivity. Since there had never been anything similar to CROSSROADS in the past all decisions had to be based upon assumptions. It was assumed that all the ships of the target array would contain radioactive contamination, in varying degrees, after both blasts. But that was only one of the dangers to be met. It was also assumed that the ships would be seriously damaged by the heat and blast of the bombs, and by the explosion of ammunition and the burning of fuel oil and gasoline. So in addition to radioactivity, it was believed that the damaged ships would also be hazardous because of loosened structures, flooded compartments, ruptured steam lines, and because of concentrations of carbon monoxide and itrous gases. It was therefore decided to create joint Safety Precautions and Damage Control Boarding Teams, to return to the ships as soon after detonation as possible and rule on the permission for other members of the Task Force to inspect the effects of the bomb. (CJTF-1, Report on CROSSROADS, VII (Section C))

To put a complete safety program into effect ten Initial Boarding Teams were organized, each under the command of a specially trained Safety Officer. The teams were provided with equipment and instruments commonly used for detection of radioactivity and toxic gases and vapors. (CJTF-1 Report on CROSSROADS, VII (Section C); AAF Technical Report, Operation CROSSROADS, Appendix G, prepared by TG 1.5.)

In selecting the personnel for the Safety Precautions Damage Control program, the Navy assigned to the Task Force ten Hospital Corps officers. These latter were sent to the Damage Control Training Center in Philadelphia for a week of intensive training during the last days of February and the first few days of March. Later, additional training was given by the Industrial Medical Section of the Bureau of Medicine and Surgery at the Naval Gun Factory. Still later the course for Safety Officers--whose number had risen from ten to sixteen--was extended to include nuclear physics, communications procedure and the use of technical equipment. (CJTF-1, Report on CROSSROADS, VII (Section C).)

The training courses were all completed just in time for thirteen of the sixteen officers to reach the West Coast a few days after the President's decision to postpone the tests. While waiting to resume their interrupted journey to the Forward area, the Safety Officers familiarized themselves with the target vessels then at anchor in the harbors of San Pedro and San Francisco. This type of work continued until 29 May when the USS HAVEN sailed for the atoll taking the Safety Officers overseas. (CJTF-1, Report on CROSSROADS, VII (Section C).)

After the Safety Personnel reached Bikini two conferences were held, 12 and 13 June, between the commanders of the task groups, the Safety Officers, Target Coordination Officers, and Medical Officers of all target ships. It was then that plans were presented for the maintenance of safe conditioning on board target ships during the re-occupation and technical inspection of the vessels. The radiological safety program was explained in detail, as well as the methods which had been worked out for the continued collaboration between the Radiological Safety Precaution Project and the Damage Control Section. (CJTF-1, Report on CROSSROADS, VII (Section C).

Technical Group VI, Radiometry, was divided into two projects. The first was Measurement of Total Radiation, and the second was Spectrography. The Total Radiation experiments planned to use five thermo-couples aboard the KENNETH WHITING as well as a number of bolometer recordings to trace the radiant energy versus time in the first blast. In Spectrography all measurements were to be concentrated on Shot ABLE. The measurements were designed to consist of an integrated spectra in the region 2,000 to 8,000 angstroms to be obtained by one "medium" and two "small" spectrographs. (Report of the Technical Director Operation CROSSROADS, Encl H.)

Technical Group VII, Radiation Measurements, consisted of three projects to determine the radioactivity in the target area. These measurements were additional to those required by Radiological Safety. Very briefly, the experiments were for Gamma Ray Timing, Neutron Density Determination, and Collection and Analysis of Radioactive Samples for Nuclear Efficiency Determination. The last of these three projects was of particular interest to Los Alamos which provided the necessary filter paper to make the tests. Wright Field and Navy Bureau of Aeronautics collaborated in the design and procurement of about twenty filter units to be mounted on bomb racks and on carburetor intakes. It was agreed that sixteen Navy F6F drones and from four to six AAF B-17 drones would be employed to effect the collection of high altitudes. The radio-chemical analysis of the exposed filters, however, remained the work of Los Alamos, as well as the analysis of water and solid samples to be taken from the immediate vicinity of the target. (Report of the Technical Director Operation CROSSROADS, Encl J.)

Technical Group VIII, Remote Measurements, was planned as a comprehensive survey of physical phenomena as recorded at great distances from Bikini. As a matter of national security the data was needed in an attempt to devise a means of detecting atomic explosions anywhere in the world. In preparing for the necessary observations, it was determined to alert stations in the United States, Alaska, Hawaii, and on several islands in the Pacific. The observations proposed were Seismographic Measurements by the Coast and Geodetic Survey; Tidal Measurements by the Coast and Geodetic Survey; Terrestrial Magnetism by the Carnegie Institute; Ionospheric Phenomena by the Bureau of Standards and the Carnegie Institute; Atmospheric Electric Effects by the Naval Research Laboratory; Radioactivity by the Weather Bureau; Astronomical Phenomena; namely an attempt to detect by microphotometry any changes in illumination on the dark side of the moon, to be undertaken by the Naval Observatory; and finally Radiosonde and Wind Observations to determine the angle at which the sound wave would strike the ground, to be supervised by the Weather Bureau, the California Institute of Technology, and by various Army and Navy weather stations. Group VII also called for an attempt to take photometric measurements of the total radiated by the blast, and the variation of this light with time. (Walker, pp. 70-71; Report of the Technical Director Operation CROSSROADS, Encl K.)

Technical Group IX, Technical Photography, was kept theoretically quite distinct from other phases of CROSSROADS photography. In actual practice, however, Technical Photography was inseparably part of the elaborate overall photography program of the Task Force intended to cover technical and historic films and news reels. The Technical Photography under Captain R. S. Quackenbush, was made Group IX, whereas J-2 was responsible for the non-technical movies and stills. (CJTF, Operation Plan No 1-46, Annex L and Annex G; CJTF-1, Report on CROSSROADS, VII (Section C).)

When Captain Quackenbush was placed in charge of Group IX, it was assumed that the sole responsibility for Technical Photography rested with the Task Force. The program was therefore designed for the needs of MANHATTAN District, including Los Alamos Scientific Laboratory, two important projects sponsored by the Bureau of Ships, and several other scattered projects which sought a faster record of the blast from the air. Elaborate plans were made for the location of several types of cameras in the ground, and also for placing special cameras in aircraft. The latter involved the use of AAF and Navy planes. To meet these requirements there was set up within the AAF Task Group 1.5 and the Navy Air Task Group 1.6 Special photographic units, TU 1.5.2 and TU 1.6.2, to carry out the photographic requirements of Technical Group IX. Task Unit 1.5.2 was placed under the command of Colonel P. T. Cullen, and the Navy designated the USS SAIDOR (CVE 117) as "Photographic Carrier" of Task Unit 1.6. (Walker, pp. 103-142; Charlotte Knight, "Photographing the Big Bang," Air Force, May 1946.)

Long after Captain Quackenbush completed his basic arrangements for Technical Photography, the Commanding General MANHATTAN District, announced that the MANHATTAN Task Group, known as Technical Task Group 1.1, would handle its own photographic coverage for the following activities:

1. All phases of bomb assembly.

2. All states of bomb handling from the ship and into the plane for Test ABLE, and into the final position for Test BAKER.

3. All laboratory setups aboard ships carrying personnel of the Los Alamos Group.

The Task Group also planned to have its own laboratory facilities located ashore and staffed by Los Alamos personnel. It was added that MANHATTAN planned to call upon the photographic facilities of the Task Force only for the most general coverage. (Ltr, Maj Gen Lesli to VAdm W. H. P. Blandy, 7 Mar 1946.)

The decision of MANHATTAN to do its own photography cut down the extent of work to be done by Technical Group IX. But Captain Quackenbush still found it necessary to employ civilian assistance. On 23 January, a conference was held in Washington between representatives of JTF-1, AAF, the Navy, Bausch and Lomb Optical Company, the Eastman Kodak Company, the Fairchild Camera and Instrument Corporation, and Los Alamos Scientific Laboratory. The overall problems of the Technical Photography program were frankly discussed and the advice of the civilian companies was sought. As a result of this conference a contract was signed with the Fairchild Camera and Instrument Corporation to perform some aspects of the Technical

Photography Projects. (CJTF-1. Report on CROSSROADS, VII (Section G).)

The historical coverage of the operation was far less extensive than the technical photography. There was some hope in the early days of getting Hollywood producers interested in the undertaking. On 30 January, a representative of JTF-1 met representatives of the producers in the office of Eric Johnson to discuss the matter. At first the producers were enthusiastic but as time went on interest waned. It was not long before the producers decided against committing themselves and the work had to be done by the Army Air Force and the Navy. (CJTF-1, Report on CROSSROADS, VII (Section G).)

As part of the Public Information Program it was necessary to contact the various newsreel organizations. (Memo from Cdr W. C. Park, USN, R. S. Quackenbush, 3 Feb 1946.) On 5 February, a representative of JTF-1 addressed a meeting in New York of the editors of Pathe News, Fox Movietone News, Paramount News, Universal Newsreel and MGM News of the Day. The discussion covered such subjects as the general plans for news reel recordings of the operation and a consideration of the restrictions which had to be observed for the sake of security. A few days later, the news reel representatives held a meeting of their own in which they accepted all the conditions presented to them by the JTF-1 representative. Mr. E. P. Genock of Paramount News was selected as the pool director, and the pool itself was set at seven men. This group of civilians was promptly organized and immediately began cooperation with the Public Information Office of Joint Task Force ONE. (Minutes of meeting of Representatives of JTF-1, Pathe News, Fox Movietone News, Paramount News, etc., N. Y. 5 Feb 1956.)

The cost of the photographic program underwent frequent revisions, and it was not until 4 March that it was possible to present anything like a definite estimate. The totals were submitted to Captain Quackenbush in the following table: (CJTF-1, Report on CROSSROADS, VII (Section G).)

Aerial cameras	$159,766.00
Still Cameras	8,280.00
Motion picture cameras	111,503.00
Laboratory equipment	33,839.00
Film, paper, chemicals	207,219.00
Fairchild conversions	130,000.00
Fairchild reconversions	20,000.00
Total	$670,607.00

Since a large number of cameras were to be located on the ground it was necessary to have special towers to accommodate the installations, and that involved an extensive building program. On 3 February, Fairchild drafted first plans for camera housings on the island towers, the number of which increased as the Photography Program expanded. In the end six towers were erected--two on Bikini Island, two on Enyu, and two on Aomoen. (CJTF-1, Report on CROSSROADS, VII (Section G).)

The construction required by photography was combined with that required by all the Nine Technical Groups, and the total was added to the work already begun in the Forward Area by the Sea Bees. On Bikini Island there were five steel towers, each one of them being seventy-five feet high, two wooden towers, twenty-five feet high, and four steel huts, 20 X 20 feet. There were ten wave measurement piles and three photographic beacons. Four steel towers were placed on Namoen and five steel huts, a sonobuoy receiver platform, a portable radar installation, a seismic hut, some wave measurement piles, and a few photographic beacons. On Enyu Island there were three steel towers, each seventy-five feet, three steel huts, 20 X 20 feet, one wooden tower, twenty-five feet high, a seismograph hut, radio beacon installations, and two photographic beacons. On Prayer Island there was a revetment. A photographic beacon was erected on Rokar Island, and one seismographic hut each on Cherry, Yuro, and Namu Islands. When the Sea Bees were doing this construction, it was still part of the CROSSROADS plans to carry through Shot CHARLIE, the deep water burst. In preparation for this third blast, the Sea Bees constructed anchorages on Aran, Maxy, Oruk, Boku and Boro Islands. (CJTF-1, Report on CROSSROADS (Section A).)

There were various natural phenomena, characteristic of the Marshalls, which tended to hinder construction intended for the Military-Scientific Tests. For instance, during March the wind blew almost steadily at a velocity of about twenty-five knots. Because of this, it was determined that the vertical erection of the steel towers would be too hazardous for the untrained personnel to attempt. It was, therefore decided that all of the twelve towers would be constructed horizontally, on the ground, and eventually rotated or hoisted to their vertical positions. Complete fulfillment of the plan was prevented by the modifications required on the six photographic towers, but the other six were constructed as prone. (CJTF-1, Report on CROSSROADS, VII (Sections A and G).)

On 26 March, the Task Force Commander directed the J-4 representative at Bikini to interrupt work on the towers since it had been found that the camera boxes were too large to be mounted on the existing platform. The dispatch also advised that the top of the towers were being redesigned and that special structural steel was being obtained and would be shipped from the United States. Work on the towers, therefore stopped while awaiting the new drawings and the required structural steel. (CJTF-1, Report on CROSSROADS, VII (Sections A and G).)

Fortunately, by the time the steel was received, the wind had abated sufficiently to permit the vertical erection of the towers. But the modification steel was received "unpunched", and it was not possible to assemble the towers by bolting, as had been originally planned. Instead, the modifications were welded in the field. These complications brought about a further delay in completion of the towers beyond the originally planned date. However, in view of the postponement of the first shot to 1 July, these delays proved to be unimportant. (CJTF-1, Report on CROSSROADS, VII (Sections A and G).)

By the middle of June most of the photographic personnel were in the Forward Area and the entire Photographic Program was in an excellent condition. Special photographic laboratories had been set up aboard the USS ALBEMARLE, APPALACHIAN, CUMBERLAND SOUND, KENNETH WHITING, BLUE RIDGE, AVERY ISLAND, MOUNT MCKINLEY, BURLESON AND PANAMINT. Another laboratory was erected on Ebeye Island and facilities at Kwajalein were also made available to the Task Force photographic personnel. (CJTF-1, Report on

CROSSROADS, VII (Section A and G); Critisize of 7 June) In addition, by 15 June, the following laboratories in the United States were designated to process the ABLE and BAKER Day films:

1. The Consolidated Film Industries, Hollywood, for black and white motion picture film, television film, camera time recording film, radar scope film.

2. Technicolor Corporation, Hollywood, for 35 mm motion picture film in color.

3. Eastman Kodak Company, Oahu, Hawaii, and Eastman Kodak Company, Rochester, N.Y., for 16mm Kodachrome.

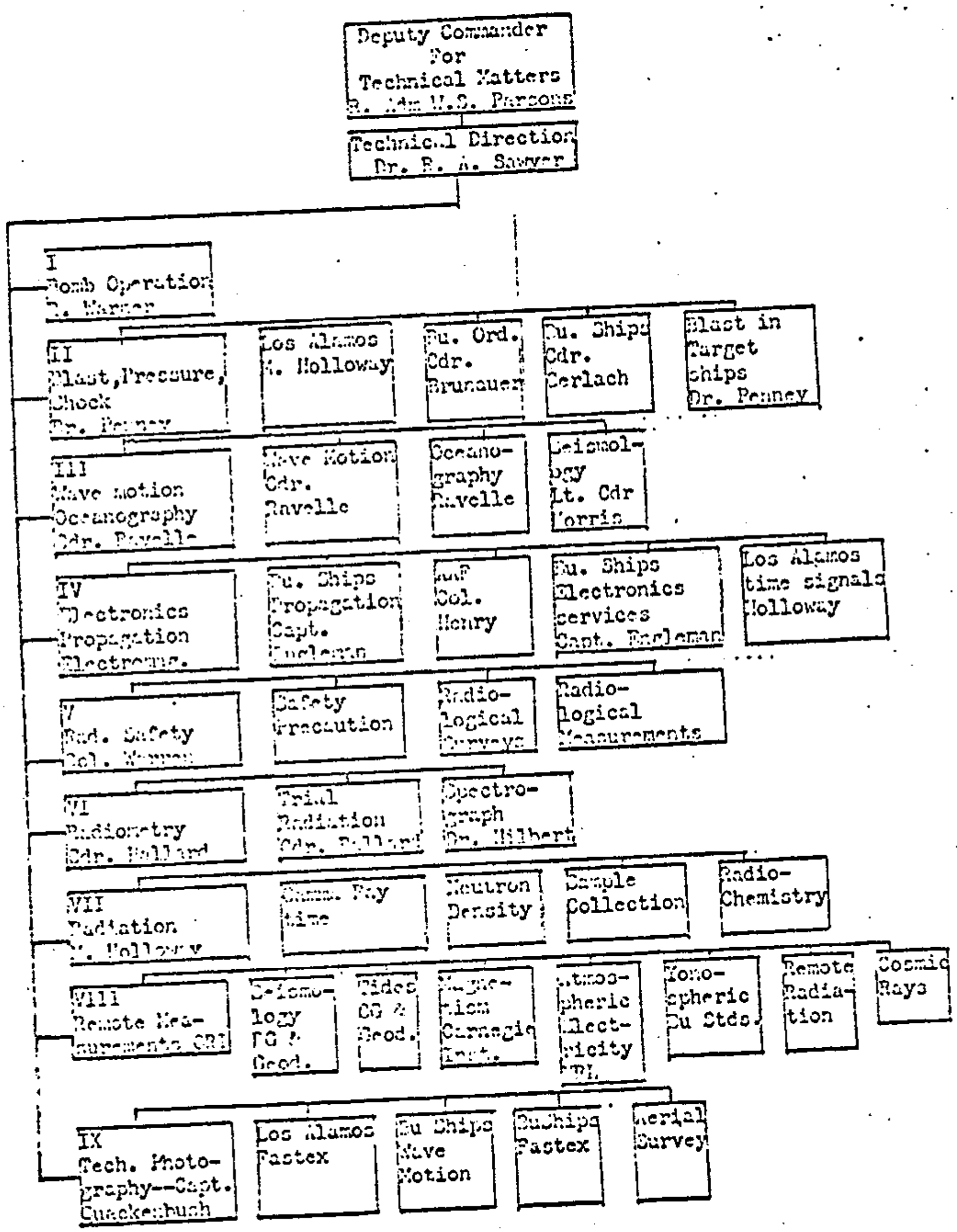
4. Ansco Corporation, Binghamton, N.Y., for all Ansco Color Film.

5. Task Unit 1.5.2, Kwajalein; Task Unit 1.6.2, USS SAIDOR: AAF Photographic Laboratory, Washington, D. C. and the Naval Photo Science Laboratory, Anacostia, D. C. for black and white still film.

6. Eastman Kodak Company, Rochester, N. Y., for all photometric film.

Actually, the major portion of the Navy's still and motion picture film was processed aboard the USS SAIDOR and at Photo Science Laboratory, Anacostia. (CJTF-1, Report on CROSSROADS, VII (Sections A and G).)

In addition to the Military-Scientific Tests directed by the Nine Technical Groups, it was determined by the Navy Medical Corps, in co-operation with the Army Chemical Warfare Service, the Army Medical Corps, and the Navy Medical Research Institute, to test the effects of the bomb upon more than 5,000 animals. The victims consisted of 200 pigs, 204 goats, 5,000 rats, and 200 mice. These animals were all, in one way or another, sufficiently like human beings for the scientists to deduce from their reactions the effect of a bomb upon the personnel of a fleet or the population of a city. Pigs were chosen because their hair and skin resembled that of man. Goats were included because the quantity of their body fluids was needed for extensive post-mortem laboratory analysis. Rats had been used for such a long time in radiology experiments that their reaction to radiation had already been correlated to that of men. The mice sent to Bikini were taken from two strains, those particularly susceptible to cancer and those considered to be normally immune. (W. A. Shurcliff, Bombs at Bikini (New York, 1947) pp. 84-88.)


Deputy Commander For Technical Matters R. Adm W.S. Parsons
Technical Direction Dr. R. A. Sawyer
I Bomb Operation
II Blast, Pressure, Shock
Los Alamos
Bu. Ord. Cdr. Brunauer
Bu. Ships Cdr. Gerlach
Blast in Target ships Dr. Penney
III Wave motion Oceanography
Wave Motion Cdr. Ravelle
Oceanography Ravelle
Seismology Lt. Cdr Morris
IV Electronics Propagation
Bu. Ships Propagation Capt.
AAF Col. Henry
Bu. Ships Electronics services
Los Alamos time signals Holloway
V Rad. Safety
Safety Precaution
Radiological
Radiological
VI Radiometry
Trial Radiation
Spectrograph
VII Radiation
Neutron Density
Sample Collection
Radio-Chemistry
VIII Remote Measurements
Seismology
Tides
Atmospheric Electricity
Ionospheric Bu Stds
Remote Radiation
Cosmic Rays
IX Tech. Photography--Capt.
Los Alamos Fastex
Bu Ships Wave Motion
BuShips Fastex
Aerial Survey

V
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Appendix III

POSITIONS OF AIRCRAFT AROUND ORBIT POINTS

Orbit Point	Bearing From TC	Distance From TC	Army Aircraft	Navy Aircraft	Altitude	Function
YOKE	030°(T)	20 NM		1 TBM	9,500	Photo
UNCLE	045°(T)	30 NM	6 B-17 (3 Drones and 3 Controls)		30,000	D and C
					18,000	D and C
					13,000	D and C
				2 PBM	2,000	Rad Rec
ABLE	045°(T)	20 NM		1 F6F	14,000	Photo Trimet before det.
DOG	082°(T)	15 NM		1 PBM	5,000	Photo
EASY	090°(T)	20 NM	1 B-17		24,000	Master C
KING	132°(T)	15 NM		1 PBM	12,000	Photo
TARE	135°(T)	40 NM	1 B-29 (5 m.e. of TARE)		25,000	Rad Rec
SUGAR	135°(T)	20 NM		8 F6F	28,000	SDC
					20,000	SDC
					15,000	SDC
					10,000	SDC
(SDC: Secondary Drone Control)				1 TBM	4,000	Photo
CHARLIE	169°(T)	15 NM		1 PBM	12,000	Photo
WILLIAM	270°(T)	30 NM	2 B-17		24,000	C and D
LOVE	315°(T)	30 NM	1 B-29		25,000	Rad Rec
VICTOR	315°(T)	20 NM		12 F6F	28,000	2 C and D
					20,000	2 C and D
					15,000	2 C and D
					10,000	2 C and D
			13 AAF			
		plus	17 Circling			
			30 AAF plus 28 Navy -		Total of 58	

Chapter VI

THE ROLE OF AAF IN CROSSROADS

At the top level, the Army Air Forces played a most creditable part in defining the shape of Operation CROSSROADS and in assisting, through the work of AAF officers, in the preparation of the Scientific-Military Test requirements and the Air Operations Plan both for ABLE and BAKER Day. At the level of the field commands AAF made equally valuable contributions, even at the expense of other plans that seemed at the time almost as important.

The State of AAF Plans in January 1946

In the autumn of 1944 General H. H. Arnold, CG AAF, began thinking of the problems that would face the Air Force at the conclusion of hostilities. He felt that AAF should have a well defined policy for the initial years of peace, and believed that the first goal should be a permanent program of research and development. He realized that if the atomic energy program was successful, as then seemed only probable, the post-war significance of science for the military would be greater than ever before. In November Arnold turned to the Scientific Advisory Group for the preparation of special studies on the role of science in the future of the Air Force, and in the spring of 1945 he requested his generals to send him their recommendations for peace-time requirements.[1]

Events moved swiftly, and before definite action could be taken the war was over. Air Force policy was then entangled with the confusing issues of returning to normalcy—demobilization, reduced budgets, reorganization,* and the inevitable changing of the guard.** Moreover, as Arnold foresaw, the matter of research and development was further complicated by atomic bombs. There were many who believed, through the inertia of conservatism or because of the scarcity of fissionable material, that atomic weapons would always be phenomenal, and that no change should be made in plans for the conventional system of aerial warfare. Others were convinced that atomic weapons would soon be abolished by international law. Yet others saw that eventually the restrictions of scarcity would be lifted, that atomic bombs would be accepted, that some day they would alter the nature of warfare, and that the Air Force must include within its plans for research a program for the development and use of the new weapons.***2

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*The most important reorganization was that of unification, discussed from the end of the war until Sep 1947 when theoretically it went into effect.

**Gen H. H. Arnold was among the victims of war-responsibility strain. He never fully recovered from a heart attack of Feb 1946, and in November requested retirement so that "younger men" might be in the driver's seat. He was succeeded on 1 March by Gen Carl Spaatz as CG AAF. (H. H. Arnold, Global Mission (New York, 1949), p. 609.)

***One of the best statements of the Air Force dependence upon an adequate program for research and development was made in a letter from Maj Gen St. Clair Street, CG CAF, to Gen Arnold, 31 Aug 1945. Gen Street wrote:

> The Army Air Forces is, in a scientific sense, on trial for its life. The whole concept of air warfare is undergoing a rapid change and unless we grasp the impact of these changes and adapt ourselves to them quickly, they will be lost to us. The fruits of scientific advances will be forced upon us whether we like it or not and if the Air Forces does not take them up as they develop, they will be snatched at random by all other branches and the confusion and loss of effectiveness will be tremendous.

(Cont'd on following page)

Actually the Air Force made impressive efforts in 1945 to adjust to the atomic age. On 22 August Lieutenant General Hoyt S. Vandenberg instructed the Requirements Division, AC/AS-3, to initiate a comprehensive study of the effects of nuclear weapons on future AAF programs.[3] A few weeks later, in September, Arnold directed General Carl Spaatz, who was still CG United States Army Strategic Air Force (US ASTAF), Guam, to convene a board to study the future possibilities of atomic strategic bombing.[4] The Spaatz Report was issued early in November, and it led to the December appointment of Major General Curtis E. LeMay as Deputy Chief of Air Staff for Research and Development (DCS/R&D). One of LeMay's responsibilities was to plan for and direct an Air Force atomic energy program and relate it to the work being done by

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*(Cont'd from preceding page)

To avoid this situation I believe three fundamental things must be done by the Army Air Forces.

a. We should establish a staff section under a deputy whose sole responsibility is research and development.

b. We must indoctrinate the whole Army Air Forces into the principle of maintaining intimate access to the scientific world within the United States.

c. We must foster and build up among the scientific workers of this country a spirit of intense interest in the Air Forces and its problems.

Your attention is invited to the very active reorganization of the Research and Development Organization of the Navy Department. They are concentrating their research leadership under a Naval Officer with civilian advisers and are making additional extensive provisions for farming out and decentralizing much work into private university laboratories....I cannot over emphasize my conviction that the most important single factor in the future of the Army Air Forces lies in our utilization of the full national scientific effort and our providing the necessary organization to properly handle it.

MANHATTAN District.*[5] LeMay's office thus became the successor of the wartime MANHATTAN Activities Project Office, Headquarters AAF, headed originally by Colonel R. C. Wilson and later by Major General Lauris Norstad.

In the beginning LeMay was hampered by lack of direct contact with MANHATTAN since the Air Force had been rather rigidly excluded from the atomic energy program except for the operational aspect. There was a serious lack of personnel with the scientific background to understand either the wide field of nuclear physics or the more limited field of atomic weapon technology. On the other hand LeMay still had at his disposal the Project W-47 training test center, the AMC SILVERPLATE Project, and the 509th Composite Group. It was this latter which became the immediate means of incorporating an expanded atomic weapons program within the Air Force.

On 2 September 1945 USASTAF, to which the 509th had been assigned since its arrival on Tinian, requested authority to return the Group intact to the United States without sending it through a processing center.[6] Arnold immediately approved the suggestion. In October the Group reached the United States and was assigned to the 58th Bomb Wing, Second Air Force, Continental Air Force (CAF).[7] Shortly thereafter the 58th Wing, carrying with it the 509th, was transferred to the Fourth Air Force, CAF. Brigadier General Roger Ramey, commanding the Wing, had his headquarters at March Field, Riverside, California, and the Group was stationed at Roswell, New Mexico.[8] This location was convenient to Albuquerque where the other SILVERPLATE activities from Wendover had been sent in August. Project W-47 was at Kirtland Field, and an ordnance section, a duplicate of the 1st Ordnance

*See Vol II of this History for details.

Squadron, Special, Aviation,* was at Sandia.[9]

When the 509th came back from Tinian, Washington had already decided to preserve the Group as a special operational unit. In November Headquarters AAF expanded these plans, and spoke of an Atomic Striking Force with a wing headquarters and four groups, one of which was to be the 509th.** On 15 November Vandenberg approved the first blue print for the new organization.[10] At this point, Ramey, supported by Major General Samuel E. Anderson, C/S CAF, urged that all the long range bomber units be employed as the nucleus of the Striking Force, but with one small unit, obviously the 509th, kept intact for training purposes and for instant combat readiness.[11] After careful thought,[12] Headquarters AAF

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*It had been intended to keep the 1st Ordnance Squadron intact along with the other units of the 509th. Unfortunately before the necessary arrangements could be made the Squadron was depleted by demobilization. In this way the Air Force lost many of those officers and men who were highly qualified in the technique of handling atomic bombs. The personnel of the new ordnance section had to be freshly trained for the work. (AFOAT, the United States Air Force in Atomic Warfare.)

**The 58th Wing, commanded by Ramey, had participated for AAF in the Muroc tests in 1944. It then went to India and attacked the Japanese in China. Later the 58th went to Tinian where the 509th, under the 313th Wing and USASTAF, appeared in July 1945. The 58th Wing and the 509th returned to the United States at the same time, but the Wing went to March Field, Riverside, California, still under the command of Ramey, while the 509th went to Roswell. Ramey believed that the proper way to get an Atomic Striking Force was to use all of the heavy groups, organized under the four air forces of CAF, and he convinced Anderson that this idea was sound. (Memo, from Mr. F. L. Anderson, sub.: Establishment of a Striking Force, n. d., but apparently written somewhat late in Nov 1945; Memo from Maj Gen Lauris Norstad, AC/AS-5, to Chief of Air Staff, 24 Nov 1945; Ltr., Hq CAF to CG 1st AF, etc, Sub.: organization of VHB Units, 28 Nov 1945. Note: F. L. Anderson was a civilian and should not be confused with Maj Gen S. E. Anderson.)

decided to designate the 58th Wing, under Ramey's command, as the Strategic Air Striking Force. It would consist of three very heavy groups--the 40th, the 444th, and the 509th.[13] The Chief of Air Staff approved the plan on 7 January 1946,[14] but before it could be put into effect it had to be sidetracked for CROSSROADS.[15]

The JTF-1 Requirements of AAF

Headquarters AAF understood by December 1945 that Presidential approval of the atomic tests would give the Air Force a vital role in an operation that was sure to be extensive. The period of uncertainty ended on 10 January when President Truman authorized CROSSROADS. The next day, as soon as Vice Admiral W. H. P. Blandy activated Joint Task Force ONE, Arnold's office summoned Ramey and representatives of the Personnel, Communications and Supply divisions of CAF to a Washington conference on 14 January. Ramey, of course, had to cross the continent, but CAF--soon to be known as the Strategic Air Force (SAC)--was located at Andrews Field, a matter of minutes from the Pentagon.*

When the conference opened, Ramey heard that he would command the JTF-1 Air Task Group. The SAC representatives heard that their role in connection with the tests would be very important but that as yet it was impossible to give specific responsibilities. Ramey and the SAC representatives left the conference without written instructions, and with only a sense of urgency to get the work started as soon as possible.[16]

The day after the conference, Headquarters AAF received a letter from the Commander JTF-1 in which he formally requested that the

*In March 1946, the Continental Air Force was redesignated as the Strategic Air Force (SAC) and for the sake of clarity will hereafter be referred to as such.

Army Air Forces:[17]

1. Deliver one bomb as had been done at Hiroshima and Nagasaki.
2. Use two B-29's as instrument planes.
3. Employ four B-29's in the Task Force photography program.
4. Assign other type aircraft to collect contaminated air.
5. Supply the Task Force needs for ZI and overseas air transportation.
6. Participate in preparing a motion picture for historical purposes.
7. Assist in the instrumentation for technical photography.

These requirements, though long anticipated, meant that AAF participation in CROSSROADS would require special attention.[18] Air Force Headquarters used Blandy's letter as the basis for action, and created a CROSSROADS Project Office headed by Colonel Kenneth Gibson. His duty was primarily to coordinate all the test activities of the various Headquarters staff sections, and, working through LeMay, remain in constant contact with Headquarters JTF-1.[19]

On 18 January, using the work of Gibson and LeMay, Headquarters AAF submitted its Plan for the Army Air Forces Participation in the Proposed Atomic Bomb Tests Against Naval Vessels. The paper named SAC as the agency to be responsible for the personnel needed by the Joint Task Force. Six days later, 24 January, Headquarters AAF issued a directive authorizing SAC to organize, train and equip a force within the 58th Wing to participate in the joint tests. Ground echelons and organizational equipment should be ready to leave for a West Coast port by 10 March, and air and ground units should be operational in the atolls of the Forward area by 15 April. The directive noted that planning remained incomplete at the highest levels, and stated that final decisions by Joint Task Force ONE had not then been received by AAF Headquarters. When all the unknown factors in the

CROSSROADS plans were made clear, AAF would issue a supplementary directive to SAC clarifying such phases of the operation as would permit complete planning.[20]

It was also on 24 January that Headquarters AAF warned the Air Material Command to expect a heavy modification workload for CROSSROADS. Six days later, 30 January, Blandy, after long discussion with his own staff and with LeMay's office, sent a second letter to Headquarters AAF requesting a total of forty-two aircraft to perform the following missions:[21]

No. of A/C	Type of A/C	Mission
1	B-29	To drop the bomb
4	B-29's	To drop pressure gauges
10	B-17's	As Drones
6	B-17's	As "Mothers" or Drone Controls
9	F-13's	For Photography
2	C-54's	For Photography
10	C-54's	For unspecified missions
Total 42 AAF aircraft		

On 31 January Headquarters AAF sent a directive to AMC to proceed with plans for the CROSSROADS work as soon as possible and in conformity with the JTF-1 letter of the previous day.[22] These requirements imposed a heavy burden on the Air Materiel Command because of the existing time limits of the CROSSROADS schedule.

Modification Program of AMC for CROSSROADS

Headquarters AMC took advantage of the early warning that came from Washington on 24 January to prepare for the anticipated modifications. The command selected Colonel R. E. Jarmon as Project Officer. He established at once an organization that had representatives in all the laboratories and sections of Wright Field that would be involved in the work.* When the JTF-1 letter of 30 January arrived, as inclosure to the AAF directive of 31 January, AMC was ready to begin work.[23]

On 4 February Jarmon held a conference with most of the officers in his Project. They drew up AMC's CROSSROADS Technical Instructions: Serial No. T.I.-2199, which embodied the authority and guidance for subordinate units to procure the materials and proceed with modifications.[24] The program called for the modification of a number of SILVERPLATE B-29's, all of the CROSSROADS drones and control planes, the photography planes, the weather reconnaissance aircraft, the Air Sea Rescue planes and the Press and Radio Personnel planes.

There were, of course, sufficient wartime SILVERPLATE aircraft to meet the needs of CROSSROADS, but much of the equipment used in 1945 was already obsolete. A number of alterations on the previously modified B-29's were in order, and this became something of a serious problem considering the short time in which the work had to be

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*The responsibilities of the various laboratories, sections and offices at Headquarters AMC were clearly apportioned. In the Engineering Division the Power Plant Laboratory, the Aircraft Laboratory, the Equipment Laboratory, and the Systems Engineering Laboratory were all given specific assignments. The Aero-Medical Laboratory, the Personal Equipment Laboratory, and the Photography Laboratory were also made responsible for definite tasks. Outside the Engineering Division, the Photographic Division, the Budget and Fiscal Division, the Air Documents Division, the Historical Division, the Maintenance Division, and the Supply Division were also called upon to make contributions. All AMC CROSSROADS actions were funnelled through the Command Project Officer to the project officers through Headquarters and the depot units. Contact between the Wright Field CROSSROADS Project Officer and MANHATTAN District was facilitated by sending Maj R. L. Roach to Los Alamos as AMC Liaison Officer. (Daily Diary, AC/AS, 4 Feb 1946; TI-2199, Hq AMC, 4 Feb 1946.)

done.*[25] The CROSSROADS requirements also called for additional special modifications, such as the installation of Hathaway Flight Analyzers, extra VHF radio sets, and special liaison radio transmitters and photographic devices in the Bomb Carrying Aircraft.[26] Telemetering apparatus was installed in the Pressure Gauge Aircraft, as well as precipitrons. Installation of all these devices was completed by the Oklahoma City Air Depot late in April.[27]

Next to the work done on the SILVERPLATE aircraft the most important modification was of B-17's to serve as drones and drone controls in which both MANHATTAN and AAF were interested. MANHATTAN wanted the drones to collect contaminated air at various altitudes, and AAF wanted both to test the feasibility of drones and to obtain data on their structural strength and engine performance. Ten B-17's were modified for instrumentation to include electronic devices to test radio and radar propagation effects; telemetering instruments to provide records of airspeeds, accelerations, temperatures, engine torques and fuel pressure; vertical and oblique cameras for still and motion pictures; and filters and precipitrons for sampling. Six other B-17's were modified as "Mothers" or controls to include FERRET equipment and

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*On 14 Dec 1945 the post-war SILVERPLATE work had been assigned to AMC's Oklahoma City Air Depot, with instructions to re-modify twenty-two B-29's. These planes were intended to serve the 509th Composite Group in its new role as part of an Atomic Striking Force. As soon as AMC was directed to proceed with its CROSSROADS assignment, the Command was instructed to use the first eight of the twenty-two "modernized" SILVERPLATE aircraft for the AAF Task Group with JTF-1. (Msg, CG AAF to CG ATSC, 30 Jan 1946.) In less than a week the number was changed from eight to ten, and in addition seven unmodified B-29's were required by the Task Group immediately for training purposes. (AMC CROSSROADS Project Report, 6 and 19 Feb 1946.)

other electronic installations.[28] The work was done at San Antonio Air Depot under the supervision of Wright Field technicians.[29]

The photography aircraft required much simpler modifications. However twelve aircraft were involved--ten F-13's and two C-54's--and so the work was time-consuming.[30] The F-13's were modified at Oklahoma City Air Depot along with the SILVERPLATE B-29's. Each aircraft was modified to use twenty-six cameras, motion and still. Ports had to be cut in the unpressurized area, the Remote Fire Control System was altered to accomodate the cameras, and electrical circuits and timing devices had to be installed.[31] The C-54's were modified at Middletown Air Depot, Harrisburg, Pennsylvania. Mounts and equipment were need for a number of cameras all of which had to be placed on the left side of plane to meet the orbitting pattern set forth in the Air Operations Plan.[32]

The three weather reconnaissance B-29's assigned to Task Group 1.5 were obtained from the 59th VLR Weather Reconnaissance Squadron, stationed at Castle Field, Merced, California. The only modification made before sending the aircraft overseas was replacement of engines at Oklahoma City and Sacramento. Personnel of the Army Meteorological Unit, assigned from the Air Weather Service, were trained at Merced and at McChord Field, the latter located in Washington State. After completing their training they flew the aircraft to Kwajalein between 16 and 25 April.[33]

Two B-17's regularly assigned to the 2nd Emergency Weather Squadron at Guam were detached for use as CROSSROADS Air-Sea Rescue. The modification of the two planes to drop a life-boat and supplies by parachute was a minor job. Later on, when a third AAF plane was assigned to Air Sea Rescue for the area between Bikini and Eniwetok, no modification was required.

The two B-29's used by press and radio personnel were modified at Oklahoma City Air Depot. Both ships were stripped of armament, and had new fuel injection engines installed. The modified planes were redesignated as KB-29's. The press photography plane could provide for still and movie news pictures.[34]

All the modified aircraft were ready in time to permit training of crews in the United States prior to movement overseas. It was a very satisfactory achievement.*

The Work of SAC

On 15 January, the day after the Washington conference, there was established at SAC Headquarters a CROSSROADS Project Office which was composed of one officer from each Division. At first Brigadier General C. F. Born headed the office but almost at once he was succeeded by Colonel Brian O'Neill.[35] Little more could be done until specific requirements were submitted, and these came through from AAF Headquarters in the letter sent from there on 24 January. The Project Officer at SAC was then in a position to approach the Army Air Task Group (TG 1.5), which had already been activated at Roswell, for a list of requirements.[36] The Command was responsible for two broad fields: the procurement of personnel and the procurement of supplies.

The procurement of personnel was the more troublesome of the two.

*No modification was required for the standard B-29 designated as the Command Aircraft. Its purpose was to operate just prior to and during the shots, taking Brig Gen T. S. Power, Assistant to the Task Force Deputy Commander for aviation, into the air to report as airborne commander to Kepner from close range, and to recommend last-minute changes in altitudes and circuits of the target. Also, no modification was required for the ten C-54's that served Task Group 1.5 as the GREEN HORNET Transports.

Although the 509th Composite Group served as the nucleus of TG 1.5 the subordinate units required augmentation to fulfill the new mission.[37] The A-1 Division of SAC attempted to meet the needs at once but ran into serious difficulties. The unusual nature of CROSSROADS precluded the use of authorized TO's without considerable alterations. Each unit of the Task Group had to be studied separately.[38] It was the conclusion of A-1 that 1,000-2,000 additional officers and men would be required, based upon existing TO's and a knowledge of the CROSSROADS mission. In selecting personnel, Regular Army officers and enlisted men were preferred and procured first. After these sources were exhausted a serious shortage remained. It was necessary for A-1 to turn to non-Regular Army personnel.[39]

Despite every effort, the flow of personnel to the Task Group units did not come up to expectations. At the end of the first week in February there remained a shortage of 1,000 bodies.[40] Under the circumstances SAC appealed to Headquarters AAF,[41] and the latter agreed to obtain the remainder of those sought.[42] Within two weeks Headquarters AAF had filled most of the spaces and the situation was eased.[43] By early March the shortage had dwindled to fifty, and since they seemed to be less than essential to the success of the Task Group, and time was running out, it was decided not to fill the spaces.*[44]

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*Very unexpectedly there occurred a shortage of thirty radar mechanics. The crisis developed about 10 Mar and was due to the fact that by some error in stating the exact number of days for temporary duty with the Task Group, the technicians had to return to their home stations. (Hq TG 1.5, Daily Diary, 17-18 Mar 1946). To save the situation, hurried attempts were made to obtain instructor personnel from the Training Command but without success, and arrangements were made to get the services of civilians in AMC. (Col Brian O'Neill, Report of CROSSROADS Project with Regard to SAC, N. d.)

The President's decision to postpone the tests for six weeks necessitated a complete rescreening of the Task Group personnel to determine the loss that would result between 1 September and 1 October, the new date set for release. On 6 April a directive authorized the Task Group to extend the duty orders of all its personnel to 1 October. As a result of the screening it appeared that only 150 enlisted men would be lost, and replacements would not be necessary since the Task Force would have completed its mission by that date even under the schedule of the postponed tests.[45]

By 12 April the Strategic Air Command—with the assistance of Headquarters AAF—had solved the problem of Task Group personnel.[46]

In executing its responsibilities of supply and maintenance, SAC encountered the same basic problem met in the procurement of personnel—there was no precedent to follow. Just as A-1 had to devise TO's for TG 1.5 without knowing the full extent of the CROSSROADS mission, so A-4 had only sixty days in which to requisition and get to ports of embarkation unknown quantities of unknown supplies.[47]

All sorts of barriers were met. The War Department did not publish movement orders immediately, and without authority to act the supply depot transportation officers, finance officers, and other agencies were unwilling to permit the expenditure of funds for rail transportation. Some depots refused to honor requisitions for supplies, including controlled items, pending further information. The bottleneck was not corrected until 6 February when Army Service Force authorized by letter to its commands a top priority for all Task Group requisitions.[48]

Four main supply sources were used by the Task Group. As agreed upon in the early days, the Oklahoma City Air Depot furnished all AAF supplies. The Red River Depot at San Antonio dispersed ordnance supplies. Quartermaster supplies were obtained as indicated in Supply Bulletin 1-182, and Engineer supplies were requisitioned directly from the Office of the Chief of Engineers, Military Supply Division.[49]

By 22 March, when the tests were postponed, the supply situation was good. The B-17 supplies, scheduled for air shipment, were at Clovis ready to move. At least 90% of the water shipment was on its way. Of the C-54 supplies, 95% of the airlift was at Roswell with 15% already flown to Kwajalein, and 97% of the water lift had been shipped to the port and 90% of this was on the high seas. All of the air lift for the B-29 and F-13 supplies was at Roswell ready to be loaded on Task Group aircraft. Of the water lift belonging to these planes, 95% of the total had been received at the port, and 90% of the latter had already been shipped to Kwajalein. All of the requisitioned Army Service Force property had been shipped by air to Kwajalein except such as was going with the various organizations. In this lot of material 99% of that scheduled to go by water had reached the port, and 93% had been shipped from the port to Bikini and its area. All the photographic material to go by water had been shipped. Approximately 20,000 pounds at Hamilton Field were scheduled to go by ATC, and 6,000 pounds were scheduled for air lift from Roswell. A remaining 11,500 pounds not procured in time for water shipment were also slated for air shipment, as well as two panels, weighing 1,000 pounds, not obtained until 10 April.[50] Thus the cushion provided by the delay in shot days helped to ease the last minute shipments, but was by no means necessary to the successful completion of supply transportation to meet the deadline.

Organization of Task Group 1.5

When Ramey returned to Headquarters 58th Wing, at March Field, on 15 January, he was disturbed by the realization that his plans for creating an atomic striking force had to be indefinitely postponed, and also by the fact that he had been assigned undefined responsibilities as Commander of the Air Task Group.[51] At once he called a staff meeting of the 58th Wing and explained his quandary—the need to act promptly without knowing what was required.[52] At least one firm decision could be made. Although most of the Task Group subordinate units would have to be taken from the 509th, the entity of the Composite Group should not be sacrificed. Ramey therefore planned a dual control system of the task units in Roswell by establishing a Task Group Headquarters to work jointly with the Composite Group Headquarters in an operational administrative division of authority.

Because he wanted to remain for the time being at March Field, Ramey selected his deputy, Colonel H. C. Young, to go to Roswell as the head of an Advanced Echelon, Headquarters 58th Wing, to activate the Task Group and its units.[53] Young, accompanied by a small staff, arrived at Roswell on 17 January. During the next few days he depended upon telephonic communications with the CROSSROADS Project Office at SAC for briefings on the changing situation.[54] On 21 January Advanced Echelon issued General Order No. 1 which activated Task Group 1.5 with Ramey as commander and Young as Chief of Staff, the order also specified five task units:[55]

Air Tactical Unit, Prov., TU 1.51

Air Photo Unit, Prov., TU 1.52

Air Instrumentation and Test Requirement Unit, Prov., TU 1.53

Air Transport Unit, Prov., TU 1.54

Special Test Unit, Prov., TU 1.55

General Order No. 1 led to a minor misunderstanding between the Task Group and the Task Force. Headquarters JTF-1 had devised a two-decimal system of designation for the task units, such as TU 1.5.1, whereas the Task Group used a one-decimal system, as TU 1.51. The difference was less than trivial, but proved to be mutually irritating to Washington and Roswell. Moreover, the J-3 Division of JTF-1 had given the title of Air Service Unit to TU 1.5.5--whereas the Task Group assigned the title Special Test Unit.[56] The Task Force drew up a formal complaint, but SAC supported the Advanced Echelon's decision, and sought to have the Task Force accept Air Force terminology. Headquarters AAF compromised. Air Force terminology would prevail as long as the Task Group remained in ZI and under the control of the 58th Wing. As soon as the Task Group moved overseas, however, and passed under the control of the Task Force, JTF-1 terminology would be accepted.[57] Consequently SAC and JTF-1 continued to employ separate systems of designation, and this led to some slight confusion from time to time.

It was also on 17 January that Advanced Echelon issued an Operational Planning Letter. It delineated the missions of the task units, placed their organization on a running table basis, and specified the strength of the Task Group as 2,500 officers and men. All five units were to be manned by 15 February. Training would be completed and operational status would be assumed at Kwajalein and Eniwetok by 15 April.[58] This letter, of course, was intended solely as a means of getting the work started. The staff TG 1.5 knew that a revision would shortly be in order.[59]

Almost as soon as GO No. 1 and the Planning Letter were issued, TG Headquarters began to function, and personnel were selected from the base at Roswell for duty as special staff heads.[60] On 22 January the Task Group began plans for the training of B-29 crews, and drew up lists of equipment for itemizing what was needed and what was on hand. From then on, TG 1.5 kept all phases of its activities constantly revised and parallel with the plans and organizational growth of Joint Task Force ONE.[61]

It is interesting to note that Task Group 1.5 was activated and began to function one week before Headquarters AAF issued its directive to SAC on 24 January authorizing the creation of such a force.[62] It was another five days, 29 January, before SAC sent its first written directive to Ramey, informing him officially that the Task Group would:*[63]

1. Drop one atomic bomb on the target array.
2. Gather technical data with ten drone and six mother B-17's.
3. Complete a photographic record of the drop with eight F-13's.
4. Supply MANHATTAN with personnel and aircraft from Kirtland Field for special test purposes.
5. Maintain an air transport service between Washington and Santa Fe, between Roswell, Santa Fe and the West Coast, and between Roswell and Kwajalein via Hamilton and Hickam Fields, using ten C-54's.
6. Provide third echelon maintenance for all TG 1.5 aircraft, and full maintenance facilities at Kwajalein for overseas transports.
7. Maintain an "on call" domestic air transport service with two squadrons of C-46 aircraft.
8. Maintain a transport force prepared to evacuate Eniwetok on a one-hour notice.

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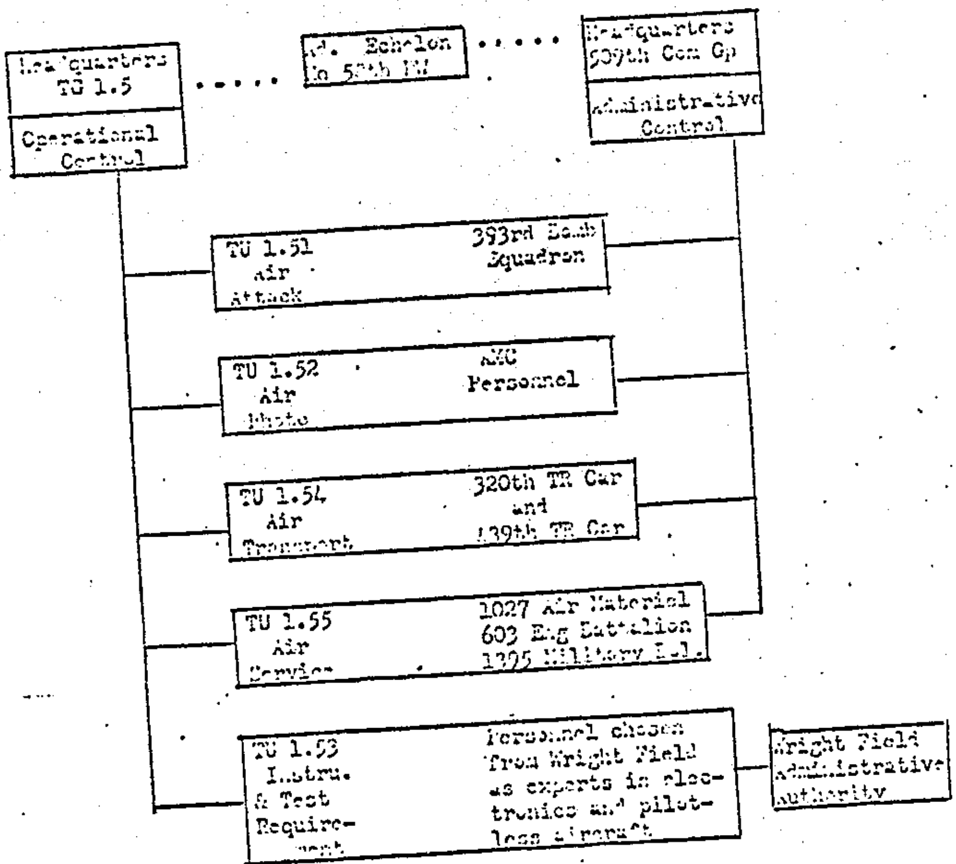
*The Directive also provided that prior to the movement overseas, TG 1.5 would remain under the 58th Wing which would contact SAC directly on all CROSSROADS matters, by-passing the Fourth Air Force. The latter, however, would be designated by the War Department to prepare TG 1.5 for movement overseas.

The SAC directive also instructed TG 1.5 to devise manning tables for all the task units, and to man them with personnel available through 1 September 1946. The directive sounded a word of caution in its provision that all concerned must realize that speedup in demobilization had seriously reduced the AAF and SAC personnel strength. Task Group 1.5 was therefore to requisition the minimum number of personnel consistent with requirements. Oklahoma City was designated the supply depot for the Task Group, and the latter's requisitions had high priority.[64]

These written authorizations from AAF and SAC "legalized" the actions previously taken by the Advanced Echelon, and gave the Task Group some degree of confidence. The first action under the new status was a revision of the Operational Planning Letter of 21 January. The second version was based on a more accurate knowledge of CROSSROADS, and outlined in detail the administrative, supply and housekeeping responsibilities of TG 1.5.[65]

On 1 February Advanced Echelon rescinded GO No. 1 and issued GO No. 2 which cited the SAC letter of 29 January as authority for the activation of TG 1.5.[66] Since the task units would have to be taken almost entirely from the 509th Composite Group, the Advanced Echelon would continue to serve in Roswell as a controlling tie-in between the two group headquarters.[67] As Headquarters TG 1.5 evolved, Headquarters 509th continued to exercise administrative control over its own units which were operationally under the Task Group.[68] The unusual arrangement is explained by the following chart:



The organization permitted Colonel W. J. Blanchard to serve as the Commanding Officer of the 509th, the 393rd Bomb Squadron and Task Unit 1.51. The other Task Unit Commanders were Colonel Paul Cullen, TU 1.52; Colonel H. T. Alness, TU 1.53;# Lieutenant Colonel Payne Jennings, TU 1.54; and Lieutenant Colonel J. R. Roche, TU 1.55.

Throughout the first half of February, Headquarters Task Group 1.5 continued the trick of acting through its other self, the advanced

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#After CROSSROADS the Instrumentation and Test Requirement Unit (TU 1.53), because of its work with drones, was made a permanent organization within the 58th Bomb Wing.

Echelon, when requisitioning personnel and supplies which were technically still part of the 509th Composite Group. Not until SAC faced the prospect of moving the Task Group overseas within the immediate future was the arrangement altered.[69] On 13 February in keeping with the plan of organization set forth by Joint Task Force ONE, the Strategic Air Command issued General Order No. 10 officially creating Headquarters Task Group 1.5, and the task units 1.5.1 through 1.5.5. Personnel were assigned to the units on temporary duty only. In this way the officers and men continued to be carried on detached service or temporary duty by the parent organizations. While in the United States the units were attached to the 427th AAF Base Unit, Roswell, New Mexico, for quarters and rations. Not until their arrival overseas were the personnel of the units attached to Joint Task Force ONE for operational control, quarters, and rations.[70]

Despite the unusual circumstances under which Headquarters Task Group 1.5 had to work during the first few weeks of its existence, satisfactory progress was made. Gradually directives and letters of information were disseminated throughout the Task Groups by Headquarters Joint Task Force ONE. Also, TG 1.5 received clarifying statements from Headquarters AAF, Headquarters SAC and Headquarters 58th Bomb Wing. As the scope of Air Force participation in CROSSROADS became fixed[71] it was possible for the Task Group, in coordination with J-3 at Headquarters JTF-1, to plan and execute an intensive training program with emphasis upon practice bombing by bomb crews.[72]

Early in February TG 1.5 published a Tactical Doctrine, and it was amended at later dates as needed. It set up standards for training, established procedures to be used in the actual drop of the bomb, and included plans for the evacuation of Eniwetok. Some of the provisions of the Doctrine were derived verbally from higher headquarters, but most of them were based upon the knowledge acquired by Task Group personnel through experience. The Doctrine was submitted to Task Force Headquarters, and, with a few changes, became part of the Task Force plan of operations.[73]

It was also in February that the Task Group published its first Operations Instructions, a compilation of material concerning the Group and its mission. The document reaffirmed the unit organization of the Task Group, and mentioned for the first time the "Advanced Echelon 509th Composite Group". The latter was the same thing as Headquarters 509th. It went overseas with the Task Group as an administrative unit to maintain the records of 509th personnel, and thereby preserved the same organization plan used at Roswell.[74]

Summing up the status of Task Group 1.5, the Instructions stated:

> Task Group 1.5 is the Army Air Group of Joint Task Force 1, and has been assigned the mission of dropping the atomic bomb on a designated target vessel and securing technical and photographic data and records on the drop and its effect as well as technical and photographic data on the static bomb test. This Task Group is also charged with the responsibility of operating a domestic and overseas air transport service, providing personnel and aircraft to the Manhattan Engineer District for special test purposes, compiling a photographic history of Task Group 1.5 and conducting such maintenance, operational and administrative activities as are necessary at domestic stations and overseas bases for the accomplishment of the primary mission.

The specific mission of each unit within the Task Group was then defined, and the passage is here quoted in full as implementing the information concerning the task units already given elsewhere.

> Air Attack Unit 1.51 (prov): The initial mission of this unit is to organize and train operating maintenance, service, administrative and special ordnance troops to enable them to perform their overseas mission. The overseas mission of this unit is to operate the bomb and pressure instrument dropping aircraft of Task Group 1.5.

Air Photo Unit 1.52 (Prov): Initially this unit has the mission of organizing and training operating and maintenance personnel for such photographic personnel as are assigned. Their overseas mission is to obtain and process such photographs as are required by the Task Group Commander in conjunction with Naval, Air Force and Manhattan Project personnel. This unit is also charged with compiling a photographic history of Task Group 1.5.

Air Instrumentation and Test Requirement Unit 1.53 (Prov): The initial mission of this unit is to organize and train operating and maintenance personnel in the operation of remote controlled aircraft, and the overseas mission of this unit is to operate all facilities at its base at Eniwetok required to support its operation and, by use of its aircraft and equipment, secure such scientific data in the vicinity of the atomic explosion as directed by the Commander, Task Group 1.5.

Air Transport Unit 1.54 (Prov): Initially this unit has the mission of operating a transport service within the Continental United States for the movement of personnel, supplies and equipment of Joint Task Force 1 connected with the CROSSROADS Project, as well as training operating, and maintenance personnel for the operation of a transport service overseas. The overseas mission of this unit is to provide airlift for personnel, supplies and equipment of Task Group 1.5 from the Continental United States to Kwajalein and Eniwetok, Hawaii, Guam and other points as required during the overseas operation of Task Group 1.5, provide aircraft for possible evacuation of Eniwetok and provide the air transportation for films, personnel and supplies back to the united States upon completion of the overseas operation.

Air Service Unit 1.55(Prov): Initially this unit must provide personnel to man and operate sections B and C maintenance and air corps supplies for all units at Roswell AAFld. The overseas mission of the Air Service Unit is to provide personnel, supplies and equipment required to support the operating units of Task Group 1.5, and which will not be provided by the units themselves or by the U. S. Navy on both Kwajalein and Eniwetok.

The acquisition of three B-29's prior to 1 April, and equipped for weather reconnaissance, was noted by Operations Instructions with the provision that these aircraft, arriving complete with operating and maintenance crews, would be attached to the Air Attack Unit for operational control. The Operations Instructions also called for the establishment of a Field Evaluation Section under the Chief of Staff of the Task Group to direct implementation, the conduct of the tests and the preparation of the data obtained in such form as to insure the maximum benefit to the AAF agencies concerned.[75]

Within a few days after the Operations Instructions was issued, two other task units were added to Task Group 1.5. This was done because Headquarters JTF-1 decided that there was need for an air orientation unit and an air weather unit. Accordingly, Air Orientation Unit, TU 1.5.6, and Air Weather Reconnaissance Unit, TU 1.5.7, were organized and activated. Neither of the two units, however, was attached to the Army Air Force Base at Roswell. The Air Orientation Unit was at March Field for quarters and rations while training, and was under the command of Major C. T. Ireland, Jr. The Air Weather Reconnaissance Unit was attached to the base unit at Castle Field, Merced, California, under Major Paul H. Fackler.[76]

Throughout February, in accordance with JCS policy of using existing Army and Navy organizations and channels of supply and maintenance until movement overseas, the normal channels of AAF became the funnels of supply for Task Group 1.5. The Joint Task Force agreed that all instructions to the Task Group would be sent to the Commanding General, Army Air Forces, in the form of requests. Accordingly, AAF desired all messages from Task Force Headquarters to TG 1.5 to go through Air Force Headquarters. From there, the communications passed first to SAC and then directly to the Task Group, by-passing the Fourth Air Force, and thereby removing one link in a tediously long chain of command.[77]

Actually, the procedure developed quite otherwise than that provided for in theory.[78] The Air Operations Section of the Joint Task Force decided that the time element required immediate contact with the Operations Section of the Task Group. Therefore the practice began of exchanging information directly between the Task Force and the Task

Group. However, all matters requiring action were directed through command channels.[79]

Despite precautions and planning, faulty coordination resulted which at times handicapped and embarrassed SAC. There were, for instance, several cases in which TG 1.5 asked questions of SAC concerning Task Group-SAC-Task Force correspondence which SAC had not received. This was a source of considerable annoyance to SAC Headquarters.[80]

Such was the situation when the time came under the original CROSSROADS schedule to crystallize plans for the movement overseas, and thereby begin the third phase in the history of TG 1.5. On 15 February SAC outlined for the Task Group Commander the plans for the transportation of personnel to the Forward Area by air and sea. The majority were to move by air. Two weeks later, 1 March, the Advanced Echelon Party left Roswell Army Air Base for the Forward Area expecting Headquarters and the various task units to follow in the immediate future. At the same time there began a daily departure of one loaded C-54 aircraft of Task Unit 1.5.4, the Air Transport Unit, from Roswell to Kwajalein, and the number of AAF personnel in the Forward Area increased steadily. Within two weeks the Advanced Echelon was able to set up air installations on Kwajalein . Soon an advanced group of the Air Instrumentation Unit, Task Unit 1.5.3, did the same thing on Eniwetok.[81] The change in the shot schedule came too late to delay this work.

Meanwhile additional personnel had begun to move across the Pacific. The water echelon, consisting of 39 officers, 629 enlisted men, and 5 civilians, was split into two sections. The first, including 34 officers, 557 enlisted men and the 5 civilians, left San Francisco, 10 March. The second section, composed of the remaining personnel of 5 officers and 132 enlisted men, moved out 15 March.[82]

On 23 March, the day after the President announced the postponement of the tests from 15 May until 1 July, Kepner called Task Group 1.5, and delivered by 'phone the following verbal instructions.[83]

1. Cancel C-54 overseas schedules to Kwajalein until further notice.

2. Continue the domestic...(air) schedule as existing.

3. Notify all Task Group 1.5 personnel of the delay in the tests.

4. Continue training in complete bombing rehearsals with a view to greater flexibility of operations in order to take advantage of rapidly changing weather conditions which would prevail in the Forward Area during late June and throughout July.

5. Continue such shipments of personnel and cargo on Air Transport Command schedules where such shipments were necessary to keep planned functions at Kwajalein alive during the period of delay.

At the time CROSSROADS was postponed a large portion of the AAF personnel was already overseas, as indicated by the following tables:

UNIT	TOTAL REQUIREMENTS OFF	TOTAL REQUIREMENTS EM	OVERSEAS REQUIREMENTS OFF	OVERSEAS REQUIREMENTS EM	OVERSEAS OR EN ROUTE
Hq., TG 1.5	38	30	38	30	18
First Flight Test Unit	17	361	00	00	00
Air Instrumentation and Test Requirement Unit	37	220	37	210	187
Hq. 509th Group	18	66	8	13	24
Air Attack Unit	95	558	72	219	145
Air Service Unit	30	1242	10	608	507
Air Photo Unit	79	376	79	250	141
Air Transport Unit	56	220	5	46	16
Air Weather Rec. Unit	38	24	38	24	00
Air Orientation Unit	14	30	14	30	19
Totals	442	3237	301	1529	1251

Of the total requirements of 422 officers and 3,237 enlisted men, only 301 officers and 1529 enlisted men, totalling 1820 were due overseas. Of these latter 1151 were either in place or en route, leaving a total residue of 669 officers and enlisted men waiting for overseas movement. No aircraft, other than transports, had at that time left for the Forward Area.[84] The following statistics show the status of CROSSROADS supplies and equipment when postponement was decreed:[85]

UNIT	STATUS
Hq. T. G. 1.5	98% en route by water
First Flight Test Unit	Stationed at Kirtland Fld. Has all Equipment
Air Instrumentation & Test	95% en route by water
Hq 509th Group	90% en route by water
Air Attack Unit	97% en route by water
Air Service Unit	97% en route by water
Air Photo Unit	97% en route by water
Air Weather Rcn. Unit	97% en route by water
Air Transport Unit	98% en route by water
Air Orientation Unit	To use equipment and supplies of Air Transport Air Attack Units.

Under the new schedule it was necessary to set up tentative plans for a resumption of the overseas movement of the main Air Echelon on 20 April. It was estimated that all transportation of personnel to the Forward Area would have to be completed by 7 May.[86] Since no TG Aircraft, other than TG 1.5.4 transports, had left for the Forward Area prior to postponement, an entirely new schedule was drawn up. It provided for their flight as follows:[87]

Date of Departure	Number and Type of Aircraft	Unit
15 April	3 B-29's	Weather Unit
20 April	1 C-54 and 1 F-13	Photo Unit
21 April	4 B-17's	Instrumentation and Test Req Unit
22 April	4 B-17's	Instrumentation and Test Req Unit
23 April	4 B-17's	Instrumentation and Test Req Unit
24 April	4 B-17's	Instrumentation and Test Req Unit
25 April	3 B-29's	Air Attack Unit
26 April	3 B-29's	Air Attack Unit
27 April	3 B-29's	Air Attack Unit
28 April	1 C-54 and 3 F-13's	Air Photo Unit
29 April	3 F-13's	Air Photo Unit
30 April	2 F-13's	Orientation Unit

The first to arrive overseas after resumption of the movement was the Weather Reconnaissance Unit, which was in place 28 April. Headquarters 509th Composite Group, the Air Attack Unit, and the Air Service Unit officially opened their offices on Kwajalein the same day. The Air Instrumentation and Test Requirements Unit officially moved to Eniwetok 1 May, the Air Photography Unit moved 7 May, and the Air Transport Unit on 13 May. The Air Orientation Unit did not come to Kwajalein until 19 June, as planned. The bulk of supplies and equipment arrived before the Task Group was officially transported, and by the first week in May maintenance shops and facilities were operational.[88]

From 28 April until 7 May, only a rear echelon, under command of Major W. B. Martensen, functioned at Roswell and performed the necessary duties in closing the Task Group Headquarters in ZI.[89] By the end of the first week in May most of the personnel and equipment were in place on Kwajalein, and Headquarters Task Group 1.5 officially opened in the Forward Area at 0001 hours, 7 May. General Ramey however, did not arrive until 21 May, and until then Colonel Young, Chief of Staff, was in command.

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Chapter VII

THE TRAINING OF AAF UNITS FOR CROSSROADS

Joint Task Force ONE Operations Plan established the CROSSROADS training standards, and at the level of Task Force Headquarters it was the responsibility of the Deputy Commander for Aviation, Brigadier General William E. Kepner, to direct the preparation of AAF units to meet their ABLE and BAKER Day obligations.[1] Kepner's office kept in close contact with Headquarters of Task Group 1.5 and gave verbal instructions which included the advice and recommendations of Los Alamos and Wright Field.[2] Headquarters TG 1.5, in turn, prepared written training plans which were approved by Kepner before transmission to the several task units that conducted the training in the field.

At the level of Task Group 1.5, training fell into two main categories—general and specialized. The latter was intended to point up techniques peculiar to the missions of each element, and was much more important than the former. The Task Group began to consider training as soon as activated, 21 January 1946, and memorandums for each phase were published periodically, beginning 30 January. On 15 February the Task Group released its Tactical Doctrine[3] which, after a few changes, was incorporated in the Joint Task Force Operations Plan.[4] The training of the Air Transport Unit (TU 1.5.4), the Air Service Unit (TU 1.5.5) and the Air Orientation Unit (TU 1.5.8) was so simple that it can be considered routine. The Air Meteorological Unit (TU 1.5.7) had a very important role in the ABLE and BAKER operations but its training too was little more than the continuation of normal activities.* The AAF Photo Unit (TU 1.5.2), the AAF Instrumentation and Requirements Unit (TU 1.5.3) and the AAF Drone Unit (TU 1.5.6) struck out along new lines and their training was distinctly more than normal operations. The AAF Tactical Unit (TU 1.5.1) had the most unique of all the task unit roles, and its training deserves detailed treatment.[5]

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*The mission of the AAF Transport Unit 1.5.4 to provide transportation within the United States and overseas for the movement of personnel and supplies precluded a special technical training program. In the normal course of events the Unit was obligated to train some operating and maintenance personnel, much of which was accomplished in refresher ground courses. In addition, another function was to instruct the transport crews in their participation in the Air Operations Plan. (Air Operations Report Operation CROSSROADS.)

The AAF Service Unit 1.5.5 had to provide supplies and B and C maintenance in this country as well as personnel, supplies, and equipment not provided by the Navy or other units to support the operation overseas, and the nature of these requirements precluded special training. Also, the training problem of AAF Orientation Unit 1.5.8 was slight. It consisted of nothing more than the training of a few crews in teletype and radio. (Report, Col Brian O'Niell to C/S, SAC, sub.: Report of CROSSROADS Project with Regard to SAC, undated.)

The AAF Weather Reconnaissance Unit 1.5.7 had to train three weather reconnaissance crews and indoctrinate them in the Air Plan. Emphasis was placed on radar and wind runs so that weather observers, navigators and radar operators could make radar wind runs. Since three B-29 a/c were not available, the weather observers were sent to McChord Field and the 53rd Weather Reconnaisance Squadron (VH) for practical experience. The three B-29's reached McChord 13 March, and an intensive flight training schedule was begun. The crews completed 114 hours of day-time and fifty-nine hours of night flying by 1 April when they were prepared to move overseas. (Air Operations Report Operation CROSSROADS.)

Photography, Instrumentation and Drone Training

The mission of the Photo Unit called for most careful instruction. Crews had to be prepared to operate F-13 and C-54 photographic equipment, and training courses were given for this purpose at Roswell. The greater number of missions flown were photographic sorties when experience was gained in the techniques of photography. On coordinated missions with other task units, and especially on coordinated missions with Task Unit 1.5.1, photography was perfected for the overall mission. Proficiency in ground training was also attained, and special courses were established for airplane commanders,[6] pilots, flight engineers, and bombardiers.* The navigators, radar observers, radio operators, and gunners of the Photo Squadron received their ground training with the Task Unit 1.5.1 and attained proficiency in the same subjects as the men of the latter unit. In addition, all personnel received lectures on medical problems in the theater, and certain phases of TG 1.5's Tactical Doctrine.[7]

The training objective of the AAF Instrumentation and Test Requirements Unit and the AAF Drone Unit was to prepare ground and air crews

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*Fifteen courses were listed for airplane commanders and pilots: hydromatic props, fuel system, ceco carburetors, ditching and crash landing and bail out from the pilot's viewpoint, check lists, engines SOP's emergency procedures, camera orientation, flying safely, photo orientation, photo mapping, camera operation, radar photography, and electrical systems.

Flight engineers had to excell in thirteen subjects: fuel systems, propellers, ceco carburators, aircraft structures, oil system, hydraulic systems, turbos, cabin pressure and heat, vacuum system, oxygen system, electrical circuits, cruise circuits, cruise control planning, and weight and balance.

For bombardiers, the list included procedures, central fire control operation, photo orientation, camera operation, radar photography, bomb trainer, and target identification.

to operate four B-17 drone control or mother aircraft and one master control plane. Task Unit 1.5.3 had also to supervise the instruments on the drones so that the latter could successfully perform their ABLE Day and BAKER Day missions. The drones were specially equipped with air filters and air collector bags to gather samples of the cloud and its column, and with cameras to photograph the cloud at short range.[8]

Under the direction of representatives from the Air Materiel Command's technical section, some courses in electronics were given at Wright Field for TU 1.5.3 personnel. Ground training was initiated at Clovis, New Mexico, both for TU 1.5.3 and for the crews of ten drone and six mother aircraft of TU 1.5.6.* Flight training began 11 February, even though all crews were not then on hand. The training of radio control pilots began 15 February in the use of airborne and ground control equipment. There were special courses in the utilization of radio controlled instruments. Long-range navigation and cruise control missions were included in flight training as well as radio controlled landings and take-offs, and both low and high altitude missions, in order to achieve coordination between the

*For the radio control pilots, eight subjects were requisite--operation and first echelon maintenance of BC-925 transmitter; operation and first maintenance of BC-617 receiver; operation and first echelon maintenance of AN/AXT-3 television and telemetering transmitter; operation and first echelon maintenance of AN/AXR-1 television and telemetering receiver; special equipment such as air bags, filters, Geiger counters; control equipment such as trim boards, relays, electric motors, and automatic flight control equipment; radio control take-off, flight, and landing procedures; and briefing on standard operating procedures for primary mission. (Ltr , Hq., Air Instrumentation and Test Requirement Unit 1.5.3, to CTG 1.5, Summary Report of Training 29 Mar 1946.) Drones were not flown without emergency crews until ABLE Day.

drone and mother ships. Considerable attention was devoted to ground approach and the development of a standard operating procedure for all phases of drone operation and control.[9] By the termination of flight training at Clovis, 138 flying hours of radio control and ninety hours of metal stick training were accomplished. The overall training can be broken down into the following categories with their corresponding number of hours:[10]

1. Pilots, co-pilots, and radio control pilots — 19:30 hours
2. Navigators — 37:30 hours
3. Radio operators — 17:30 hours
4. Radar counter measure observers — 4:00 hours

Training the Tactical Unit

The training of TU 1.5.1 was directed toward one aim—increasing the capability of AAF personnel to deliver atomic weapons. This goal was simple in itself but it complicated the work of training. Theoretically Task Group 1.5 was responsible for the supervision of TU 1.5.1. But it was necessary for the Army Air Forces Headquarters and for Joint Task Force ONE Headquarters to intercede with MANHATTAN District before the Tactical Unit could successfully complete its training program and select a bombing crew for the ABLE Day operations.

Obstacles Imposed by MANHATTAN District

As soon as the Task Group was activated, 21 January 1946, its headquarters undertook the formulation of training plans for the Tactical Unit. Two weeks later, 7 February, Colonel M. C. Young, C/S TG 1.5, issued a directive for the ground and flight training of TU 1.5.1. At approximately the same time Headquarters AAF decided that a number of

B-29 crews should compete for the honor of dropping the ABLE Day bomb. There was no question that Colonel Paul W. Tibbets and his bombardier, Major T. W. Ferebee, could deliver the weapon. They had performed magnificently at Hiroshima and were quite capable of doing so again. On the other hand there was much to be gained by familiarizing as many bomb crews as practical with the techniques of atomic bombing. To this end SAC assigned to TU 1.5.1 the following five pilot-bombardier teams, each supported by a full B-29 crew, to enter the ABLE Day competition:[11]

Pilot	Bombardier
Col. P. W. Tibbets	Maj. T. W. Ferebee
Maj. C. R. Eatherly	Lt. Franklin Wey
Maj. J. J. Catton	Lt. C. L. Coy
Maj. Woodrow Swancutt	Capt. David Semple
Maj. W. R. McPherson	Lt. C. R. Hammack

The hope of AAF to further its mastery of atomic techniques was at first something of a strain on Air Force-MANHATTAN relations, but in the end a better understanding developed between the two agencies. As soon as the B-29 crews began their [illegible] training they found themselves in need of MANHATTAN top secret information on the ballistics of the FAT MAN weapon, the type selected for the ABLE Day shot. At the same time the Air Force determined to have its own atomic weaponeers and thus to become independent of MANHATTAN personnel once the bomb was placed within AAF aircraft. When Air Force [illegible] attempted to negotiate with MANHATTAN District, however, [illegible] selves without a common [illegible] for the exchange of [illegible].[12] [illegible] appeals to General Groves resulted in acceptable solutions.

The Question of the [illegible]. Because the first [illegible] differed greatly from conventional bombs, it was imperative [illegible] five competing teams to practice extensively with FAT MAN [illegible]

[illegible] and within a short time several of them were used in practice drops at Albuquerque.*[12] Results showed erratic behavior on the part of the models.[13] In each case toggling was performed by bombardiers who relied on bombing tables prepared by Sample when he was working for MANHATTAN in 1945. After the first few drops Sample doubted the validity of his calculations for current needs.[14] The tables had been computed for missions against low altitude targets and were not applicable in the high altitude of New Mexico.[15]

To meet the emergency Sample proceeded to work out provisional tables for the atmospheric conditions of New Mexico. His revisions eliminated 75 per cent of the error, but to improve beyond that point it was necessary to know exactly the ballistic qualities of the bomb. The problem was to extract the ~~[illegible]~~ information from [illegible] ~~[illegible]~~ MANHATTAN.

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*Four varieties of simulated bombs were used in the practice drops.

1. An Inert SN or KN that carried a small amount of explosives and was intended to assist MANHATTAN representatives in experimentations with the detonating mechanism. The term used was SN for drops made in the United States and KN for drops made in Kwajalein.

2. A live SN or KN equipped with a charge of high explosive and a mechanism that simulated that in an atomic bomb intended to give MANHATTAN teams practice in the assembly of fuzing and detonating mechanisms.

   It is worth pointing out that AAF B-29 crews were cooperating with MANHATTAN personnel at the same time that MANHATTAN District was anything but willing to cooperate with AAF personnel.

3. A live high explosive bomb to assure the bombing crew experience in dropping atomic weapons.

4. An inert PUMPKIN filled with concrete. This model was inexpensive and easy to make, and was extensively used in the [illegible] practice drops.

Headquarters AAF was aware of the situation, and somewhat worried. To meet the difficulties the Assistant Chief of Air Staff, Operations, AC/AS-3, assigned Colonel J.J. Preston and Robert Dorfman to the Operations Analysis Section, J-3, JTF-1. Their instructions were to prepare a report on the ballistics of the bomb.[16]

Upon their arrival at Task Force Headquarters on 18 February 1946, Brigadier General Thomas A. Power, Assistant Deputy Commander for Aviation, warned them that the tables being used were inaccurate and spoke of the eccentricities of the weapon. The analysts saw at once that to do their work they needed three types of data: specific information on the ballistics of the bomb, including all pertinent tables and the calculations on which they were based; the effect of internal geometries on the exterior shape of the bomb; and the dependence of the detonation upon the outer dimensions.

Preston and Dorfman took it for granted that, since the bomb was being used for scientific tests, MANHATTAN would willingly supply the data on a need-to-know basis. Dorfman, who was largely responsible for the early phase of the study, set out to get the information as part of the day's work. He was baffled by the stone wall attitude of MANHATTAN representatives. Actually his questions probed deep into the secret depths of MANHATTAN files, struck at the wartime habit of security, and perhaps wounded the normal pride of possession. At Task Force Headquarters, MANHATTAN spokesmen seriously contended that training needs could be met by [illegible] outmoded estimates [illegible]. Since this argument was at variance with Power's comments, Dorfman decided to see for himself. On 2 March he went to Roswell and observed several practice drops. After a careful study of results he saw that [illegible] tables were inadequate, a fact of utmost importance for Headquarters JTF-1, and for Task Group 1.5 as well.[18]

Dorfman's first remedial move was to request an operations analyst for TG 1.5. As one with whom he could readily work he suggested Mark Eudy, an analyst of excellent reputation who was then assigned to the Startegic Air Command (SAC). Dorfman's recommendation was approved, and Eudy was promptly placed on TDY with the Task Group. Thereafter he and Dorfman worked together in close cooperation.[19]

Such was the situation on 7 March when Semple, still working to devise new tables, crashed in a B-29 and was killed. His death was a serious loss to the Task Force, ~~and [illegible]~~ to Task Group 1.5, and especially to ~~[illegible]~~ Preston, Dorfman, and Eudy who had to continue their search without the practical counsel of his experience. There was then little hope of producing proper tables for training in the United States, but it was essential to have the information for the overseas phase of training. The analysts therefore intensified their efforts to get the requisite data from MANHATTAN, ~~[illegible]~~. The response remained more cautious than helpful. When the analysts complained that they were being held "at a long distance on this thing," MANHATTAN personnel retorted that "lots of other people are in the same situation."[21]

In order to break the obstacles of this self-defeating security, Preston and Dorfman took their cause to General [illegible] who went direct to General Groves.[22] After that negotiations were less stagnant than [illegible] scarcely free flowing. In the end MANHATTAN agreed to prepare new tables, but refused to release the supporting data. [illegible] then other delays [illegible] ensued, and protraction seemed interminable to those responsible for training. If the President had not postponed the test from 15 May to to 1 July the entire training period, overseas as well as ZI, would have passed without the use of correct tables.[23]

On 23 April the Joint Task Force, impatient with the long delay, requested MANHATTAN to submit the tables by 15 May at the latest.[24] There was no reply. Repeated requests by TWX met the same silence. On 8 May, when USS *Mt McKinley* sailed from San Francisco with Headquarters JTF-1, no one knew whether the tables would ever be delivered.[25] The next day there was word by radio from Los Alamos that the tables ~~ma~~ were already in Kwajalein. They had been entrusted to Dr M.G. Holloway, a member of the Military-Scientific Tests, who sailed sometime before on the USS *Albemarle* transporting the bomb to the Forward Area.[26]

The Question of Weaponeers. In the midst of the tables controversy the Air Force found it necessary to raise the issue of weaponeers. Wartime secrecy had endowed MANHATTAN with the characteristics of a quasi Atomic Military Service, wanting only a delivery system. That was why the Air Force had been called on to transport the Hiroshima and Nagasaki bombs without responsibility for their maintenance and readiness. Even then the restriction was irksome to Headquarters AAF because some members of the 1st Ordnance Squadron, 509th Composite Group, had already demonstrated a technical competence to arm and monitor the new bombs, and In this very limited but service-wise major area a few AAF officers lacked nothing except the seniority of Parsons and Ashworth. Nevertheless the Air Force willingly accepted [illegible] in 1945 as a necessary war measure, but hoped for better days to come.

Early postwar plans would have kept the Squadron intact as a source of future weaponeers and bomb technicians, but the organization lost its effectiveness because of MANHATTAN's refusal to relinquish its exclusive control of bomb technology.* When CROSSROADS approached its operational stage the Air Force was still denied responsibility for monitoring the mystery weapons even when transported in AAF aircraft.

Under the circumstances Arnold went straight to Groves and vigorously presented the AAF viewpoint. Arnold did not mince his objections to the implications that only MANHATTAN representatives had the capacity to learn the simple task of monitoring the bombs. On 13 March Groves made important concessions. He agreed that MANHATTAN would train six AAF officers as bomb commanders and five junior officers as weaponeers. The bomb commanders, a new title, were ~~intended~~ intended by the Air Force to become a nucleus of experts capable of planning for the tactical employment of atomic weapons. And one of the bomb commanders would supervise the work of the ABLE Day weaponeers. The arrangement opened new roles for AAF in the atomic energy program of the future.[28]

The training given the weaponeers was very technical, but that offered the bomb commanders was informal. The weaponeers were taught the secrets of the bomb's circuits and the means of in-flight tests. The commanders were kept in constant association with Los Alamos groups and gained a more thorough knowledge of the weapon's safety checks and structural principles. Colonel John R. Sutherland, an operational type officer, became the first bomb commander, and [illegible]

*This incident is treated with detail in Vol II.

enough technical indoctrination to determine whether the weaponeer had done a satisfactory job. On ABLE Day it would be Sutherland's responsibility, after taking into consideration such operational features as weather and terrain, to decide whether the airplane commander should order the bombardier to release the bomb.[29]

Competition to Drop the ABLE Day Bomb.

While Joint Task Force ONE and Headquarters AAF were settling the questions of the bombing tables and the training of Air Force weaponeers, TU 1.5.1 had gone on with the training of the bombing crews. There were two phases--training at Albuquerque, 15 February-9 April, and training at Kwajalein, 11 May-14 June.

During the nearly eight weeks training at Albuquerque a large number of bombs were dropped, but most of them served MANHATTAN teams who were interested in the firing mechanism. In all, forty simulated bombs were dropped by the competing pilot-bombardier teams, and only thirty-one were considered "qualified drops".*[30] The Range Detachment Scoring Unit, used during the war to serve the 509th Composite Group, came in from Los Alamos to score the drops. Measurements were made by the circular error of each drop. The statistics were transmitted to a detachment of the 509th located at Kirtland Field. There the data was combined with pertinent information received from a Radar Bomb Scoring Detachment and an analysis was made of each run. The Detachment had two mobile vans containing an SCR-584 Gun Laying Radar with which the bomb carrier was tracked, manually in range and automatically in elevation and azimuth. The second van contained the RC-294 Automatic Plotting Equipment.[31]

*At an early date a distinction was made between "qualified" and "unqualified" drops. The unqualified drops were those in which an error occured for which the pilot-bombardier team was not responsible.

The Swancott-Semple team made four drops between 19 and 28 February. Semple's death 7 March eliminated the entire crew from the competition for the time being, and it seemed doubtful whether Swancott would obtain another bombardier in time to reenter the contest. On 22 March the Eatherly-Wey team was also eliminated. Of its five drops, not one came within the permissable circular error of 500 feet, and three of them were 1,000 feet or more off target. That left only three teams in the race. But in the last days of March Major Harold E. Wood replaced Semple, and the Swancott-Wood team, with the old Swancott-Semple crew, made a satisfactory drop on 2 April and became the fourth competitor. On 9 April, when the last drop was made at Albuquerque, the record was as follows:

Team	No of Drops	Average C.E.	Comments
Tibbets and Ferebee	6	442.00 feet	
Catton and Coy	6	376.00 feet	
McPherson and Hammack	9	453.22 feet	
Eatherly and Wey	5	911.00 feet	Withdrawn
Swancott and Semple	4	509.75 feet	Withdrawn
Swancott and Wood	1	310.00 feet	This was not an average but the accuracy was impressive.
Total Drops	31		

In addition to the practice drops, three special missions were performed in which most of the Task Group's aircraft scheduled for participation in the ABLE and BAKER Day operations took part. The first two missions were flown over the Albuquerque Bombing Range, 8 and 9 March. Both were successful and provided satisfactory bombing and formation results. The third mission was more realistic. Known as Operation Zebra, it was scheduled for 14 March, and was to be enacted 100 miles from San Diego off the coast of California. Bad weather prevented the Navy from placing the target, a landing craft infantry (LCI), on the correct position in time for the operation, and the mission was postponed until the next day, 15 March. The mission was a full scale dress rehearsal of the air drop, and it was conducted in conjunction with personnel of the Navy and MANHATTAN District. An HE 1561 FAT MAN type bomb, minus nuclear components, was dropped in order to test the equipment and tactics to be used in the shots at Bikini. Aircraft participating in the test included one bomb carrying plane and three B-29's to drop pressure recording instruments—which took off from Kirtland Field—and eight photographic F-13's based at Roswell. One of the B-29's carrying pressure instruments aborted, but all the other aircraft completed the mission.[32]

Because of high seas and the smallness of the LCI, the bombing plane had difficulty locating the target. The white caps and waves precluded the use of radar. The difficulty in sighting the target resulted in dropping the bomb on coordinates. Observers reported that the bomb exploded approximately 1,000 feet above the water. Communications on the bomb run were as planned except that the tone signal was not transmitted due to faulty equipment in the bomb carrier. Cameras in the photographic planes consequently had to be turned on manually after the bomb-away signal was given.* These cameras operated for approximately six minutes and obtained good coverage of the bomb burst.[33]

The mission was not run as briefed because of the invisibility of the target both to the naked eye and to radar.[34] Under such conditions the results were gratifying. Photography and instrumentation were successful. The staff observer reports indicated that the individual crews had attained

*In a subsequent flight in early April over the San Pedro Naval Yard, the tone signal was tested with the naval control ship, and satisfactory results were obtained. (Hq., TG 1.5, Daily Diary, 8-9 April 1946.)

a high degree of proficiency. The MANHATTAN District considered the operation more valuable for testing equipment and tactics than all the previous deliveries at Albuquerque.[35]

The postponement of the tests was announced shortly after the conclusion of ZEBRA. The delay afforded further time for training, both in the United States and the Forward Area. Additional ground school classes and training flights were scheduled to maintain the optimum level of proficiency while the Task Unit was still in the United States.[36] With the timetable for overseas movement of tactical aircraft adjusted to 15 April, in line with the postponement, training was rescheduled to terminate 12 April at which time all crews and personnel were ready for overseas duty. Some training in the air continued until the departure of the last units of the Task Group for the Forward Area at the end of the month.[37] The transfer of Task Unit 1.5.1 from New Mexico to Kwajalein began a serious break in the training program, however, since it was not possible to effect the movement overseas without loss of time. The last practice drop in the United States was made 9 April and the first bomb was not dropped in the Marshall Islands until 11 May, more than a month later.[38]

Before the training of TU 1.5.1 was discontinued in the United States plans had already been made for the resumption of training in the Forward Area. As early as 4 April a pit was completed on the edge of Kwajalein airfield for loading SILVERPLATE aircraft with simulated and true atom bombs. At the same time, the Sea Bees constructed a target on Erik Island, in the Bikini Atoll, simulating the deck of the target ship. The area, cleared of all brush, was 75 by 500 feet, and was made of crushed and flatly rolled coral on a cleared space.[39] So it was that as soon as Task Unit 1.5.1 completed its move to Kwajalein it was possible to resume practice bombing which was, of course, the heart of the training, conducted by Task Group 1.5.

Between the 11 May and 14 June the four competing teams made a total of twenty-five practice drops. The averages were:

Team	No of Drops	Average C.E.	Average C.E. in ZI
Tibbets and Ferebee	6	314.00 feet	442.00 feet
Catton and Coy	6	540.00 feet	376.00 feet
McPherson and Hammack	5	808.00 feet	458.00 feet
Swancott and Wood	8	484.00 feet	310.00 feet for one drop only
Total Drops	25		

As soon as practice bombing began at Bikini there was a serious departure from the accuracy standards recorded at Albuquerque.[40] Apparently something was now wrong far beyond the absence of long-sought bombing tables. Kepner, who arrived at Pearl Harbor on 14 May, was disturbed by these reports.[41] He ordered his analysts to fly immediately to Kwajalein, pick up the bombing tables from Holloway, and see what could be done.[42] Two weeks later, 28 May, Kepner too reached Kwajalein and learned that the increased errors were due in small part to interrupted training and poor visibility, but were primarily the result of the local wind structure.[43] The newly acquired bombing tables were indispensable for the cure of old ills, but could not overcome this unexpected handicap. The only remedy would be to calculate a detailed and unusually complex ballistic wind.[44] The abstraction ~~was~~ would be an average derived from all the winds encountered between the altitude of bomb release and the target, and weighted to predict their collective buffeting on the bomb in flight.[45]

The theory was not new, having been known and used to some extent in World War II. But the wind structure at Bikini was very different from that met in military operations elsewhere.[46] Unless its patby Task Group 1.5.

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The theory was not new, having been known and used to some extent in World War II. But the wind structure at Bikini was very different from that met in military operations elsewhere.[46] Unless its nattern could be reduced to a workable formula for bombsight correction[47] it might be impossible to bomb with reliable accuracy at CROSSROADS. The situation was discouraging because time was short, but the analysts undertook a systematic plotting of the wind shears,[48] and completed a sophisticated study on 8 June, twenty-three days before ABLE Day.[50] Thereafter it was possible to profile the atoll winds, weight them ~~properly~~ properly, and adjust the bombsight.[51] At once there was a marked improvement in results.

Selection of the Bombing Crew

By the end of May, more than two weeks before the scheduled conclusion of practice bombing, and approximately a month before Test ABLE, Ramey concluded that the time had come to select the winning team. It would be a critical decision for Task Group 1.5, for the Joint Task Force, and indeed for the Army Air Forces as a whole. The nation had invested millions of dollars in CROSSROADS, and at the same time was expending an atomic bomb while the scarcity of fissionable material meant that the nuclear components of a single weapon was an appreciable factor in the military strength of the United States. Failure to make the air drop within the promised accuracy of 500 feet would have serious repercussions. Everybody concerned wanted the bombing team selected on an indisputably objective basis.[52]

Under these circumstances Eudy contended that selection should be made in accordance with an impersonal and strictly mathematical consideration of the chances of each crew to perform a successful ABLE Day mission based upon four requirements. First, the bomber must not abort; second, communication procedures must be carried out successfully; third, the mission must be performed without deviation from the time schedule; and fourth, the bomb must detonate within 500 feet of the Target Ship.[53] To some, Eudy's proposal seemed objective and rational. To others, his methodology appeared artificial, complicated, and lacking in "common sense judgements." In its desire to be objective, Headquarters TG 1.5 supported Eudy,[54] but thereby made the actual bombing record of the team only one among four factors to be considered in the selection.

On 10 June Blanchard directed Eudy to report on the bombing competition within forty-eight hours. Eudy asked Dorfman to assist, and the work was done entirely by those two.[55] Their memorandum repeated in summary all that Eudy had previously argued for. Then the team scores were assembled, and the percentage of normal drops was multiplied by the probability of having the point of detonation within 500 feet of the target center. The results were put in the following tabular form:[56]

Crew	% Normal	X	500-ft Probability	Score
Tibbets-Ferebee	82	X	.83	68%
Catton-Coy	82	X	.65	53%
McPherson-Hammack	93	X	.34	31%
Swancott-Wood	86	X	.80	69%

This method of deriving a score was certainly far removed from the simple tabulation of cumulative error. When it is realized that the score was only one of four factors to be considered, it does seem that the theory was not altogether realistic.

The Operations Analysts did not concern themselves with anything except the derivation of the score from the practice drops, and while Eudy and Dorfman were at their work, 11-12 June, Blanchard had the 509th Operations Staff prepare a study on the efficiency of the bomb carrier crews, each considered as an entity. The study was based on the considered opinions of the operational supervisors.[57] Each of them had flown at least one mission with all four of the competing teams, and was required to furnish a grade for each crew on the basis of ideal procedure execution. The actual process which the staff members were requested to use was a summation and evaluation of discrepancies noted in procedures of the entire crew.[58]

In addition, certain of the operations staff members who had examined logs and interrogated crews were requested to furnish a rank for each of the crews on the basis of ability to execute requirements. It is important to understand that these were not ratings on individuals of the crew, but ratings on the entire crew in particular fields, that is, navigation, communications and so on.[59]

On 13 June Blanchard submitted the Eudy-Dorfman Memorandum and the Operations Supervisors Report to Ramey, and recommended "that Major Swancutt's crew be selected to drop the atomic bomb on ABLE Day, and that Colonel Tibbet's crew be utilized as alternate," provided that there were no major changes occasioned by the bombing scheduled for 14 June.[60] Continuing, Blanchard said that Swancutt's move into the lead had not come as a surprise, for the crew "had been carefully selected ... to work with Captain Semple," from whom they had received invaluable training. Moreover, Major Wood who replaced Semple had had very extensive bombing experience during World War II, and "was utilized for two Air

Force Leads, four Division Leads, and five Wing Leads.... Major Wood was selected for the above leads because of his stability under adversity in combat, his student-like study and execution of prescribed bombing procedures, and his knack of being able to hit." The fact that the crew could re-enter the contest after having been eliminated at the time of Semple's death indicated their tenacity.[61]

The three practice drops made 14 June did not materially alter the calculated standing of the four teams, and the Commanding General Task Group 1.5 accepted the recommendations made by Blanchard. At a meeting on 15 June, attended only by the competing bombing crews and the Operations Staff, Ramey announced that he had chosen Major Woodrow P. Swancutt and crew as representatives of the Army Air Forces to drop the bomb on ABLE Day.[62]

Up to that time the B-29 No. 354 which the Swancutt crew was flying had been given no name. On 15 June, after having been selected to do the ABLE Day bombing, Swancutt and his crew decided to name the aircraft Dave's Dream in honor of Captain Semple.*[63]

*For the sake of the record there is here appended a list of all those who were on board DAVE'S DREAM on the ABLE Day bombing mission.

Maj. W. P. Swancutt, Airplane Commander and Pilot
Brig. Gen. P. M. Ramey, Commander, TG 1.5
Capt. W. C. Harrison, Co-Pilot
Maj. H. H. Wood, Bombardier
Col. J. R. Sutherland, Bomb Commander
Ens. D. L. Anderson, USN, Weaponeer
Mr. L. D. Smith, Weaponeer
Capt. Paul Chenchar, Radar Observer
Maj. W. B. Adams, Naviagator
Lt. R. M. Glenn, Flight Engineer
Corp. R. M. Modlin, Scanner
Corp. H. B. Lyons, Scanner
T/Sgt. J. W. Cothran, Radio Operator

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Chapter VIII

ABLE DAY OPERATIONS

In addition to the overseas training of the units in Task Group 1.5, there were other phases of training which were more general in nature and which led directly to ABLE Day Operations. Thus, there were three dress rehearsals conducted by TG 1.5 during the latter part of May for all the Army Air Force units intended to participate in the ABLE Day Operations. The first, a satisfactory rehearsal, was flown 20 May. The second was begun 27 May, but weather conditions forced a cancellation before it could be carried to completion. The third was flown 30 May and was considered very satisfactory.[1] On 5 June the Navy Air Task Group (TG 1.6) arrived at Kwajalein, and after that the overseas training broadened out to include the Navy units.* Joint TG 1.5-1.6 rehearsals were held on 10 and 20 June.[2]

The entire overseas training was brought to a dramatic climax in the QUEEN Day rehearsal, held 24 June, which involved the whole Task Force. Air Operations began early that morning when the Command Aircraft, with General Thomas S. Power aboard as Airborne Commander, took off from Kwajalein at 0423. The take-off of other aircraft continued, despite the unfortunate death of Captain James E. Bishop who walked into the roaring propellers of the Bomb Carrying Plane which was warming up on the runway. Weather necessitated a fifteen munutes' delay, and detonation occurred at 0914. The drop was considered very satisfactory, with the point of burst approximately 400 feet from the USS *Nevada*.[3]

*The units of TG 1.6 had carried on their own training and had executed several rehearsals of the air plan off the coast of California and also while enroute on the aircraft carriers to the Forward Area. The Navy units were well prepared to joint the AAF units in general rehearsals.

The day was without serious operational mishaps, but minor discrepancies were found in some of the drones.[4] At the critique of QUEEN Day operations, held on board the USS <u>Mt McKinley</u> on 26 June, Vice Admiral W. H. P. Blandy, Task Force Commander, expressed satisfaction and said no further training was necessary.[5]

With the completion of the QUEEN Day Critique, the Task Force was ready for ABLE Day, and the VIP's began to arrive with every incoming plane from the United States. There were senators, representatives, flag officers, general officers, and members of the Evaluation Board. As expressed by a phrase which went the rounds of the <u>Mt McKinley</u>, there were "top cards in all suits", and the high point in the pretest ritual was the arrival of the Secretary of the Navy who was piped aboard the flagship shortly after noon, 29 June.

That same morning, careful attention was given to the weather situation. There was a widespread high pressure cell with its center located 600 miles northeast of Midway.[6] For a while there was some anxiety, but at the daily weather conferences at 0830 L, on 30 June, the following forecast was presented to the Commander JTF-1 by Colonel Ben Holzman, head of the Aerology Unit on board the <u>Mt McKinley</u>:

> Two to three tenths cumulus clouds with bases at 1,500 feet and tops at 5,000 feet. No middle clouds. About six tenths cirrus clouds at altitudes above 30,000 feet. Total cloud below bomber at target time two to three tenths. Winds aloft to be easterly 10 to 15 knots up to 15,000 feet, variable two to eight knots between 15,000 and 25,000 feet, and northwesterly 25 to 35 knots above 25,000 feet.

On the basis of this weather prediction, the Commander, Joint Task Force ONE, decided that the atom bomb would be dropped the following morning, 1 July 1946. He set the hour for the take-off of the Bomb Carrying Plane at 0649 and HOW Hour, time for dropping the bomb, at 0830 L. The Task Force was immediately informed of the decision and all units began final readying for the next day.[7]

When the decision was made to hold ABLE Day on 1 July there were, in the Bikini Lagoon, in addition to the Target Array, and in addition to the USS Saidor and the two guard destroyers, ninety-two ships and innumerable small boats, all of which had to put to sea, or be otherwise protected, before the bomb could be dropped. The Plan of Evacuation provided for the withdrawal of the fleet in four main divisions, leaving at 1200, 1300, 1500, and 1600, with scattered sailings set between periods and some isolated departures to occur after 1600. A few ships including the Mt McKinley were required to remain in the lagoon over night. The schedule was observed, and by 1700 the evacuation of eighty ships had been completed.[8]

Throughout the night of 30 June-1 July constant watch was kept for every sign of change in the condition of the weather.[9] At 0500 in the morning of 1 July a forecast was made at another weather briefing of two-to three-tenths clouds at target time, and plans moved forward steadily toward H-Hour.[10] In less than thirty minutes after the briefing, Brigadier General Thomas H. Power, Airborne Commander, reported on station at 23,000 feet above Bikini, having just arrived from Kwajalein. He made a last minute upwind reconnaissance and called in favorable reports. Blandy then made his final decision to hold the test, and at 0542 gave permission for the Bomb Carrying Aircraft to take off from Kwajalein. However, at the same time he changed HOW Hour from 0830 to 0900 to permit a greater dissipation of the clouds over Bikini.[11] Immediately thereafter the evacuation of the lagoon was resumed. As the Mt McKinley headed out to sea and passed the Target Array, it was carefully noted that every one of the deserted vessels was flying the

"Yoke" signal of no personnel aboard.* [12] The ships of the live fleet, safely at sea, awaited MIKE Hour.[13]

ABLE Day activities had begun at Kwajalein the previous morning. The bomb, brought from the United States by the USS Albemarle, was assembled and brought to the loading area on a dolly designed by Los Alamos personnel.[14] The weapon was first lowered into the pit[15] and then raised into the aircraft after the latter had taxied into position.[16] The loading operation consumed approximately forty-five minutes.[17] A check revealed that a connecting plug had been broken, and when this was repaired, the bomb was "christened" Gilda in honor of the movie of that same name in which Rita Hayworth had recently starred.[18] The bomb and the aircraft were then placed under guard until take-off.[19]

By noon on 30 June TU 1.5.1 was tensed for action. Colonel W. H. Blanchard, Commanding Officer, issued Operations Order No. 52 which set forth an exact schedule for the Unit's personnel for the next nineteen hours, by which time the last of the 1.5.1 aircraft would have taken off. By 1600 hours all planes slated to participate in ABLE Day operations were reported as ready for their missions.[20]

The activity on Kwajalein was duplicated on Eniwetok where drones and their mothers were given an exacting last minute inspection.[21] Similar preparations were made by TG 1.6, and its aircraft were given final checks even while the aircraft carriers were moving toward their designated positions.[22] All special equipment was given a thorough testing.[23]

By midnight 30 June-1 July all units of Task Group 1.5 and Task Group 1.6 were waiting to execute the Air Operations Plan.

The first plane to be airborne on ABLE Day was a B-29 of the Weather

*A yellow and red flag raised by the last man to leave each ship.

Reconnaissance Unit which left Kwajalein at 0130.[24] In perfect timing all other aircraft,[25] except the Bomb Carrier, left their stations on Kwajalein or Eniwetok, or the Navy's flat tops according to schedule.[26] The AAF drones took off and reached their Orbit Point without incident,[27] but one Navy drone crashed and its four control aircraft were returned to their base aboard the USS Shangri-La.[28] By 0855 all other Army and Navy aircraft scheduled to participate in the ABLE Day air pattern prior to or immediately after detonation were on station. The thirty-three AAF planes were distributed as follows:

- 3 B-29 Weather Reconnaissance Aircraft, one west and two east of Bikini.
- 1 B-29 Command Aircraft at approximately 23,000 feet in vicinity of Bikini.
- 2 B-29 Blast Gauge Aircraft, at 28,000 feet, on 7 NM radius, slant range circle.
- 7 F-13 Photographic Aircraft at 23,000 feet, on 12 NM radius circle.
- 2 C-54 Photographic Aircraft at 12,500 feet, on 12 NM radius circle.
- 4 Orientation Aircraft on 20 NM radius circle.
    - 2 C-54 aircraft at 7,500 feet
    - 1 B-29 Press Aircraft at 7,000 feet.
    - 1 B-29 Radio Broadcast Aircraft at 4,000 feet.
- 2 B-29 Radiological Aircraft, at 25,000 feet at Orbit Points LOVE, 30 NM 315°T, and TARE, 40 NM 135°T.
- 9 B-17 Drone and Drone Control Aircraft.
    - 1 Master Drone Control 24,000 feet at Orbit Point EASY, 090°T
    - 2 Drones and Controls 24,000 feet at Orbit Point WILLIAM, 30 NM, 270° T.
    - 6 Drones and Controls at Orbit Point UNCLE, 30 NM, 045°T.
        - 2 at 30,000
        - 2 at 18,000
        - 2 at 13,000
- 3 Air-Sea Rescue Aircraft between Eniwetok and Bikini.

Total 33

In addition, there were the Bomb Carrying Aircraft, Dave's Dream, and its accompanying F-13 which increased the total number of AAF airborne aircraft participating in ABLE Day operation at 0900 hours to thirty-five.

Of the thirty-nine Navy aircraft that had been launched between 0503 and 0750, twenty-nine remained airborne at 0900,* and were distributed as follows:[29]

6 PBM's of Seaplane Patrol Squadron
  1 Radiometry Plane at 015°(T), 15 NM, 9,500 feet.
  2 Radiological Aircraft at Orbit Point UNCLE, 045°(T), 30 NM, 2,000 feet.
  3 Photographic Aircraft
    1 at Orbit Point CHARLIE at 169°(T), 15 NM, 12,000 ft.
    1 at Orbit Point KING, 132°(T), 15 NM, 12,000 ft.
    1 at Orbit Point DOG 082°(T), 15 NM, 5,000 ft.
3 PBM's of the Air-Sea Rescue Squadron.
  1 at Orbit Point LOVE, 315°(T), 30 NM, 3,000 ft.
  1 at Orbit Point UNCLE, 045°(T), 30 NM, 3,000 ft.
  1 over Wotho Atoll at 7,000 feet
2 TBM Air-Sea Rescue Aircraft over USS SHANGRI-LA
1 F6F at Orbit Point ABLE at 045°(T), 20 NM, 14,000 ft.
2 TBM Photographic Aircraft
  1 at Orbit Point YOKE at 038°(T), 20 NM, 9,000 ft.
  1 at Orbit Point SUGAR at 135°(T), 20 NM, 4,000 ft.
3 Drones at Orbit Point VICTOR, 20 NM, 315°(T)
6 Primary Drone Control Section at Orbit Point VICTOR, at 315°(T), 20 NM.
  2 at 20,000 feet.
  2 at 15,000 feet.
  2 at 10,000 feet.
6 Secondary Drone Control Section at Orbit Point SUGAR, 135°(T), 20 NM
  2 at 20,000 feet.
  2 at 15,000 feet.
  2 at 10,000 feet.

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29 Navy Aircraft airborne at HOW Hour.

33 AAF Aircraft airborne at HOW Hour.

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62 AAF and Navy aircraft airborne at HOW Hour.
10 Navy planes withdrawn before HOW Hour.

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72 AAF and Navy aircraft which participated in ABLE Day air operations up to and including the time of the drop.

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*Thirty-nine Navy planes had been launched, but one drone had crashed and its four mother or control aircraft had been returned to base, reducing the total number of airborne Navy aircraft to thirty-four. In addition, a flight of five Navy photographic F-6F's had twice crossed the Target Array, made predetonation photographs and, upon completion of their missions, had returned to base. That left a total of twenty-nine.

At 0542, when word was received from the Mt McKinley that the Bomb Carrying Aircraft could take off, the crew raced toward the plane.[30] One of the very critical moments in the ABLE Day operations had been reached. It was known that a SILVERPLATE aircraft tended to be nose heavy when loaded with an atomic bomb. To counteract this lack of balance, 1500 pounds of buckshot, placed in ammunition cans, had been located at the farthest points aft in the fuselage compartments of Dave's Dream to make takeoff easier. Nevertheless, tension remained acute as the bomber went down the runway, and there was general relief on the part of the crew and all members of the Task Force when the plane reported herself to be airborne at 0555--twenty-two minutes behind schedule, but only thirteen minutes after permission for takeoff had been received from the Mt McKinley.[31]

Once the plane was on flight, the Bomb Commander, Colonel John Sutherland, and his two junior assistants weaponeers busied themselves with the last preparation and testing of the bomb. The duty of the Bomb Commander, as a senior officer, was to supervise the work of the weaponeers and to inform the pilot when the plane could be pressurized before gaining altitude. It was also the duty of the Bomb Commander to remain alert for unexpected situations and to give the requisite decisions. At the time of release it was the responsibility of the bomb commander to check the bombardier and see that the latter was ready.[32]

The bomb laden aircraft and the F-13 made a prescribed dry run at 0820. The Edgerton flasher on the Nevada could be clearly seen and was used to synchronize on the target. The radar beacon was also picked up from a distance of fifty miles and was used to find and maintain the desired course. The bombardier was further aided by the white turrents of the USS Nevada. Visibility was excellent and interference by the two-tenths cloud was regarded negligible. Simulated release was at 0831. The dry run was considered successful.[33]

The Bomb Carrying Aircraft and the accompanying F-13 returned to Orbit Point BAKER, located at 225° (T), fifty miles from the target. From there they began together the live run at 0849 on true course 46°, at an altitude of 29,000 feet, and with calibrated indicated air speed of 190 miles per hour. Ballistic wind data was obtained from the radar unit in the USS Mt McKinley. The bombardier then corrected for wind, for bomb weight and added a small compensation for an inherent tendency to hit short with KN bombs. Bombing tables were used in all computations. The bombardier's calculations were later checked and found to be correct.[34]

For the first three minutes of the live run clouds obscured the target but there remained four minutes of unhindered sighting operations. Previous attempts to parallel the HF tone timing had been abandoned after trial proved it liable to failure. Even the HF tone timing transmission was found to be unsatisfactory on the dry run though it was received by a majority of the participating units. The aircraft's radio operator performed minor adjustments to the transmitter between runs and there was a satisfactory tone signal transmission on the live run. Timing was very nearly perfect. Accepting actual release as the basis for measuring errors, the ten minute signal was fourteen seconds late; the five minute signal was twelve seconds late; the two minute signal was eight seconds late; and the one minute signal was only three seconds late. The bomb was released electrically in normal manner at 0859.46, exactly fourteen seconds early. Theoretical detonation was calculated to be at 0900:34.116. It was observed at 0900:36.[35]

For the personnel of Joint Task Force ONE, whether serving with the circling aircraft or with the fleet below, the fifty seconds following "bomb away" became a period elongated far beyond its actual brevity. Tense with expectancy, 40,000 men awaited the blast. Then it burst before them—a sun of white fire, brighter than day and fiercely hot. Within seconds there was a dulling pressure on the ear drums, and a prolonged, inconclusive, distant thunder, deep and ominous.

From the surface of the sea rose the column and its cloud, at the rate of 10,000 feet a minute. At about 35,000 feet the upward surge became slower. The cloud trembled and steadied, shining against the sky. The lower half continued to be troubled and unstable, but the upper half was calm. The crest sparkled with a sheen of crowning ice. A moment later, the cloud broke through its crystal container, and streams of vapor tumbled down its sides.

By 0945 the strength of the cloud was spent. High altitude winds destroyed its outer fringe, and by 1000 hours it was no longer spectacular.

Upon release of the bomb, the pilot of the Bomb Carrying Aircraft executed a 150° level turn to the left, then a shallow dive losing 1,000 feet while increasing air speed to 240 miles per hour. The shock wave was felt eighty-four seconds after release and the secondary wave immediately thereafter. Neither affected control of the ship though an odor was noticed in the aircraft for the next thirty seconds similar to that in a laboratory during the generation of high voltage. The aircraft returned to Orbit Point BAKER as briefed, and from there went direct to the base at Kwajalein where it landed at 1018 hours.[36]

As soon as the bomb release signal was given, other phases of the

Air Operation Plan began to move.[37] Ten seconds after the bomb started to fall the two pressure gauge aircraft successfully released their instruments attached to parachutes. The purpose of these was to measure the intensity of the shock wave caused by the blast, as recorded by the gauges and sent back to the aircraft by automatic radio. As the data was received it was photographed by special cameras. This had also been done at Hiroshima and Nagasaki.[38] Both aircraft returned directly to the base at Kwajalein and landed at 0955 and 1021.[39]

All other post detonation air activities of ABLE Day can be divided into four phases:

1. Close observation of the cloud and column from aircraft circling at a distance of eight NM from 0900 and 0906 when circling was discontinued;
2. The passage of drones through the cloud and column, from 0906 to 0930;
3. Tracking the cloud in its stages of disintegration and testing the Target Area from air and sea preparatory to the return of the supporting fleet to Bikini Lagoon, from 0930 to approximately 1500;
4. Additional late activities of the Army Air Forces from 1200 on 1 July to 0200 on 2 July by aircraft which did not take off until late morning and through the afternoon of ABLE Day.

During Phase One twelve Army aircraft were moved in to eight miles from the rising cloud for purposes of photography and close observation. The seven F-13's came in and remained at 23,000 feet, and the two C-54's were below, at 12,500 feet. Immediately beneath these nine Army planes was a Navy F6F at 10,000 feet. Then there were the two Army C-54 VIP Observer Aircraft at 7,500 feet and the B-29 press photography aircraft at 7,000 feet. Beneath all these was a TBM at 4,000 feet. At its Orbit point fifteen NM from the Target Center on bearing 015°(T) was another Navy seaplane which performed radiometrical work without changing its station.[40]

At 0906 Phase Two began as planned, six minutes after detonation. RADEX* was established as the area between the bearings 180° (T) and 309°(T). Therefore at 0906 all circling of the cloud ceased, and many of the aircraft returned to base. Three F-13's however, and the two C-54's, continued photographic work by flying back and forth on that arc of the eight mile circle not included in RADEX. In this they were joined by two Navy planes. At the same time the Navy sent in three other photographic seaplanes which did not fly on the arc of the circle but covered the northern half of the area by flying on given courses near the Target Array.[41]

When the aircraft terminated their circling of the cloud and its column, the Army and Navy drones and their control planes converged toward the Target Center from their orbit points.[42] The four AAF and three Navy drones entered the cloud or column at the following times and altitudes:

Service	Time	Altitude
Navy	0906	10,000 feet
Army	0908	24,000 feet
Navy	0909	20,000 feet
Navy	0910	15,000 feet
Army	0920	30,000 feet
Army	0921	18,000 feet
Army	0922	13,000 feet

The performance of the drones was remarkably fine. Contrary to expectations there was no serious interference with control. While the drones were going through the cloud, sampling bags operated satisfactorily,

* RADEX was the term applied to the area considered to be dangerously contaminated with radioactivity.

opening by radio control when Geiger-Mueller Counters showed by radio transmission that there was sufficient radioactive material to warrant sampling. The bags were closed automatically by the Agstat relay fifteen seconds after being operated.[43]

The interception of the AAF and Navy drones was also excellent. The Navy planes were landed at Roi. The AAF planes returned to Eniwetok. As the drones came in, they were taxied by radio control to the Radiological Safety Area without incident. All engines were cut by remote control, except for one AAF plane which had to be shut off manually. A tail wheel locking system was used to disengage the tail wheel. The aircraft were pulled aside and MANHATTAN personnel assumed control. Air bags and fuselage filters were transferred to transport aircraft and flown to Kwajalein for scientific study.[44]

Much to the surprise of unit technicians, the television equipment functioned exactly as it did on previous missions. Even while the drone aircraft were actually in the cloud, block operators reported usable presentations on the television screen. On one drone the iconoscope of the nose set had an image of the cloud burned into its surface. Two drones were particularly successful in collecting samples, and one of them gained several thousand feet in altitude after entering the cloud. Radio communications were not affected but the radar jamming equipment, AN/APT 5, aboard the drone aircraft was silenced for ten minutes from the instant of detonation.[45]

All drones and drone control aircraft left the Target Area by 0930, and planes operating on the eight mile arc were also withdrawn.[46]

Phase three of ABLE Day was surprisingly unimportant. It began at 0930 in the morning and ended at 1500 that afternoon. At the beginning of the Phase the Army Air Force B-29 Broadcasting Aircraft was permitted by the Radiological Safety to remain at Orbit Point EASY until 1000 hours, after which time the plane headed for Kwajalein.[47] Meanwhile other flights began tracking and photographing the cloud to determine its persistence and radioactivity. But the cloud dissipated much more rapidly than had been anticipated, and by early afternoon there was no further need for radiological reconnaissance.

As Phase Three drew to a close the Navy began to test the area of the Target Array for radioactivity preparatory to the return of the observer fleet. First, seaplanes flew over the locality in a pattern of several levels before 1500 hours. The Navy also sent drone boats into the lagoon to collect sample water. Some of these boats were controlled from the USS *Begor*, but for the most part they were controlled by four Navy aircraft.[48]

The conclusion of Phase Three was marked by the withdrawal of all three AAF and five Navy air-sea rescue planes from their stations at 1500.[49] At the same time the Eniwetok Emergency Air Evacuation Unit, Task Unit 1.5.4, with five C-54's standing by to evacuate personnel should the wind bring radiological danger, had its alert cancelled. There never was any danger to Eniwetok.[50]

In view of the prevailing situation at the end of Phase Three, the Commander, Joint Task Force ONE, at 1618, officially declared the area within 500 NM of Bikini to be radiologically safe for flight operations. The ban which was imposed on the presence within the area of aircraft other than those of the Task Force was thus lifted at a much earlier hour than had been anticipated.[51]

Phase Four, like Phase Three, was also unexpectedly of little importance. Rather elaborate plans had been made for all night missions to observe and trace the cloud, but they proved to be not only unnecessary but useless and were soon cancelled. For instance, an F-13 mission intended to continue through the night, began at 1343 and was called off at 1627. Two B-29's were sent out as precipitation radiological aircraft. Both flew over the Bikini Area and returned to Kwajalein about midnight. Though there had been little to observe, both planes proved to be highly radioactive. Two Navy F6F's went up from the Saidor in the late afternoon on a special oceanography survey of the lagoon. They remained at altitudes of 250 to 400 feet and returned before night.[52] So, Phase Four added five aircraft to the total participating in the ABLE Day operations, but their accomplishments were not important.

Task Group 1.5 considered the ABLE Day mission highly successful. Operations went off almost entirely as planned. There were no aborts or mechanical malfunctions for AAF aircraft. The Air Instrumentation and Test Requirement Unit did not lose a single plane and acquired all the scientific data desired.*[53]

The full extent of air operations on ABLE Day, before, during, and

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*No account of ABLE Day can be considered complete without at least mentioning that both the Radiological Sample Aircraft returned from Eniwetok and Roi Islands as scheduled. The special film courier aircraft, slated to depart for Washington on the evening of ABLE Day, however, was cancelled, and the film was put board a B-29. The first special film courier aircraft departed for Washington on ABLE plus One Day, and the second on ABLE plus Two. Radiological Samples Aircraft departed for Santa Fe on ABLE plus Four Day, and a third film courier aircraft, specially requested by the Air Photographic Unit, was dispatched on ABLE plus Five Day. (Lt. Col. Payne Jennings, Hq., TU 1.5.4, to CG, TG 1.5, ABLE Day Contributory Report, 9 Jul 1946.)

after detonation, is shown by the following table:

PRIMARY MISSION OF A/C	NUMBER OF AIRCRAFT ARMY	NAVY	TOTAL
Command	1	0	1
Bomb Carrying	1	0	1
Drones	4	4	8
Drone Control	5	16	21
Drone Boat Control	0	4	4
Day Photography	10	11	21
Night Photography	1	0	1
Radiological Survey	4	2	6
Pressure Gauge Dropping	2	0	2
Radiometry	0	1	1
Precipitron Sampling	2	0	2
Oceanography	0	2	2
Air-Sea Rescue	3	5	8
Weather Reconnaissance	3	0	3
Operation	4	0	4
Totals	40	45	85

At the end of the day General Kepner sent the following message to the commanders of Task Group 1.5 and Task Group 1.6: "I commend you and all your personnel for one of the most outstanding air operations in history. It was superior." 54

There was only one trouble. The bomb had missed the target with a serious error both in range and deflection. 55

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ABLE Day Operations

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Chapter IX

INVESTIGATION OF THE ABLE DAY BOMBING

The magnitude of the ABLE Day bombing misfortune was not grasped at once. True, the general opinion of the Navy personnel was not complimentary to the skill of AAF bombing crews, once the smoke had cleared and the orange form of the *Nevada* stood out sharply and unmistakably upon the waters of the lagoon.* Yet scorn turned to surprise when the live fleet approached the Target Area and the damage caused by the bomb became more and more apparent with the discovery of each new detail of havoc. By 2 July there was a widespread belief that the drop had been satisfactorily accurate and some representatives of the Army Air Forces could not refrain from a "laughs last laughs best" attitude.[1]

Among those who were in a position to know the real situation, however, there was a growing concern over the bomb's point of detonation. During the morning of 3 July General LeMay and Colonel Roscoe C. Wilson came aboard the USS *Mt McKinley* and paid a call of some length on General Kepner. The conference was closed even to General Kepner's secretary. No document has been found purporting to disclose what was then under discussion, but the impression it made, among those already uneasy over the bombing mishap, was to stimulate the conviction that the ABLE Day test had gone very poorly indeed.[2]

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*David Bradley, who was flying in a Navy plane, described the Target Array by saying that the *Nevada*, 'gaudy red forward and pretty well singed aft, turned out to be some distance from the most intense radiation, so we all know that Dave's Dream had not exactly scored a bull's eye....The apparent damage was surprisingly slight....Expecting much more dire and dramatic events our crew was disappointed. There was much pooh-poohing of the Bomb over the interphone, and at last the co-pilot growled: "Well, it looks to me like the atom bomb is just about like the Army Air Force--highly over-rated." '

David Bradley, *No Place to Hide* (Boston, 1948), p. 58.

Robert Dorfman's Journal is indicative of the gradual change of opinion. His entry for 2 July ~~is~~ was devoid of any important comment,[3] but the next day he recorded a definite comprehension of how far the detonation had been from the target.[4]

Twenty-four hours later, 4 July, the official investigation began. Colonel Preston and Dorfman were ordered to Kwajalein to assist General Power in determining the cause of the miss. They were instructed by General Kepner, first, to obtain the bombardier's settings and data; second, to get photographs from airplanes following the Bomb Carrying Aircraft; third, to check the bomb weight and inspection procedure; and, fourth, to determine the altitude of the Bomb Carrying Aircraft. In addition, Colonel Gancy suggested that the analysts should follow events chronologically, check on instrument calibration and make a calibration flight as further check, and investigate F-13 photographs as a possibility of determining the point of release.[5] General Kepner felt from the first that there was something wrong with the fins and baffles of the bomb, and he insisted that the analysts should pay particular attention to this possible cause of apparent error. With these suggestions in mind Colonel Preston and Dorfman left the Mt. McKinley, 5 July, and signed in at Headquarters, Task Group 1.5, Kwajalein, that same afternoon.[6]

In less than two hours after arriving at Kwajalein, Colonel Preston and Dorfman were in the first of many conferences held at Headquarters

Task Group 1.5 between then and the evening of 9 July, four days in all.
Task Group 1.5 was much troubled by the event and had already begun an
investigation of its own, but slight progress had been made. Task Unit
1.5.1 was represented at the conference by its Commanding Officer,
Colonel Blanchard, and also by Colonel Perna, Colonel Sutherland the
Bomb Commander, Captain Beahan the Staff Bombardier, and Mr. R. N.
Davis the Operations Analyst. Dorfman represented Operations Analysis
Section of Joint Task Force ONE. It turned out that Davis had begun a
study of the photographs taken by a vertical 6" K-17 located in the Bomb
Carrying Aircraft and also those taken by hand cameras located in F-13
which had followed the Bomb Carrying Aircraft at a short distance. These
pictures showed the bomb leaving the bomb bay, but Davis was not ready
to make a report of any kind.[7]

Checks were made during the course of the investigation on the
bombsight and each member of the crew was questioned concerning the run.
Nothing wrong could be found.[8] By 8 July, the vertical photographs were
regarded as unreliable and Colonel Sutherland suggested that the movies
of the bombfall taken by the F-13 should be inspected to check the
possibility of rotation or wobble of the bomb while in flight.[9] The few
errors discovered were of such a nature as to have caused no more than
minor deviations from correct bombing. On 9 July, bombsight personnel
were interviewed but again without results.[10]

Dorfman returned from Kwajalein the morning of 10 July. That after-
noon a conference was held on board the Mt. McKinley. It was attended

by General Kepner, General Power, Admiral Parsons, Dr. Warner, who was in charge of preparing the bomb, Colonel R. G. Butler, Jr., of MANHATTAN, General Nichols of the Engineers, Captain Ashworth, USN, Colonel Caney, Dr. Bradbury, Colonel Preston, and Dorfman. The conferees examined the flight pictures brought from Kwajalein by Colonel Preston, and it was agreed that the cause of the error had not been established.[11]

On 11 July, General Power, in a ~~letter~~ report to General Kepner, summarized all the work so far done in the attempt to understand the cause of the ABLE Day misfortune. General Power said that the size of the error indicated exceptional circumstances above the cumulative total of minor inaccuracies always present. The ABLE Day miss was [redacted] worse than any [redacted] error made by the crew during the training period. Statistically it was considered "almost impossible for this crew to make such an inaccurate release in the absence of extremely abnormal conditions." General Power went on to enumerate the various checks made in an endeavor to locate the source of error, and nowhere could it be found. The bombsight had been slightly out of adjustment four days before ABLE Day but this had been promptly corrected, and all subsequent inspections showed the bombsight to be in proper adjustment. It was established that the bombardier had extracted the figures on trail-setting and ground speed for the bombsight and that he used proper tables. Detailed information on the mission generally, including the operation of radar equipment, navigation technique, and bombing analysis, revealed no major errors.[12]

General Power declared that since good bombing conditions had existed on ABLE Day and all normal checks had been taken to insure a perfect bomb run, and no unusual occurrences had been reported, there remained two possible causes of the error. First, there might have been a malfunctioning of the bombsight which gave a false impression to the bombardier as to the position of the aircraft in space relative to the target. Second, there might have been an unpredictable bomb which was dropped properly and from the correct position but which did not follow the computed trajectory. It was felt that the only means whereby the exact cause could be determined, was a careful analysis of all available photographs taken on the bombing run from the Bomb Carrying Aircraft and the F-13 following nearby. Such an analysis would mean a study of four types of photographic record. First, there were the vertical photographs taken on the bombing run from the Bomb Carrying Aircraft by a K-17 camera. Second, there were the radar scope photographs taken from the radar scope in the Bomb Carrying Aircraft during the bombing run. Third, the movie film taken from the F-13 aircraft following the Bomb Carrying Aircraft and photographing it until release, and for a short time after release. And fourth, there were such still photographs as were taken from the F-13 aircraft near the Bomb Carrying Aircraft at the time of release.[13]

General Power concluded his analysis of the ABLE Day Bombing with four recommendations. First, ~~that~~ all available photographs indicating the position of the Bomb Carrying Aircraft at the time of release should be assembled at a suitable place for further study. Second, ~~that~~ professional personnel, trained in photographic interpretation and analysis, should be assigned to determine by photographic computations the exact position of the Bomb Carrying Aircraft when the bomb was released. Third, ~~that~~ the bombing crew and the Bomb Carrying Aircraft, which had already returned to the United States, should make one or more practice releases with the same equipment used on ABLE Day, and ~~that~~ when the bombsight ~~be~~ checked at a depot. Fourth, ~~that Colonel~~ Preston and ~~Mr~~ Dorfman, being thoroughly familiar with the problems, should return to Continental United States at once to monitor and coordinate the later phases of the investigation.[14]

General Kepner gave his concurrence without delay,[15] and implemented his decision by ordering Preston and Dorfman to return to the Zone of the Interior as soon as possible. The two analysts left Kwajalein on 12 July and reached Fairfield, California, the next day.[16]

During all this time Headquarters AAF was fully informed of events at Bikini.

Between 1 and 4 July Admiral Blandy covered the general results of ABLE Day in frequent wires to Spaatz, but directed the members of his staff to transmit no additional statements. The restriction was lifted on 5 July and Kepner immediately summarized his concern and disappointment in a letter to CG AAF:[17]

> I am having a thorough investigation made of all conditions affecting the flight of the bomb. Ramey stated that it was a good run. He was on board the bomb carrier both on Queen Day and on Able Day. The same bombing crew made the drop. The pilot states that he had, if possible, a better run on Able Day than on Queen Day. Further, he says that the bomb sight was set up so well that he did not have to touch it for the last thirty seconds of the run.

On 11 July Kepner wrote Spaatz again, forwarding Power's report of that same day and agreeing with the latter's view that "it is highly important...[to] find out why and where so large an error occurred. It is important to know what dependence can be placed in the present conception of the ballistics for the bomb."[18] Kepner added that though the failure was of primary interest to the Air Force, MANHATTAN too was directly involved, and indeed had participated somewhat in the investigation. He regretted that a final report could not be completed in the Forward Area, and emphasized the need to carry on the study in the United States. To this end he had sent Preston and Dorfman back to ZI, and urged that AAF sustain their efforts, and also obtain the full cooperation of MANHATTAN.[19]

Headquarter lent full support to the investigation. As soon as Preston and Dorfman landed at Fairfield on 15 July they 'phoned LeMay. He order them to the Aeronautical Chart Service, St Louis, where he believed the pictures of the bomb fall were then located.[16] He also selected Colonel H.G. Montgomery, a bombing expert of RAF and AAF World War II experience, to assist them. That same day LeMay asked Groves to give Montgomery, Preston and Dorfman a clearance that would relieve them from MANHATTAN's security limitation during the course of their work.[20] He justified his unusual request by pointing out that the Bikini bombing had caused serious concern since it could not be attributed to any particular malfunction on the part of the equipment or to the technique of the operating crew. He felt that a complete investigation should be made. As it was, the error reflected upon the reputation of the Air Force, and every precaution should be taken to prevent a repetition of the failure when the stakes might be incalculably greater.[21]

[redacted]

It was the next day, 16 July, that Colonel Preston and Dorfman arrived at St. Louis. There they were informed that the movies they wanted had been taken by a representative of MANHATTAN District and deposited in the Photo Science Laboratory, Anacostia, D. C., but the Aeronautical Chart Service agreed to begin at once the photogrametric work on the vertical photograph taken by the bomb carrying aircraft. The Chart Service also agreed to analyze the trimetrogon photographs by the aircraft which trailed the Bomb Carrier.[22]

The following morning, when Colonel Preston called Washington,[23] he learned that he, Dorfman, and Colonel Montgomery had been appointed by Headquarters Army Air Forces as a three man board to investigate the error, and submit their report not later than 1 August 1946.[24]

The tempo of the investigation then seemed to gather greater momentum, if that was possible. Dave's Dream had preceded Colonel Preston and Dorfman in returning to the States preparatory to reenactment of the ABLE Day bombing at Sandia Bombing Range. The aircraft flew another PUMPKIN test mission using the same bombsight and stabilizer employed in the bombing of 1 July, bombing from approximately the same altitude as that over the Bikini target. Release and fall of bomb were both good, and impact was attained with a circular error of 220 feet.[25]

Once Preston and Dorfman reached Washington they, together with Montgomery, began a period of conferences, hurried trips half way across the continent and back, and consultations with scientists and specialists in many lines. The first meeting of the three man board was 18 July.[26] They decided that they would have to determine the bomb release point and then analyze pictures and movies of the bomb in flight. They next had some blown-up stills made of the critical movies, but these turned out to be hazy and indeterminate. Dorfman and Colonel Preston went back to St. Louis for 23-24 July to see the work done there at the Aeronautical Chart Service. Again these pictures failed to check with those shown in the Pentagon, so Colonel Preston returned to Washington on schedule and Dorfman remained in St. Louis for another two days. When he reached Washington, 26 July, he found that General Groves, on the previous day, had cleared the three members of the board to see the movies and still photographs pertaining to their work.[27] The three man board was broken, however, 1 August, when Colonel Montgomery was ordered to his new post at Maxwell Field.[28] At the time Colonel Montgomery was put on the board it was expected the Analysis Report would be completed and submitted by 1 August. So there was no conflict between the two assignments given the Colonel, but the time proved to be too short and the two remaining analysts were given until 12 August to finish this work.[29]

During the first ten or twelve days of August Colonel Preston and Dorfman saw many people, and received many reports. Through this whole period of investigation, as bit by bit the evidence was assembled, one fact was established by the various documents. Nothing was clear-cut. The analysis of a given set of photographs by one specialist was contradicted by the analysis of another set of photographs - or, indeed, the analysis of the same set of photographs by a second analyst. Even more confusing was the reaction of those who saw, at the same time, the same movies of the bomb fall. Thus, 25 July, Colonel Preston and Colonel Montgomery together went over some enlarged photographs of the bomb in flight. Montgomery said the photographs showed "definite eccentricities"; Preston could not see them. On 9 August Dorfman, with Colonel Butler and Mr. Samuel Feltman, of the Ordnance Department, were shown movies. Dorfman felt that the pictures proved something wrong with the bomb.[30] Other disagreed with him, but the long range motion pictures of the actual fall showed irregularities in the flight path. Unfortunately the image was too small for the pictures to be regarded as conclusive. In view of these uncertainties no specific explanation was made of the error, but it seemed reasonable to conclude "that some unusual force affected the bomb causing it to veer off in an unpredictable and erratic manner."[31]

Completion of the Preston-Dorfman report did not end the matter. High ranking civilians in the Task Force questioned the adequacy of the Air Force investigation. The incident did not promote kindly feeling[32] or dispassionate discussion.[33] In a top level conference,[34] however, it developed that the critics of the report had resorted to photographic evidence without understanding the position of the bomb carrier.[35] Consequently they had not made proper allowance for the camera tilt, and their calculations were valueless.[36] Apologies eased the situation, but no one was as yet fully satisfied, and after the Task Force was inactivated the Air Force requested that Aberdeen Proving Ground continue the investigation.

To assist the Proving Ground authorities, a resurvey was made in late November 1946 of the Target Array on ABLE Day to determine the position of the aircraft when the bomb was toggled. In addition, special studies were prepared by the National Bureau of Standards and the Navy Photographic Intelligence Center to determine the lens distortion in the camera on the Bomb Carrier, and to obtain a mean analytical burst position of the bomb. Between 19 November 1946 and 23 January 1947 an Aberdeen Bombing Mission conducted tests at Muroc Army Air Base in which five FAT MAN models were dropped from 30,000 feet to find the average deflection. Statistics from all these studies were evaluated along with a restudy of the bombardier's data sheet. The conclusion at Aberdeen in March 1947 was that the error in [illegible] range was certainly attributable to the bomb. The lesser error of deflection, however, could have been due either to a faulty bomb or to an off-course track of the aircraft before release, or perhaps to both.[37]

The inconclusive findings were disappointing to the Air Force. But the Aberdeen study proved the objective and straightforward nature of the earlier AAF investigation; it established the fact that there was something wrong with the bomb as shown by the range error; and it could find no positive evidence that the aircraft was off-course prior to the drop. By implication the study cleared the bombardier of [illegible] serious error in the bombing, but the incident of ABLE Day nevertheless injured the reputation of the Air Force for quite some time to come.

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Chapter X

BAKER SHOT AND JTF-1 ROLL-UP

Long before the investigation of the ABLE Shot was completed, BAKER Day operations had been held, and Joint Task Force ONE had returned to the United States and been inactivated.

Plans for BAKER Day

Preparation for Test BAKER, both for the Target Layout and the Air Operations Plan, began in Washington at the same time that the plans began for Test ABLE, and the two were interwoven, at least in part, into one document.[1] The original plans for the Target Layout were almost identical for the two tests,[2] but some important changes were made for the BAKER Shot, and whenever they were made the same Navy-Air Force difference of purpose was manifest that governed the development of the ABLE plans.[3] The first BAKER layout was ready for examination on 7 February. A week later General LeMay protested that the plan would not permit the acquisition of the desired data,[4] and the BAKER layout was not agreed upon for a long time. Indeed Admiral Blandy himself expressed the opinion on 26 February that the plan should not be put in final form until after the ABLE Day operations.[5] Several revised layouts appeared in the course of the next few weeks,[6] however, and on 15 April AAF concurred in a tentative disposition of ships, but only as a compromise.[7]

When the plan reached JCS on 16 April, the Chief of Staff, USA, objected that no layout could be adopted until the exact position of the bomb had been determined.[9] This statement opened a discussion that continued for a month.[10] Not until 10 May did the Joint Chiefs approve the underwater shot detonation at a depth of 50-100 feet,[11] and it was another week, 20 May, before they sanctioned the general

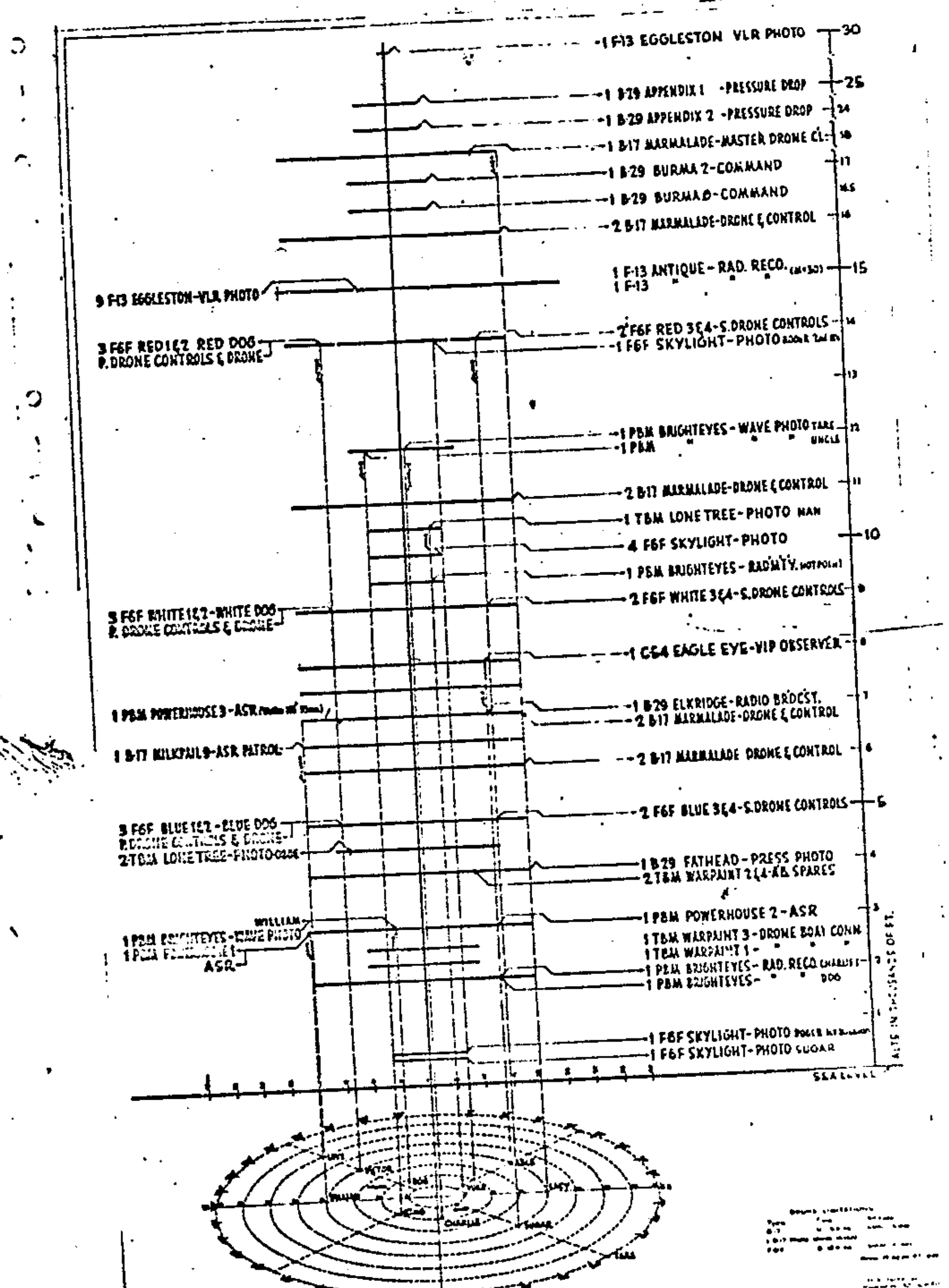
Layout plan.[12] Even then the exact position of the bomb had not been agreed upon. On 6 July Blandy conferred with the Evaluation Board on this question, and the problem was returned to JCS by TWX.[14] In the end the "Target Ship" Saratoga was placed approximately 330 yards from Point Zero. Other changes in the plan were made after ABLE Day.[13]

Meanwhile, since the Air Operations Plan for Test BAKER, as written in Washington, was sound, nothing further was done to it until ABLE Day lessons were learned.[15] Then there were demands for changes, many of which were derived from a better knowledge of the bomb, and the belief that the underwater blast would be even less hazardous than Shot ABLE due to a reduced radiological danger in the atmosphere, and the absorption by the water of light, heat and pressure.[16]

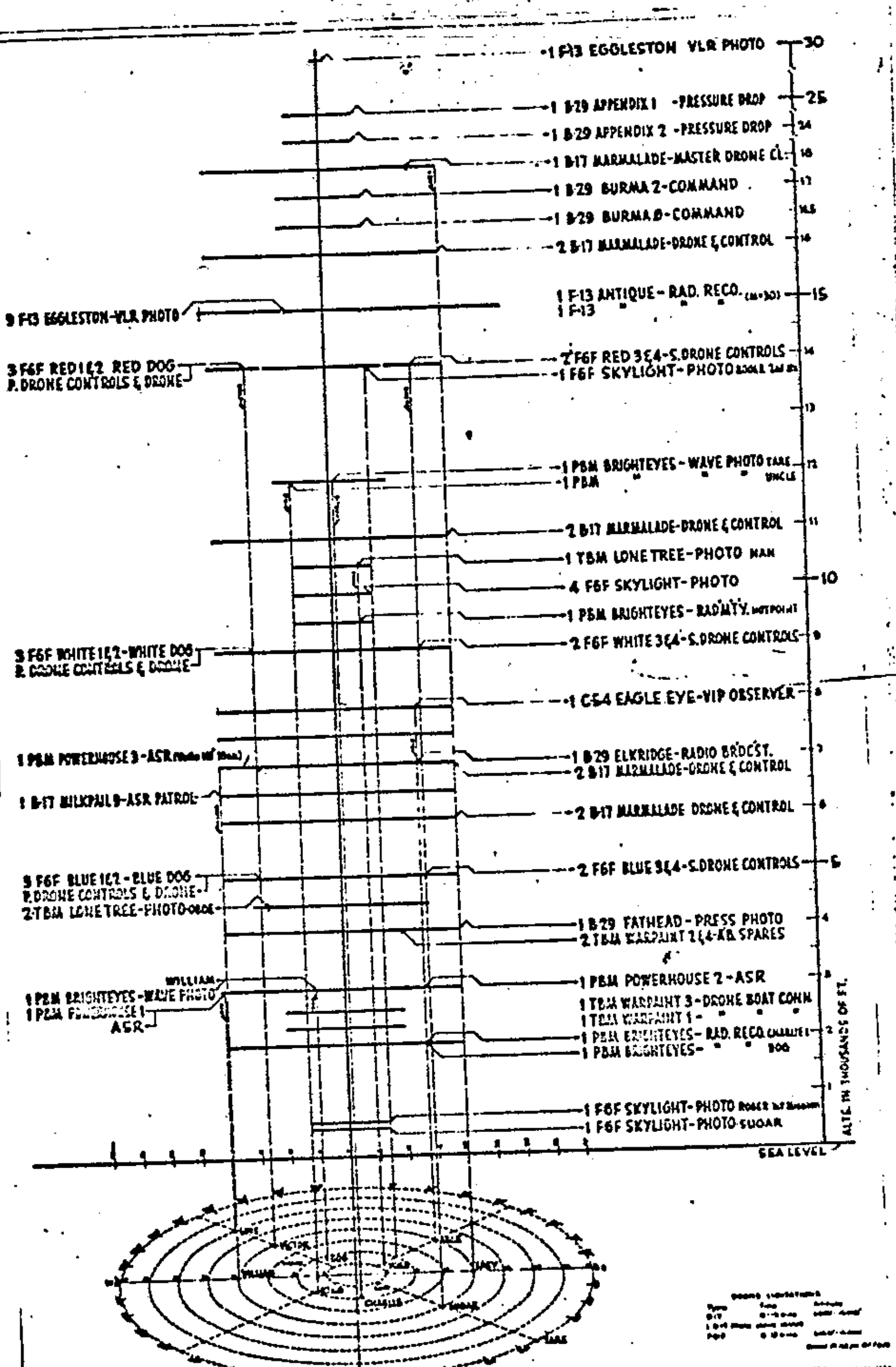
Brigadier General William E. Kepner, Deputy Task Force Commander for Aviation, called a conference for 9 July to make final preparations for BAKER Day which had been set for 25 July.[17] The WILLIAM Day full dress rehearsal was to be on 19 July, with special rehearsals for the AAF TG 1.5 and the Navy TG 1.6 on 14 July.[18] Increasing probability of poor weather made it advisable to place as many aircraft as possible below the middle cloud altitude of 16,000 to 18,000 feet. Energy absorption by the water meant that the NM slant range for circling aircraft could also be reduced.[19] In brief, there would be general pulling-in or tightening of the ABLE Day air pattern, but with only minor changes in emphasis.

The bull's eye of the Target Center would be marked by radar and beacon on the *Saratoga*.[20] A closer approach to Point Zero was advantageous to photography,[21] and the F-13 which had accompanied the Bomb Carrying Aircraft on ABLE Day was given a mission directly over the blast at the moment of detonation.[22] Drone operations remained practically unchanged,[23] and so did the missions of most other AAF units.[24] The persons responsible for firing the bomb by radio played the relative part of the Bomb Carrying Aircraft and the bombardier.[25] As far as the AAF Task Group was concerned, the three hour conference[26] did little except reduce the assigned radii and altitudes.[27] The Army Air Sea Rescue plans[28] and the mission of the Navy Air Task Group were also essentially those of ABLE Day.[29]

Not withstanding the similarity of the ABLE and BAKER plans, and the intensive preparations which had preceded Test ABLE, active training programs were initiated for the second test almost as soon as ABLE



TEST BAKER • A/C POSITION & ALTITUDE AT HOW HOUR



TEST BAKER • A/C POSITION & ALTITUDE AT HOW HOUR

Day was over. From 2 July until 24 July all activities of Task Group 1.5 were concentrated on preparing the air crews, equipment and aircraft of all task units for a successful BAKER Day operation.[30] There was also some special training for the Photographic Unit.[31] The TG 1.5 and TG 1.6 rehearsal was held on 14 July.[32] The mission was performed smoothly, and the next day a critique of the operation was held on board the Mt McKinley.[33] Some errors were found and corrected in the plans for drones,[34] the altitude of the F-13 directly over the Target Center resulted in overheated cylinders and was reduced from 31,000 to 30,000 feet,[35] and corrections were made in the orbits of the Blast Gauge Aircraft.[36]

The full dress rehearsal of WILLIAM Day was on 19 July, but it was hampered by unfavorable weather,[37] although the forecast had been favorable.[38] The early stages of the rehearsal preceded without trouble. The evacuation of the lagoon was completed on schedule and aircraft took off from Kwajalein and Eniwetok and from the carriers of Task Group 1.6. At 0700 rain was visible to the south and east of Bikini and it was apparent that the equatorial front was moving northward rather than southward. Radar observations were taken constantly and they showed that weather to the eastward was rapidly deteriorating. A northward bulge of the front approached from the east and caused winds to converge ahead of it. Convective clouds of all types developed and showers soon became prevalent throughout the Target Area. By ~~0000~~ 0730 the total cloud cover over the target below 20,000 feet was 8/10,[39] Omit ~~the weather deteriorated rapidly and~~ at 0740 Kepner ordered all aircraft except F-13's, B-29's and Air-Sea Rescue to return to base.[40] Participation in the rehearsal was thus reduced to a minimum.

The WILLIAM Day rehearsal suffered from another misfortune. The flash bomb at the center of the Target Array, to be used for a test of camera timing and intended to detonate at 0905, fired prematurely at 0815. The cause was never determined. Naturally there was some consternation among Task Force personnel who felt that there was a possibility of the atom bomb detonating on BAKER Day before the evacuation of the lagoon had been completed. The incident was also given considerable publicity by broadcasters.

As a means of reassuring both the Task Force personnel and also the public, the Commander, Joint Task Force ONE, issued a public statement in which he gave an indication of the elaborate safeguards provided for BAKER Day. He said that the premature explosion had no significance for BAKER Day, since the flash bomb was operated on the camera actuating circuit. For the atom bomb there was a system equivalent to a time lock in a bank superimposed on the radio linkage in such a manner that no signal, not even lightning, could possibly fire the bomb prematurely, for the operation would depend on a particular sequence of specific radio signals. The Admiral concluded by saying that a dummy bomb had been on the firing barge lacking everything except the firing equipment to be used on BAKER Day. A scientist had remained on the barge on WILLIAM Day to check the firing mechanism and he had heard in a microphone the sound of the dummy bomb as it fired under water at exactly the right moment. This statement did much to reassure the Task Force personnel.[41]

An air critique of WILLIAM Day was held at Kwajalein on 21 July, and a few changes were made in BAKER Air Plan.[42] The next day a Task Force critique was held on the Mt McKinley. In view of the fact that WILLIAM Day operations had gone reasonably well in spite of the weather, Blandy decided that no further rehearsing was needed.[43]

BAKER Day Operations

On 24 July the Aerology Section predicted, with a low degree of confidence, that favorable weather would prevail the following day.[44] In view of the report, Blandy decided that BAKER Test would be held as scheduled on 25 July. At 0907 he informed the commanders of Task Group 1.5 and Task Group 1.6: "Twenty-five July is BAKER Day. Execute Air Op Order 2-46. HOW Hour is 0835 Love."[45] Final preparations, such as briefings,[46] began at once,[47] and everything was ready on Kwajalein, Eniwetok and the Navy carriers long before take-off.[48]

The B-29 Weather Reconniassiance aircraft were the first to be airborne,[49] and performed their mission well.[50] By 0300 hours they reported that the weather would be satisfactory,[51] and the evacuation of the lagoon by live ships was carried to completion.[52] The AAF and Navy aircraft took off without hitch,[53] and the Target Array was photographed moments before the blast.[54]

A simple table clarifies the extent of AAF and Navy participation in the BAKER Day Air Operations Plan:

PRIMARY MISSION	NO. OF AAF	NO OF NAVY	TOTAL
Command	2	0	2
Drones	4	3	7
Drone Control	5	12	17
Drone Boat Control	0	4	4
Day Photography	10	12	22
Night Photography	1	0	1
Radiological Survey	3	3	6
Pressure Gauge Dropping	2	0	2
Radiometry	0	1	1
Air Sea Rescue	3	4	7
Weather Reconnaissance	3	0	3
Orientation	3	1	4
Sonor	1	0	1
Total	37	40	77

Detonation occurred exactly at 0835. A shaft of water with a diameter of approximately 2,500 feet rose more than a mile in the air, carrying upward a vast amount of water variously estimated as between the two extremes of two and ten million tons.* At once, waves were seen rushing toward the reef and Bikini Island, but they were too spent to break over the atoll barriers. Behind them was the impressive base surge that engulfed battleships as though they were toys. Above all those phenomena was the atomic cloud that climbed to 10,000 feet and leveled off. It had the form of the ABLE Day cloud but it was very dark. It lacked size, height and color because so much of the energy from the explosion had been absorbed by the water. A black smoking object was seen in the cloud and there was some fear that one of the drones had been downed, but Admiral Blandy believed it was part of the LSM to which the bomb was attached. The column stood perpendicular for an instant and then began to spray out into a mushroom covering the entire Target Array. It rained back into the lagoon in a torrent surpassing the downpour of a typhoon, blotting out every trace of the Target Fleet for nearly half an hour.[55] The BAKER Day explosion was less spectacular than that of ABLE Day but there was a grim horror in the gray column of water and the downpour of lethal rain which showed the atom bomb at its worst, and surpassed anything experienced during 1 July. Test BAKER was deadly.

The AAF aircraft functioned as briefed. The F-13 at 30,000 feet, one NM horizontal range from the Target Center, arrived at its position six seconds early and succeeded in taking nearly vertical photographs.[56] The Blast Gauge Aircraft were equally successful though one of them had a leak through the rocker box oil cross-over line plug. The leak did no real harm but made observers on the Mt. McKinley fear that the plane was on fire.[57] The seven F-13's of the Photographic Flight and the two C-54's used 166 motion picture cameras and exposed 43,760 feet of film.[58]

*The difference in estimates expressed the uncertainty whether the column was solid or empty.

There were 111 still cameras and 12,567 exposures.[59] The Orientation, Press Photography, VIP Observer and F-13 Radiological Aircraft performed without incident.[60]

The most important phase of the BAKER air operations, however, was that of the drones. The information obtained through them, when combined with what had been learned on ABLE Day, convinced the military that they had only fragmentary rather than "full information" on the atomic bomb effects. Little was left of the September 1945 self-assurance.*[61]

The AAF and Navy drones all returned safely but one Air Force plane ~~which~~ ran over an embankment due to weak breaking. Air bags, filters and cameras were removed for processing,[62] and the drones themselves studied for the effects of the blast on structure and equipment. The plane at 6,000 feet over the blast suffered warped bomb bay doors and other damage. On the other hand, transmitters, receivers and recorders functioned well throughout the missions, even when passing through the cloud.[63] Television equipment proved to be exceptionally good.[64]

After detonation, AAF and Navy aircraft[65] operated on schedule through most of the afternoon [66] and during the succeeding six days.[67] This activity was much more intense than during the post-shot hours of ABLE Day, and it was due to the pronounced radioactivity of the lagoon following the BAKER blast. During this time, photography of the Target Array was an important function of aviation, and instruments located along the reef could only be reached by helicopters.[68]

On 31 July, that is six days after the BAKER shot, the Commander JTF-1 declared that all air units had fulfilled their missions.[69] This statement ended the operational phase of CROSSROADS.

*See Chapter V.

Admiral Blandy had already sent his congratulatory message to the personnel under his command "upon the successful completion of the 1946 atomic bomb tests...both upon the high efficiency of the individual units and upon their magnificent cooperation. Probably never in peace-time has an enterprise calling for so many different skills been attempted and it was only your unexcelled ability to work together, civilians and service men alike, that brought the 1946 Operation CROSS-ROADS to a successful conclusion. I am proud to have been associated with you."70

Roll-Up and Inactivation of JTF-1

As in the case with any peacetime task force, JTF-1 began preparations for roll-up some time before the termination of the operational phase. The controlling factor in the early plans was the belief, which persisted until after the return of Admiral Blandy and his staff to Washington, that CROSSROADS would be resumed in the Spring of 1947 to execute Shot CHARLIE, the deep underwater blast. Had this end been maintained it would have necessitated the return of Joint Task Force ONE to Bikini about January 1947, and that meant it was unwise to return to the West Coast all of the equipment used for Shot ABLE and Shot BAKER.

As far as the Navy was concerned there was little difficulty. The target ships surviving Shot BAKER evidently should be left in the Forward Area for the simple reason that many of them were sure to be too radioactive to permit the long term presence of an operating crew. It was also found that much of the See Bee equipment was in a state of very bad repair due to the fact most of it was not new when received and had been put through five additional months of hard usage. Careful analysis indicated that it would not be suitable for Test CHARLIE. Therefore, the Task Force recommended to COMSERVPAC that the best items of the equipment be sent to Kwajalein and Eniwetok, that economically repairable items be sent to Port Hueneme, and that all other items be abandoned. The recommendation was approved.[71]

For a while there was some doubt about the advisability of having Task Group 1.5 participate in Shot CHARLIE. Once the decision was made to have AAF participation in the test, recommendations were made 28 June to the Commanding General, Army Air Forces, that TG 1.5 leave transportation and other equipment at Kwajalein with a caretaking detachment to maintain adequate storage until the return of the Task Group in the first months of 1947. This decision considerably lessened the problem of return shipping both by surface and air. Upon the approval by Headquarters AAF, which came quickly, the Deputy Task Force Commander for Aviation and the Commanding General, Task Group 1.5, immediately began the necessary action to accomplish the storage of selected material and the roll-up of TG 1.5 to the United States. Actually, this movement on the part of TG 1.5 represented the first positive steps taken within the Task Force for its roll-up.

The first TG 1.5 aircraft to return to the United States was a B-29 which left Kwajalein 1 July to take film of Shot ABLE to Washington. Then, 6 July, Dave's Dream left for Roswell to reenact the ABLE Day bombing in connection with the investigation of the error.[72] Although neither of these two planes returned to the Forward Area, their departure for the Zone of Interior cannot be considered as part of the Task Group plans for roll-up. The Task Group had too many duties to perform in connection with Shot BAKER to initiate a return movement of planes to the United States before completion of the operations which were part of the underwater burst.

Meanwhile, as soon as the ABLE Day drop was completed the Task Group was in a position not only to consider but actually to carry through the destruction of all evidence, which, falling into wrong hands, might have revealed important information concerning the size of the bomb, its weight, and the technique employed in its handling and loading. Therefore, immediately after ABLE Day, Task Unit 1.5.1 resumed the practice bombing of the Erik Island target as a means of using up remaining PUMPKINS. The last of these pseudo-atomic bombs was dropped 16 July.[73]

When the last PUMPKIN had been dropped, it was necessary to eliminate from Kwajalein all other traces of the shape and size of atomic bombs, and of the means by which they had been manipulated. The atomic bomb hoist, which had been obtained from the Marianas, was sent to the First Ordnance Squadron at Albuquerque.[74] After that, the ramp and pit were totally destroyed by dynamite so that all form of their construction was eliminated. Even the cavity of the pit was filled with sand, and its location obliterated.[75] Finally, the boxes in which the PUMPKINS had been crated were all burned.[76]

While the last tell-tale evidence of the atom bomb secrets were being erased from Kwajalein, a plan was devised for the systematic return of the units of Task Group 1.5 to the United States but at the same time taking care of the equipment to be left in the Forward Area. By 7 July a repairable warehouse had been established on Kwajalein to which all items turned in by supply activities were prepared for shipment to POATSC,* Oakland, some by surface transportation and some by air. Also, all requisitions for crating and packing materials had been placed with POATSC, and Mr. William T. Ferguson, carpenter UN-12, civilian employee, had arrived from the Hawaiian Depot on thirty days temporary duty to supervise the packing both at Kwajalein and Eniwetok.[77]

Within the next week an inventory was begun of all accountable

*Pacific Ocean Air Transport Service Command.

property on Eniwetok and Kwajalein, and a plan had been prepared and submitted to the Commander, Joint Task Force ONE, for the disposition of all property in possession of Task Group 1.5 after BAKER Day. On 11 July a conference was held on board the USS Mt McKinley between Colonel L. B. Woods, A/CAS-4, representing the Commander, Task Group 1.5, and Colonel D. H. Blakelock,* J-4, representing the Commander, Joint Task Force ONE. The plan, as finally approved by these two officers, provided for the packing and crating for air shipment of 50,000 pounds of photographic equipment which had to be returned to the Zone of Interior. The plan also provided for the preparation for water shipment of all other equipment in the following disposition schedules:

1. Aviation Class IV-E (B-29) to Guam Air Depot
2. Aviation Class IV-E (B-17) to HAD (Hawaiian Air Depot)
3. Organizational equipment except that required by ATC at Kwajalein to the Zone of Interior.
4. Common user Air Corps Items not required by ATC to be shipped to HAD

It was also agreed to turn over to ATC on Kwajalein all Aviation Class IV-E C-54, and other items which the Air Transport Command might desire or require.[78]

On 15 July a conference was held on board the USS Mt McKinley on the requirements of Test CHARLIE. At that time it was stated that the Army Air Force's ground group would have to become operational on Kwajalein by 15 January 1947 and that the air group would be reduced, somewhat depending on the requirements of the Task Force Commander.[79] That conference altered the plans of Task Group 1.5 for withdrawal in two ways. First, it meant that some property which would otherwise have been shipped back to the United States would have to be stored on Kwajalein. Second, the storage of this property on the island would require the presence on

*General Blakelock had reverted to rank of Colonel.

Kwajalein during the intervening months of an Air Force custodial detachment to maintain the photographic laboratory and the general security of the other property. It was estimated that the detachment would consist of fifty-two officers and enlisted men.[80]

At the same time the Deputy Task Force Commander for Aviation, General Kepner, was faced with the responsibility for the orderly return to home base of the Army aircraft under his command. On 26 July, the day after BAKER DAY, General Kepner issued his orders to General Ramey, and directed that all aircraft should have the hundred-hour inspection before their departure from the overseas base, and that the route home would be Kwajalein-Hickam-Fairfield-Home Base via the shortest route. Kepner specified that layovers would be at Hickam and Fairfield for maintenance and crew rest, with all landings in daylight. He fixed the rate of return at four aircraft daily with the departure of the drones determined by Radiological Safety personnel, and the departure of all other aircraft when released by the Commander, Joint Task Force ONE.[81]

Nearly a month prior to BAKER Day a special plan had been conceived for the return to the United States of the Drone and Drone Control Aircraft which was given the code name of Operation REMOTE. On 29 June 1946, General LeMay, who was then in the theater of operations for Test ABLE, had verbally requested Colonel Alness to draw up a plan for the radio controlled flight of two B-17 drones from Hawaii to Muroc Army Air Base, California. On 7 July Colonel Alness forwarded to General LeMay a written proposal for Operation REMOTE. He recommended that all technicians of Task Unit 1.5.3, enlisted men and officers, be sent to Hickam as soon as possible after BAKER Day. There the technicians were to prepare for the take-off of the drones by remote control from Bellows Field or Hilo, on Hawaii, both of which offered excellent facilities for such an operation.[82]

Take-off from Hawaii would be so timed that there would be sufficient light for an emergency return to the point of departure if necessary. Once the six planes were airborne, and safely on their way, all ground control equipment and operating personnel were to be loaded aboard two C-54's.* Since experience had taught that there was little difficulty with the instruments after a flight was well under way, the two C-54's were to keep within monitoring distance of the drones for two hours. After that, the cargo planes were to proceed to Muroc at greater speed in order to arrive ahead of the drones,[83] and so ready the ground control equipment for a remote control landing.**[84]

Colonel Alness hoped that it would not be necessary to spend any length of time in Hawaii. In order to avoid this he decided that all modifications for the trans-ocean flight should be made at Eniwetok before leaving the Marshalls. The requisite changes were neither extensive nor technically difficult, but they consumed hours. Television and transmitter units had to be installed to permit dual control of each drone on different frequencies. This provision would insure longer life and more efficient operation of both sets. Alness saw to it that the work was so expedited as not to interfere with the BAKER Day missions of the control and drone aircraft.[85]

*Alness pointed out that the airlift of the supporting personnel and ground equipment would require two C-54's, thereby providing duplicate facilities in case of a transport abort.

**The equipment consisted of four power units and four jeep trailers with control stations.

It was expected that the flight would require fourteen and a half hours. This fact caused some concern since six hours was the longest period of drone operation up to that time. The additional hours were therefore considered an important and unknown factor in the experiment.[86]

The plan as submitted by Colonel Alness was approved, and 21 July Headquarters Task Group 1.5 issued Field Order No. 3 setting forth the objective and plan of Operation REMOTE. It provided that two GREEN HORNET C-54's were to fly from Kwajalein to Eniwetok, arriving 1100 on 1 August. The two C-54's and seven B-17's of Task Unit 1.5.3 were then to leave Eniwetok between 1900 and 2000 on 2 August, arriving at Hickam at 1430 on 2 August and the drones and controls were to be moved to Bellows or Hilo Field prior to 5 August. The flight from Hawaii to Muroc was scheduled to be mounted, weather permitting, 5 August at 1700.[87]

Operation REMOTE was executed as planned.[88] Historically it was another step forward in the long development of guided missiles. The Operation was directly under the control of AAF Headquarters, but it was nevertheless an important part of the roll-up of Task Group 1.5.[89] The evacuation of other Air Force units, including personnel and aircraft,[90] proceeded smoothly,[91] and was greatly assisted by the GREEN HORNET flights.[92] The latter maintained regular schedules until 17 August.[93] The evacuation of Kwajalein was equally swift, and Headquarters TG 1.5 opened at Fort Worth Army Airfield on 7 August.[94] Thereafter there was only a Forward Detachment on Kwajalein,[95] intended to remain there during the interim to Test CHARLIE.[96] The ground echelon returned to the United States by ship.[97]

Meanwhile, the roll-up of the other task groups and of Task Force Headquarters had begun. On 17 July General Kepner took the preliminary steps to prepare his Air Staff for a return to Washington as soon after BAKER Day as possible. He desired to hasten the completion of final reports.[98] Most AAF officers with JTF-1 Headquarters reported for duty in the Navy Department, Washington, on 12 August. As the work of writing the various reports was completed, Air Staff personnel were released and reverted to the units of origin.[99]

Just at the time when Army Air Forces participation in CROSSROADS seemed practically ended, a new crisis arose. On 8 August Captain Paul Foley, USN, the ranking member of the Air Operations Section remaining on the flagship, reported that the sailing of the USS Haven from Bikini had been cancelled. That seemed to mean additional air transportation for the 200 civilian scientists and technicians whose return to the United States by 1 September had been guaranteed, and who were scheduled to sail with the Haven.[100] After much discussion,[101] the problem was solved by transferring 150 of the civilians to the USS Henrico which sailed 15 August, and by appealing to Headquarters AAF to extend the Air Transport Command flights to airlift the other fifty scientists. It was therefore not until 1 September that ATC could terminate its CROSSROADS activities.[102]

After the return of JTF-1 to Washington, MANHATTAN District, the Army, Navy and the Joint Task Force agreed that Test CHARLIE should be cancelled, at least for the time being. On 9 September the President issued orders that the third shot should be "indefinitely postponed." Admiral Blandy thereupon determined to end all further CROSSROADS activities as soon as possible, but consistent with the procurement of the desired scientific data and safeguarding of such target vessels as might be of future value. The J-4 Division had the problem of disposing of ships and material still held in the Forward Area in anticipation of the third test. It was decided to leave all the photographic towers in place as well as the mooring on the southwest islands for possible future use. Such material and equipment as was taken away was entrusted to COMSERVPAC for disposition.

On 16 September 1946, Task Group 1.5 ordered its personnel left in the Forward Area with the Forward Detachment to be returned to their permanent duty stations as soon as the material for which they were responsible had been disposed of according to instructions.[103] All the property left by TG 1.5 on Kwajalein was then released to the Commanding General, Army Air Forces, who was offered assistance by Joint Task Force ONE in effecting distribution by water.[104]

The last days of Joint Task Force ONE dragged through September and October. The number of Army Air Force personnel associated with CROSSROADS shrank rapidly. There was, however, still much desk work to be done, and the Temporary Duty Orders of the enlisted men in General Kepner's office had to be extended an addtional sixty days to supply the necessary clerical help required at the end.[105] Task Group 1.5 was inactivated 16 September,[106] and General Kepner left the Joint Task Force for his new assignment 26 September.[107] Only a few Army Air Force officers and enlisted men remained on duty with the Task Force after that date to complete the Report to JCS.

The Joint Task Force itself was inactivated, or "dissolved", 1 November 1946. Its unfinished technical reports and other residual functions were completed by a Joint CROSSROADS Committee, established at the Navy Department under the direct control of the Joint Chiefs of Staff.[108] This committee finished its work 1 June 1947. Since there was a continuing need for review of CROSSROADS photography for security classification a special Photography Panel, originally part of the

Committee, continued to perform its duties under the direction of the Armed Forces Special Weapons Project.[109]

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Chapter XI

AAF EVALUATION OF OPERATION CROSSROADS

Undoubtedly Operation CROSSROADS marked a radical improvement in the Air Force position within the atomic program despite the misfortune of ABLE Day. The change showed in many ways: better AAF-MANHATTAN relations; a general acknowledgement that the atomic bomb of 1946 was essentially an Air Force weapon; new concepts of offensive and defensive atomic war as functions of air power;* and mastery by AAF personnel of many techniques that would be the stuff of tactics in atomic strikes.

The transformation of AAF from the status of an atomic delivery agency to that of an atomic service came gradually, if thought of within the time span of CROSSROADS. But the shift came with the suddenness of revolution if seen within the four-year period of 1943-1947, the "era" of SILVERPLATE.

Obviously CROSSROADS as executed was far more complex than its sponsors originally had conceived. Intended at first only to discover the effects of an atomic blast on naval vessels, the program expanded to include the numerous scientific and military tests supported by MANHATTAN District, the Navy, the Army Ground Forces, and the Army Air Forces. The expansion was welcome, but did not alter the fact of naval predominance, something that the public understood quite well. 1

[redacted]

*These concepts were shortlived. CROSSROADS had scarcely passed into history when improvements in the design of atomic bombs offered the prospects of small sized weapons that could be employed against tactical targets and which, therefore, meant that both the Army and the Navy, as well as the Air Force, would employ nuclear bombs. The development of these additional bomb models, of course, is a subject of great importance, and has been treated with detail in Volume IV.

The extent of the Navy's contributions to CROSSROADS was impressive. The facilities of the Task Force were largely naval; the personnel was 90 per cent naval; and the Target Array was entirely naval though serving as a laboratory for all the participating agencies. In addition the Navy sent to CROSSROADS a number of officers, chief among them being Admiral Parsons, who had worked well with MANHATTAN during the war and who had acquired a valuable knowledge of nuclear physics and nuclear weapons.[2] Moreover, in 1946 the Navy possessed three scientific agencies of recognized standing--the Naval Research Laboratory, the Naval Bureau of Development, and the Office of Naval Research--all of which were helpful in quickly winning the confidence of MANHATTAN and academic scientists with whom the military shared CROSSROADS responsibility.[3]

In contrast the Air Force was still a Johnny-Come-Lately from the viewpoint of MANHATTAN's inner circle, and from the viewpoint of academic scientists as well. Not yet an independent service, though separation from the Army was unquestionably pending, AAF had relatively small investments in scientific projects, and few officers versed in nuclear physics or nuclear weapons. ~~[illegible]~~ Some AAF officers chafed against the atomic dependence of the Air Force "upon outside engineers and scientists," but their discontent, no matter how rightful, could not be relieved by edict.[4] Nothing less than wise policy and patient labor could break the disadvantages of 1946.

Headquarters itself, quite aware of the problem, remained cautious. The Air Force took up its operational tasks for CROSSROADS in much the same way that it had prepared for the delivery of atomic bombs during the war. But there was hope, and it was justified by events, that the 1946 expedition would ~~mitigate~~ rectify the balance sheet. On 4 April General LeMay expressed the current attitude of AAF toward CROSSROADS when he counseled patience and said:[5]

> At the present time....we must go slowly on this thing to assure that no mistakes are made and try to accomplish one thing at a time. The Air Force must be particularly careful not to insist on action or responsibilities which might affect the general security policies. Due to the general lack of information in the Air Forces concerning the technical problems of employment of this weapon, we are not in a very good position to submit specific recommendations at the present time.

LeMay's comments give added importance to the training of the eleven AAF officers as bomb commanders and weaponeers which was part of the Arnold-Groves agreement of 13 March. At the same time AAF took another long stride toward atomic competence by establishing a working level liaison with MANHATTAN for the direct exchange of ideas in the future.* These concessions obtained as a result of CROSSROADS, combined with what was hoped would be a demonstrable delivery capability, seemed most promising as ways of overcoming the cumbersome disadvantages inherited from the war.

Unfortunately neither the philosophy of caution nor the best laid plans could save the Air Force from the embarassment of the ABLE Day shot. Despite the well known poor ballistics of the FAT MAN, AAF gave an almost unqualified promise to drop the bomb within a tolerance of 500 feet, and the failure to do so was a shocking experience. It was somewhat late to point out the ballistic shortcomings of the weapon and to claim malfunction of the bomb. The explanation, though valid, was viewed "with a certain amount of skepticism by tongue-in-cheek critics." [6]

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*Col Leo V. Harmon was chosen to conduct the liaison work, and he was then assigned to the 58th Wing specifically for that purpose.

Though the Air Force could not look back with pleasure on the ABLE Day shot, [redacted] the mishap was not without some beneficial effects. After the investigation and the final word from Aberdeen, the Air Force could and did insist upon a weapon with better ballistics. In course of time the requests for improvement led to Los Alamos recognition "that the error of the magnitude involved was very possible with the Bikini bomb configuration." 9 It did not then require much time for the necessary changes in outer design, and surprisingly soon the stockpiled bombs were ballistically far superior to those of 1945 and 1946.

Less correctable was the loss of scientific data that resulted from the ABLE Day miss,[7] and its detraction from the value of the Scientific-Military Tests.[8] The sense of privation was aggravated by another failure for which the Air Force was in no way responsible. The technicians on the USS Cumberland Sound, charged with the electronic coordination of many diverse parts in the general system of instrumentation, failed to send the proper timing signals for cameras. The mistake created considerable confusion in the photographic aircraft. In part, the error was remedied by a late resort to the Manual Control Plan, but the Fastex photographs of the ABLE burst, which would have been of great scientific value, were not obtained.

Of course the inability of the Task Force to collect all the data anticipated was a disappointment, but should not be interpreted to mean that the total results of ABLE Day were negligible. On the contrary, reports based on this shot became a vast treasury of knowledge, though less than had been hoped for.* Admittedly the contributions of BAKER conformed more nearly to prescriptions, but that was to be expected because the novelty of the operation had diminished, mistakes were less likely, and the entire complex was much more easily controlled, and therefore less subject to the unexpected.

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*At TRINITY there was some instrumentation to test the pressure and heat radiation of the bomb, and a photographic record of the blast. But TRINITY was much less a scientific laboratory test than CROSSROADS, and the same is true of the Hiroshima and Nagasaki drops. The first important program of instrumentation was at CROSSROADS. That is why its mishaps were so unfortunate.

In 1946 the scientists were deeply interested in weapon efficiency, or the ratio of the total number of fissions in the bomb to the total number of fissionable atoms originally present. Of almost equal importance to the scientists was the yield of the bombs expressed in terms of TNT explosions per ton. These two problems consituted the heart of the Military-Scientific Tests which depended upon the instrumentation.

In all, there were 500 scientists and technicians, assisted by an equal number of enlisted and civilian aides required to operate the instruments. The scientists planned the instrumentation program and directed the many work parties which set up the instruments. The only thing that saved the ABLE Day program was the early fear that there might be a bombing error, a number of unexpected blast effects, or mechanical failures within the instrumentation system. To provide against such contingencies, the planners duplicated many tests, and overlapped instrument ranges far more than would have been necessary ordinarily. This precaution meant the use of large numbers of instruments. In Test ABLE there were 200 cameras, 850 ball crusher gauges, 300 five-gallon cans, 400 photographic badges to measure radiation, and 5,000 suphur capsules. These duplications were amply justified in view of the bombing error and the Cumberland Sound failure.

Report of the Technical Director, Dr R.A. Sawyer, 1 Dec 1945, pp 1-3.

Of much greater importance to the Air Force than a full-garnered record of ABLE Day could have been, more important indeed than the satisfaction of a successful bombing, was the overall evaluation of the bomb as a weapon. Upon this question depended the immediate determination of service atomic responsibilities, and on this question, as on few others, CROSSROADS afforded sharp conclusions. Even on ABLE Day sufficient data remained after the eccentricity of the air drop and the inadvertence of Cumberland Sound technicians to trace a gradation of damage on exposed equipment and ship structures.[10] It was possible also to decipher the penetration of radioactivity,[11] mark its intensity throughout the Target Array and the surrounding waters,[12] and diagnose its effects upon the operational worthiness of surviving vessels.[13]

The Army, Navy, and Air Force had each a different standard of combat values when considering the atomic bomb, but in their interpretations they relied upon the same body of results, and their conclusions were by no means dissimilar.

The first fact of strategic significance for all three services was that the air detonation had neither sunk nor incapacitated many of the sixty-seven ships in the Target Array. What its effect would have been with accurate delivery was still uncertain. In striking contrast, the effects of the underwater blast were indisputable. Whereas the ABLE Shot sank only two destroyers, two transports, and the Japanese cruiser Sakawa, the BAKER Shot was havoc. It obliterated the USS Arkansas instantly; and it sank the aircraft carrier Saratoga, the Japanese battleship Nagato, three submarines, a concrete oil barge, a 120-foot landing craft, and a concrete floating drydock; also, it seriously damaged two other battleships, a cruiser, two destroyers, two APA's, and an LST.[14] However, vessels located no more than one-half mile from the BAKER target center received no deformation of structure due to the absorption of shock by water.[16] In both shots the surviving ships were blinded by wrecked radars and radios. And in both shots the vicarious sacrifice of animals indicated that crews, had they been present, would have been seriously wounded by flashburns, and infected with radioactive contamination.[15]

The three services were also interested, but to a less degree, in the effect of the shots on their exposed equipment. Among the items placed on board the target ships were trucks, tanks, weapon carriers, amphibious DUKWs, and airplanes. Guns, mortars, rocket launchers, rifles, torpedoes, mines, depth charges, bombs, fuzes, grenades, flares, telescopes, and periscopes were also exposed, as well as clothing and supplies. Combustible materials caught fire up to distances of two miles from the center of the explosions. In many instances trucks and airplanes were demolished, and weapons exploded.[18]

Major General A. C. McAuliffe, USA, speaking for the Army, interpreted the results of CROSSROADS to mean that the atomic bomb, as it then existed, had little tactical value. He said that in World War II there was only one situation, the landing in Normandy, when such a weapon could have been used tactically, and that would have been by the enemy. Had the Germans possessed the bomb in June 1944 OVERLORD could have been turned into a disaster for the Allies. McAuliffe foresaw that in an atomic war of the future, ground forces might follow an air-delivered atomic attack to occupy and hold strategic points, but the nature of ground operations would not be changed greatly from those of 1939-45. "In the new atomic age," he said, "the principal avenue of attack against any nation will be the Air, not only for bombs and guided missiles, but also for combat troops and for weapons and supplies to support them."[19]

The Navy's reading was similar but less succint.

Thinking defensively, there was general agreement that Bikini showed the need for some change in ship characteristics to insure greater protection during an atomic attack. There should be a toughening of masts, stacks, and electronic equipment to withstand the blast of an air-drop detonation. And there should be greater hull strength to meet the shock of an underwater attack. Regardless of the nature of the attack, there should be additional security for personnel against the peculiar hazards of atomic warfare. But none of these measures would be needed until, in future years, enemy nations possessed atomic weapons. Consequently there was no requirement for overnight alteration of ship designs.[17]

Thinking offensively, the Navy rejected the idea of some officers that the bomb "was just another weapon." Its yield alone, the most powerful force under human control, put the bomb in a category all its own. Nevertheless, as the bomb existed in 1946 it was of little tactical significance for naval warfare. Fleets could be too widely dispersed to become a single target, as the ABLE Day shot had proved. And a single ship as target could not deserve the expenditure of a FAT MAN bomb under ordinary circumstances.[20] Nevertheless the BAKER Shot had shown that an atomic bomb, if designed for delivery within the capability of the Navy, could be significant, and this idea held great possibility for the future.

The Air Force, knowing quite well that the ABLE Day fiasco, whatever its cause, did not signify inability to deliver the weapon, had already gone on record that the bomb was strategic in nature. It should be employed only against strategic targets and, since the Air Force alone possessed the means of delivery, it should be considered as an Air Force weapon. Operation CROSSROADS strenghtened these opinions,

The Air Force viewpoint was supported by most of the official observers sent to Bikini, whether they were Air Force representatives or not. It was generally concluded that the bomb should be employed only against militarily strategic targets such as national centers of activity.[21]

With a sufficient supply of atomic bombs, it seemed likely to the observers that the populated areas of the earth could be annihilated, provided of course that the bombs could be delivered at the right time at the right places. In view of the existing technical inadequacy of guided missiles, and the probably protracted development of these instruments before reaching a stage of practical service, it appeared that the airplane alone could be counted upon to deliver the bomb as needed. This in turn meant that the atom bomb would have to be considered as primarily an Air Force weapon.[22]

The concensus that the atomic bomb was primarily a strategic weapon gave the Air Force a strong argument. Regardless of how atomic energy might be developed in the future, it was claimed that as of 1946 it could only be used to improve the ~~efficiency~~ effectiveness of Air Force strategic bombing.[23] Some Air Force general officers at once drew up a list of targets, in the order of their priority, against which the bomb could and should be used in case of war. First came factories and transportation centers, [redacted]. Next in rank were air installations, ground installations, and naval bases. Troop concentrations, combat materiel, and naval vessels were placed at the bottom of the list.[24]

So much talk about the use of the bomb as a strategic weapon to be delivered by air led inevitably to discussions of the problem of defense against an atomic attack by some hostile nation. The enemy's springboards, it was said, should be destroyed before he could strike. To do this would require the possession of forward bases for offensive and counter offensive measures.[25] In addition it was thought that all friendly Air Force ground installations should be scattered, and that as much industry as possible should be located under ground.[26]

In addition to all these opinions, there was the considered judgment of the Evaluation Board appointed by the President. The Board's report was submitted 30 June 1947 to JCS, and presented twenty-two "conclusions", four of which were particularly applicable to the situation as it existed in 1946 and 1947, and they are here quoted in full.[27]

1. If used in numbers, conceded to be obtainable in the foreseeable future, atomic bombs not only can nullify any nation's military effort, but can demolish its social and economic structures and prevent their re-establishment for long periods of time. With such weapons, especially if employed in conjunction with other weapons of mass destruction as, for example, pathogenic bacteria, it is quite possible to depopulate vast areas of the earth's surface, leaving only vestigial remnants of man's material works....

5. There must be national recognition of the probability of surprise attack and a consequential revision of our traditional attitudes toward what constitute acts of aggression so that our armed forces may plan and operate in accordance with the realities of atomic warfare. Our policy of national defense must provide for the employment of every practical means to prevent surprise attack. Offensive measures will be the only generally effective means of defense, and the United States must be prepared to employ them before a potential enemy can inflict significant damage upon us....

8. No weapon can be more effective than the means used to bring it into action against the enemy; hence the necessity for the coordinated development of atomic weapons and weapon-carriers and their integration into a series of devices, each with a tactical or strategic purpose. In the category of weapon-carrier may be included any means of ultimate delivery such as aircraft, guided missiles, rockets, torpedoes and mines of all types....

21. Dominance in the ability to wage atomic warfare, the loss of which might be fatal to our national life, can be retained only by unflagging effort to hold that leadership in science and engineering which made the atomic bomb possible. A vital part of the national defense must be not only a program of scientific and engineering research and development in every field involved in bomb production and tactical use, but in basic science as well. Such a program requires periodic tests of atomic weapons.

Thus the concept of what atomic war would involve came to be more clearly envisioned as a result of CROSSROADS.

From the tactical view of operations, AAF also gained some new ideas. Neither the practice drops at Roswell nor on Erik Island, nor the ABLE Day drop could be ignored. It was concluded by those who were most experienced in atom bombing that the technique of dropping only one bomb at a time was outmoded. Four new methods of atom bombing were suggested as being probably sufficient for the immediate future:

1. A single aircraft dropping a single bomb to terrorize the civilian population and to destroy small targets totally.

2. A single aircraft carrying two or more bombs, to drop one bomb on one side of a city and in turning away to drop the second on the other side of the city. It was felt that with the greater altitude and bomb carrying capacity of the B-36's, two bombs could be handled without difficulty. It was believed that the yet faster B-40's would be able to release bombs from straight flight and still be safe.

3. A formation of several aircraft could bomb large areas such as great cities. It was recognized that metropolitan areas would be well defended, and loss of some aircraft would have to be accepted. However, with the use of jet propelled fighter protectors, some of the bombers would certainly get through, and could paralyze a wide area.

4. If some major objectives within an area escaped destruction during the attack of several aircraft two or more aircraft could follow up and bomb the area indiscriminately.

If at any time in the future there should be need for very accurately placed atom bombs, the ballistic winds would have to be calculated during the run. It was foreseen that this could be done by releasing a trial bomb and tracking it by radar.[28]

Furthermore, the actual technique of bombing, as a result of the practice both in the United States and in the Pacific areas, was advanced beyond the expectation of the bombardment experts. Despite the ABLE Day mishap, the over-all accuracy obtained by the four crews as final contestants for the privilege of dropping the bomb, approximated artillery fire at comparable ranges. The development of radarscoping techniques, crew techniques, and over-all bombing techniques was noteworthy.[29]

The CROSSROADS test was a valuable experience for the Air Force in a number of other ways. Certainly much was learned about the logistical problems that would always be associated with the employment of atomic bombs, and there was practice in handling the special equipment that went with the bomb.[30] In photography and electronics CROSSROADS contributed a great deal to the Air Force, and in each field the progress was so great that a more detailed account of the results is fitting.

The experiences acquired by the Army Air Force Photographic Unit of Joint Task Force ONE carried forward the science of technical photography in a single leap, which ordinarily would have required several years to achieve.[31] Over 300 cameras, ranging from 16 mm motion picture cameras to a huge aerial still camera with a 48-inch telephoto lens, the largest ever used in an aerial camera, were airborne during the tests. There were over forty high speed cameras, timed to take the first few seconds of the blast. These Fastex and Eastman cameras were capable of taking pictures at the rate of 4,000 frames per second, a prodigious rate when compared with the twenty-four frames per second of the ordinary motion picture camera. The result of the Fastex camera was a very slow motion when projected at the normal rate. These cameras could "retard a bullet to a walk or make a singer's vocal cords vibrate slowly." With such equipment, the most advanced available in 1946, it would have been possible to get a record of the ABLE Day burst broken down into millionths of a second except for the incident of the <u>Cumberland Sound</u>. Other specially designed motion picture cameras were developed by Wright Field to photograph under extreme conditions of low temperature and low pressure. They were installed in F-13 aircraft. In one of these planes an operator could train nine cameras at once on any spot he desired by using the Remote Fire Control System of the B-29. Through different types of films, lenses, shutters, diaphram stops and filters, it was possible to get nine different effects. Each of the other seven Air Force Photographic Aircraft could obtain further variety in the nature of the photographs taken. This method was thought to be necessary because prior to the Bikini tests no one knew how much light to expect or how it would affect the film.[32]

The participation of the Army Air Forces in the electronics part of the experiment was also very extensive. Most of it was concerned with determining how much and in what way the atomic detonation and resultant cloud would influence radio and radar operations, propagation and reflection. Perhaps the most interesting phase of the electronics study was the use of remote-controlled B-17 drones to gather air samples and data.[33] The Drone Unit produced amazing results, and both ABLE and BAKER Day operations were nearly perfect. As a result of the experience gained and equipment developed, the Guided Missiles Program of the Army Air Forces was "advanced from three to five years over its normal progress." Personnel of the unit, upon their return to the United States, were screened so that the greatest possible number of them might be assigned to Eglin Field to become the nucleus of the first Guided Missiles Group.[34]

The work done by Remote Measurements, Technical Group VIII of the Military-Scientific Tests, was more important than has generally been acknowledged.* True, the seismological and tidal measurements did not promise much for long distance detection, but valuable data was obtained by the use of Geiger counters at many stations, both at the surface of

*As reported in Enclosure E of the Report of the Technical Director, Operation CROSSROADS. The subject is treated more fully in the chapter on Long Range Detection in Volume II of this History.

the earth and at high altitudes. The instruments obviously needed to be more sensitive, but it was evident that with proper equipment a large atomic explosion could be detected half way round the world. Although the Air Force played a small part in the work of Technical Group VIII, the experiments proved the feasibility of a permanent Long Range Detection program, a project which eventually came under USAF control.

A final point must be made for Air Force contacts with the non-military personnel of the Task Force. In the half-year that followed January or February 1946 AAF made appreciable gains in winning the confidence of many scientists and industrial representatives assigned to the operation. Antagonisms—perhaps "prejudices" would be a better word—dating from World War II slipped into the past and were largely forgotten in the day-to-day work of planning common experiments. 36 Nor were the associations unimportant that developed in the course of innumerable civilian-military flights across the continent, across the Pacific, and, as happened so often, in yet longer flights across both the continent and the Pacific. Operation CROSSROADS went far toward launching the Air Force on the "permanent program of research and development" visualized by General Arnold in 1944. There was still much to be done, of course, especially in the field of public relations,* 37 but the Air Force made great strides in overcoming the disadvantages that prevailed when the 1946 atomic tests began to take shape.

*There is ample evidence that by August 1946 Headquarters AAF was keenly aware of a better functioning public relations program. Indeed that fact was doubtless among the "lessons learned" from Operation CROSSROADS.

In summary, despite the ABLE Day shot, Operation CROSSROADS appears to have been a turning point in the history of Air Force participation in the national atomic energy program. The TRINITY Shot had been purely a weapons test. The two drops over Japan were combat operations in which AAF had only delivered the bombs. But at both the ABLE and BAKER shots the Army Air Forces did more than routine operational activities. The first steps were taken to train Air Force personnel in the technology of the atomic weapons; more personnel were trained in the technique of dropping the bomb; and good contacts were made with the Los Alamos group. What was even more important, Operation CROSSROADS led to the open expression of a latent doctrine that the weapon could only be delivered by a B-29, and other type AAF aircraft under construction. In the interest of national security, the time had come for the Air Force to press its claims even though the all-important issue of unification had not then been settled.

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Chapter XII

THE END OF PROJECT SILVERPLATE

When Operation CROSSROADS was concluded the time was almost at hand to finish Project SILVERPLATE. It had begun in 1943 to provide the modification of a few B-29's needed to drop the first atomic bombs on Japan. The code word was never officially authorized and so it was never included in the United States Joint Services Code-Word Index, JANP 299. Consequently, the word came to be somewhat loosely used. Thus, in the course of the war, SILVERPLATE came to signify not merely the modification of the B-29's needed to drop the bombs but the whole effort which AAF put into the atomic energy program such as the build up of the 509th Composite Group. After the war the term remained undefined, and although SILVERPLATE was never used to designate AAF participation in CROSSROADS, the term was employed to signify the AAF effort which progressed in a parallel fashion with the operation. Therefore, when CROSSROADS terminated SILVERPLATE was still a functioning AAF project ~~but~~ even though the word remained without official sanction.[1]

The scope of the modification program itself expanded constantly from September 1943 until the early months of 1947. At first there was just one hand-modified B-29 at Wright Field. Then the order went out to modify three others. Soon the total was increased to fifteen and then to twenty-four--to twenty-five including the hand-modified plane. In February 1945 the total was again increased, this time to forty-nine, to be completed by September. But that was not the end. In April 1945, SILVERPLATE plans called for modification of fifty-four B-29's. By September, however, only forty-six had been modified, and for a short time after the cessation of hostilities no furthur modifications were begun.[2]

Then, in the first few months of peace, when AAF began to plan for an atomic striking force, more thought was given to SILVERPLATE. Twenty-two of the modified aircraft of the 509th Composite Group were placed in the Oklahoma City Air Materiel Depot, December 1945, for installation of the MX-344 radar computer, more easily removable engine cowling, and other miscellaneous items which improved the performance of the planes.[3]

Such was the situation as regards Project SILVERPLATE when it was necessary for the Army Air Forces temporarily to forego the organization of an atomic striking force and concentrate on Operation CROSSROADS. In connection with the new plans, Headquarters AAF directed AMC, 30 January 1946, to assign the first eight B-29 SILVERPLATE aircraft then being modified at the Oklahoma City Air Materiel Area to CROSSROADS. However, early in February 1946 the number of SILVERPLATE aircraft for CROSSROADS was increased from eight to ten, and in addition seven unmodified B-29's were ordered to Roswell for training purposes. All of the ten SILVERPLATE B-29's were delivered to Task Group 1.5 at Roswell by 27 February. Two of these were damaged beyond repair in a taxiing accident 1 March, but they were replaced by the Oklahoma City Air Depot. On 10 February it was decided at Roswell to take nine of the ten SILVERPLATE aircraft overseas, and these included five bomb-carrying planes and four others to be used as pressure gauge aircraft.[4]

Support of the Oklahoma City Air Materiel Area B-29 modification project, which was intended to improve the performance capabilities of the initially modified aircraft, involved unusual supply actions. Also, the proposed employment of these SILVERPLATE B-29's on CROSSROADS necessitated the installation of numerous special devices, instruments, and communications equipment not previously anticipated at the time the to Sacramento ~~[illegible]~~ as a model.[9]

On the original SILVERPLATE ~~modification~~ project, conducted at the Glenn L. Martin-Nebraska Company in 1944 and 1945, it was found necessary to make many on-the-spot deviations. This circumstance made it necessary for the Sacramento Air Materiel Area to re-engineer practically the entire installation with the assistance provided by the Engineering Division Coordinating Office for the MANHATTAN Project. In order to assist the depot further, a representative of the MANHATTAN District, Sandia Base, was sent to the Sacramento Air Materiel Area.[10]

The SILVERPLATE engineering information supplied by the Engineering Division to the Maintenance Division included many items "dictated by the strategic situation" and the developmental stage of the special weapons at the time the project was current. New developments resulting from the usage of SILVERPLATE aircraft required continual change in the modification program at Sacramento. These changes caused many delays in accomplishing the work. Also, difficulty was encountered in providing required parts through normal supply channels.[11] The supply support story of this project was "largely one of hundreds of emergency actions one after another together with large expenditures of overtime labor."[12]

In September 1946, after CROSSROADS, work was started by the CROSSROADS bomb commanders and weaponeers, on temporary duty at Kirtland Air Force Base, and Major Roark of AMC to standardize further the installation of the SILVERPLATE modification. Personnel of the Los Alamos Scientific Laboratory and the Sacramento Air Materiel Area participated with Air Force personnel in working out a "cleaner" modification. Many circuits and instruments designed and installed primarily for the CROSSROADS tests were eliminated.[13] Subsequently, Major Roark prepared modification ~~specifications~~ drawings for any bombardment aircraft then in use or for future use.[14] However, as late as December 1946 the AMC Engineering Division Coordinating Officer for the MANHATTAN Project stated that the SILVERPLATE modification was undergoing continuous review for the purpose of general improvement and simplification. For this reason any available modification data at the Air Materiel Command at that time could not be considered final.[15]

The full extent of SILVERPLATE modification program in its maximum accomplishment is indicated by the following table showing the number of modified aircraft in existence at the end of 1946 and the early months of 1947.[16]

a. Forty-six B-29's had been modified as SILVERPLATE aircraft with location and serial number as indicated.

(1) Sixteen operational aircraft at Roswell Army Air Force Base

44-27298	44-86346 BIG STINK
44-27300 STRANGE CARGO	44-86347 LAGGIN' DRAGON
44-27301	44-86382
44-27302 STRAIGHT FLUSH	44-86383
44-27304 UP AN' ATOM	44-86384
44-27353 GREAT ARTISTE	44-86430
44-27354 DAVE'S DREAM	44-86432
44-86291	44-87472

(2) Two B-29's at Oklahoma City Materiel Command Depot.

44-27299, NEXT OBJECTIVE, operational, awaiting delivery to SAC

44-86431 awaiting storage and removal of SILVERPLATE equipment

(3) Five aircraft at Kirtland Field, operational, for use by MANHATTAN

42-65324	42-65386
42-65384	44-27285
42-65385	

(4) One aircraft, operational, 42-76259, at Fort Worth Army Air Base.

(5) Eighteen aircraft were in storage in the following depots, and, according to AMC records, had already been stripped of SILVERPLATE equipment. These aircraft were the initial planes delivered to the 509th Composite Group, and lacked the more advanced modifications being used by 1946 such as fuel injection, solar collection rings, winker type bomb bay door, and bomb bay heatings.

(a) Seven at Davis-Monthan, Arizona.

42-65209	42-65239
42-65235	42-56260
42-65237	42-65264
42-65238	

(b) Seven at Pyote, Texas.

42-65216	42-65261
42-65236	42-65263
42-65240	42-65258
42-65259	

(c) One, 42-65217, at Victorville, California.

(d) One, 42-65262, at Warner-Robbins Air Materiel Command Depot.

(e) Two at Davis-Monthan Field, Arizona, for delivery to the Army Air Forces Museum.

44-27297 BOCK'S CAR; 44-86292 ENOLA GAY

b. Four aircraft had been salvaged and AMC records indicated SILVERPLATE modifications had been removed prior to reclamation.

(1) 42-65287 at Kirtland Field, as of 12 March 1946.

(2) 44-27296 at Roswell Field, 9 April 1946.

(3) 44-27303 washed out at Chicago, with reclamation complete, 31 October 1945.

(4) 44-86473 at Roswell, reclamation completed 9 April 1946.

c. Nineteen new B-29's were being modified on Project DOM-515. Sixteen serial numbers had already been chosen and the others were to be supplied within a short time.

45-21736	44-86444
45-21739	44-86445
44-86401	44-86447
44-86437	44-86448
44-86439	44-86451
44-86440	44-87752
44-86443	44-87771
45-21818	44-87774

By April 1947, Colonel J. R. Sutherland reorganized and revised somewhat the statistics presented above in an excellent summary of the state of SILVERPLATE as of that date. Forty-six B-29's, he stated, had been modified and nineteen others were in process of modification. Of the forty-six previously modified, twenty were still being used by the 509th Composite Group. It was pointed out that five of the aircraft had crashed, one had been seriously damaged in a fire but was awaiting repair, and one was being used as a mock-up for further standardizations of SILVERPLATE. Four were at Kirtland Field being used by the Flight Test Section, and two were in the museum at Davis-Monthan. The remainder had been or were being stripped of their SILVERPLATE equipment.[17]

Meanwhile, there were some who felt that because SILVERPLATE had never been given official approval and had never been included in JANP 299, there had come about a serious problem in security. Within the SILVERPLATE Program there were projects of several categories which varied in classification from RESTRICTED to TOP SECRET.[18] The problem of classification became all the more important by the spring of 1947 for by that time it was estimated that 8,500 AAF personnel were required to have access in one way or another to SILVERPLATE material which was considered RESTRICTED DATA. On the other hand, of that total, 6,500 had access only to the special modifications of the aircraft to carry the bomb. So, in view of the sudden burden placed upon FBI with the need to have Q clearances for thousands of persons throughout the United States, it was believed to be necessary to discard the word SILVERPLATE and to give each of its component activities a separate code word with its own classification.[19]

Such in general was the situation in the spring of 1947 which prompted Washington to notify the Air Materiel Command, 12 May, that because the code word SILVERPLATE had been compromised it was to be discontinued. The new code word SADDLETREE was officially assigned at that time to cover the overall modification of the B-29 aircraft necessary for the transport of atomic bombs.[20] Although no more SILVERPLATE modifications were begun after May 1947, these B-29's did not immediately become obsolete. They were capable of carrying the already stockpiled FAT MAN bombs and it was felt as late as September 1949 that the SILVERPLATE aircraft could still be used for combat in an emergency, and that they would be of great value in the ferry plan already devised whereby atomic weapons were to be transported from the United States to forward bases.[21]

The end of SILVERPLATE, coming as it did shortly after the inactivation of Joint Task Force ONE and at approximately the same time that the Joint CROSSROADS Committee was dissolved,* 1 June 1947,[22] marked the end of the first period of Air Force participation in the atomic energy program. For these three and a half years, from September 1943 through May 1947, the cost of Air Force activities in SILVERPLATE and CROSSROADS** amounted to an approximate total of $25,000,000 divided as follows:***

*See the end of Chapter XI.

**The costs do not include expenditures for any other projects, such as RAND, NEPA, or CHICKENPOX which had already been started, but which are treated in Vol. II of this history.

***The statistics for Phase II may be considered exact having been prepared by Fiscal and Budget at the conclusion of Operation CROSSROADS. However, the statistics for Phase I and Phase III are very rough estimates. All documents pertaining to this subject belonged to the Army and after Unification in September 1947 they were transferred from Washington and connot be located. Consequently the tables had to be based on incidental reports found here and there.

PHASE I: The War Period, Sep 1943-Dec 1945.

Personnel Services	$2,242,000	
Travel	500,000	
Transport of Materiel	12,000	
Communications	100,000	
Supplies	2,500,000	
Contractual Services	200,000	
Aircraft Modified, 46 at $25,000 each	1,150,000	
Total	$6,704,000	$6,704.000

PHASE II: CROSSROADS, Jan 1946-Oct 1946

Personnel Services	$1,805,295	
Travel	206,647	
Transport of Materiel	9,989	
Communications	30,889	
Supplies	11,959,227	
Equipment less Value at End	31,581	
Structures	82	
Contractural Services	131,463	
Total	$14,175,173	14,175,173

PHASE III: Post-War Build-Up, Nov 1946-May 1947

Personnel Services	$2,100,000	
Travel	100,000	
Transport of Materiel	20,000	
Communications	10,000	
Supplies	1,500,000	
Aircraft Modified, 19 at $25,000 each	475,000	
Total	$4,205,000	4,205,000

Grand Total of cost of SILVERPLATE for AAF $25,084,173

Meanwhile, at the same time that the Army Air Forces prepared for Operation CROSSROADS, renewed thought was given to the build-up of an atomic striking force and also to the development of an AAF research and development program. Gradually the new concept of strategic bombing with atomic weapons was crystalizing. It became evident that increaced efficiency in the use of fissionable material made it possible to have an unexpectedly large stockpile of weapons despite the doctrine of scarcity, even though it was still assumed that there was a limit to the number of weapons which could be manufactured. Under these circumstances the bomb was regarded by AAF as a purely strategic weapon which, because of its numerical limitations and its ruthless destructiveness, should be expended only when its use would be certain to contribute most toward the defeat of an enemy.[23]

Under such conditions it was believed that only the most critical of the enemy's nerve centers should be attacked with atomic bombs. Success in future wars, it was said, would depend more than ever on industrial capacity and efficiency. Therefore to destroy an enemy's industrial capacity would be the most crippling blow possible, a fact which, combined with a limited number of atomic weapons, implied that the most profitable targets for atomic bombs would be large industrial plants. Other suitable targets, depending upon the availability of weapons, were listed as seats of government, centers of communications, port areas including naval bases, storage areas, and surface petroleum installations. Tactically, atomic bombs would be used only to repel large water-borne invasion forces.[24]

It was said that the atomic bombs gave to one airplane "the destructive power equivalent to approximately 250 aircraft" using conventional weapons. In view of the continuing refinement of radar bombing techniques and the promise of developing a bomber capable of supersonic speeds there was some speculation whether the mass raids of World War II might not give way to raids by one aircraft flying at high altitudes under cover of weather and darkness. Such techniques, using long range bombers, were foreseen as permitting devastating blows in the heart of enemy countries without the necessity of procuring too many intermediate bases. The atomic bomb was looked upon as having removed the chief limitation of strategic bombing known during World War II, namely, the payload that could be delivered at the maximum radius of action. It was doctrine by 1947 that a strategic air force backed by an adequate supply of atomic bombs would have the potential to destroy the enemy's means of waging war and the reduction of his will to fight. There were some who believed that, with a reasonable supply of bombs and an aim to subjugate the enemy, it would be feasible to risk an all-out atomic attack at the beginning of a war in order to stun the enemy into submission.[25]

At the same time, the atomic bomb brought the Army Air Forces face to face with the problem of an adequate defense of the United States against an atomic attack. It was evident from the results of the TRINITY Shot and the bombing of Hiroshima and Nagasaki that dispersion and underground construction would be the best safeguards against an atomic explosion. This conclusion was further strengthened by CROSSROADS. On the other hand, the cost of dispersing and moving all industries underground was prohibitive. Consequently it was seen that the protection of the United States depended upon the destruction of the hostile atomic carrier before it could reach its target. The situation, therefore, seemed to call for the development of intercept aircraft, radar counter measures, anti-aircraft artillery proximity fuses, and target seeking projectiles.[26]

No specific date can be given for the acceptance by Headquarters AAF of the offensive and defensive implications of the atomic bomb. Certainly the concepts were incipient by the first of 1946; certainly they were explicitly expressed by the first of 1947. As early as March 1946, the Air Defense Command was activated as part of plans for a twenty-four hour operational continental air defense system.[27] At the same time, renewed thought was being given to the creation of an atomic bombing force,* which, in January, had been postponed as a result of preparations for CROSSROADS. In conformity with the Vandenberg memorandum of January, the 58th Wing was designated the atomic striking force in late February. Then, at least partly to avoid having one particular organization associated solely with atomic weapons,** the Continental Air Force, to which the 58th Wing was assigned, was redesignated the Strategic Air Command, 13 March 1946.[28]

In June 1946, while Joint Task Force ONE was tensing itself for the ABLE Day drop, Major General Curtis LeMay, Deputy Chief of Air Staff for Research and Development, stated that "for some time the over-all program of the development of AAF interests in the atomic bomb has been in the doldrums because of the redeployment and establishment of the 400,000 man Air Force and various other factors incident to the ending of the war." The Air Materiel Command was advised, however, that after a number of

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*"Action is now being taken to organize the 58th Wing as mobile striking force for employment of... (the atomic) weapon. A conference is being held on the 15th of April (1946) for the purpose of determining the requirements of this wing. Representatives of this Headquarters, Strategic Air Command, and the 58th Wing will be present."

Ltr , Maj Gen Curtis E. LeMay to Brig. Gen. Roger M. Ramey, Hq Task Group 1.5, 4 Apr 1946, Incl. - cy ltr , SAC, 28 Mar 1946.

**See Chapter IV.

weeks of conferences, one wing, the 58th, of the Strategic Air Command had been organized to be concerned primarily with carrying atomic bombs. The 58th Wing was at that time engaged in Operation CROSSROADS, and upon its return to the United States it was to be reorganized and in operation by the end of 1946.[29]

The plan of the Strategic Air Command for operational training and strategic employment of its units was presented on 18 July 1946. The mission of SAC, as stated by Headquarters AAF, was:

> To be prepared to conduct long range offensive operations in any part of the world, either independently or in cooperation with naval forces; to provide combat units capable of intense and sustained combat operations, employing the latest and most advanced weapons; to train units and personnel for the maintenance of the Strategic Forces in all parts of the world; to perform such special missions as the Commanding General, Army Air Forces, may direct.

The plan stated that no strategic threat or requirement then existed nor, in the opinion of the country's best strategists would such a requirement exist "in the next three to five years."[30] Therefore it was assumed that the Army Air Forces would have approximately three years to man, equip, and train operationally a strategic striking force without interference from "outside elements." The plan was predicated on the following assumptions:

1. That the occupation in the Far East would continue for approximately three years utilizing five VHB Groups and four Fighter Groups.

2. That the 58th Wing with three VHB Groups would be maintained in ZI as a Strategic Striking Force in reserve until the completion of the occupational period and during this period the 58th Wing would continue to train and act as a reservoir for atomic bomb technical knowledge.

3. That the eventual composition of the Strategic Air Command would comprise twenty-one Bombardment Groups (VH), nine Fighter Groups (VLR), three Reconnaissance Groups (VLR), their associated services and certain separate supporting squadrons.

This plan was intended to provide a highly mobile, strategic striking force, "currently trained in all likely areas of operation and capable of immediate employment in all parts of the world, for the maximum protection at the least expense."[31]

By the second week in August, the elements of the 58th Wing which had participated in Operation CROSSROADS had returned to the United States.* The 509th Composite Group was located in Roswell. The other three groups of the Wing were located in Tuscon, Salina, and Fort Worth. The Wing Headquarters was also at Fort Worth. On 1 November the 58th Wing was inactivated and the 7th, 43rd, and 509th Very Heavy Bombardment groups were assigned to the Eighth Air Force** which, along with the Fifteenth Air Force, was part of the Strategic Air Command. Part of the mission of the Eighth Air Force was to act as liaison agency between SAC and MANHATTAN.[32] By the end of 1946, therefore, AAF had put into effect its plan to have an atomic striking force.

It was also during 1946 that the Army Air Forces began a program of research and development in various "atomic " areas. Though still severely limited by the close grip on atomic information maintained by MANHATTAN District, the AAF effort represented at least a respectable beginning. On 1 March the RAND Project was initiated as a contract with the Douglas Aircraft Company. The purpose of RAND was to guide and stimulate the development of the most effective methods of intercontinental warfare, and this aim gave definite connections with the atomic field. On 29 March AAF entered into an agreement with North American Aviation, Inc., in Project MX-770, and authorized the use of atomic energy for

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*See Chapter X.

**Under the command of Maj Gen Clements McMullen with Brig Gen Roger M. Ramey as C/S. Within a matter of weeks, McMullen was succeeded by Ramey as CG.

propulsion in the long range guided missile if feasible. Finally, 23 May, the Nuclear Energy Propulsion for Aircraft (NEPA) Project was begun as a contract with a number of aircraft companies headed by Fairchild. During the summer, Headquarters AAF began several other activities as part of an atomic energy program. Plans were drawn up for an extensive indoctrination of personnel. The Air Force also assumed the task of designing, developing, and procuring handling equipment for the bomb. Modification projects continued for B-29's. Under the new code word CHICKENPOX another modification program was undertaken for C-97's. The purpose was to give an additional mobility to the atomic striking force—the Eighth Air Force—by modifying the C-97's to serve as "flying assembly rooms." The intention was to fly the CHICKENPOX aircraft to forward bases to serve as units where the bomb could be assembled. Incidentally, and somewhat later, it was also suggested that the CHICKENPOX planes could be used, along with SILVERPLATE B-29's, to transport the bombs from the United States to the forward areas in the ferry plan. Thought was also given to the development of new atom bomb carrying aircraft, and there was great interest in the perfection of guided missiles.[33]

The national atomic energy program went through radical changes at the end of the year. Public Law 585, "The Atomic Energy Act of 1946", passed Congress in August and was signed at once by the President. But the law did not become effective until midnight 31 December 1946-1 January 1947. The MANHATTAN District was abolished by the act and the Atomic Energy Commission (AEC) came into existence as a successor. At the same time two other agencies were set up—the Military Liaison Committee (MLC) and the Armed Forces Special Weapons Project (AFSWP). The former was specially provided for by the Atomic Energy Act and was established to serve as the only channel of communications between the War Department and Navy Department in dealing with AEC. On the other hand, AFSWP was created by the War Department and the Navy Department to perform such residual functions of MANHATTAN District as were not assumed by AEC. In attempting to keep pace with these important changes, AAF established at Kirtland, in October 1946, the Tactical and Technical Liaison Committee (TATLC) which functioned as a "working level" channel of information to keep the Army Air Forces abreast of the work to be done by AEC.

From any point of view, 1943-1946 were important years. Nuclear physics had already reached the point of producing an atomic bomb by the time that AAF began its SILVERPLATE Project. Then MANHATTAN and SILVERPLATE had contemporaneous existence through the crucial months when the first atomic bombs were made and an air unit was organized and trained to drop the weapons on Hiroshima and Nagasaki in one of the most dramatic and climatic missions in military history. In quick succession there followed CROSSROADS as an expression of the national atomic energy program. In parallel AAF history there was the continuation of SILVER-PLATE and the emergency of a somewhat nebulous but healthy atomic energy program which created an atomic striking force and began a program of research and development. MANHATTAN District and SILVERPLATE were discontinued at approximately the same time--31 December 1946 and 12 May 1947.

The national atomic energy program henceforth, instead of being guided by one agency headed by one man, became the expression of a delicate balance of opinions, estimates, and priorities achieved among a variety of agencies and departments, both military and civilian. In this complex scene the Army Air Forces, despite the energetic program on which it had embarked, was not in a particularly strong position to press for what it believed to be essential. It was of course in a distinctly subordinate status prior to its recognition as a coordinate department within the National Military Establishment in September 1947. Even then, the United States Air Force remained something of a suspect, and it held only minority representation on all the new joint boards and committees which controlled the recommendations to AEC and the allotment of funds. Moreover, these funds became increasingly short with the transition to a peace-time point of view and an economy drive by the Department of Defense. In Congress, too, the general belief that the atomic bomb would remain an American monopoly for some years to come led to the concept of a balanced defense and a proportionate distribution of money among the services.

The result was to be considerable frustration among the exponents of all-out atomic developments in the Air Force. Operating in favor of the program they advocated, however, were factors similar to those which had helped the Air Corps ten years before--a rapidly mounting period of international tension and the general conviction that atomic weapons joined to air power would be decisive either in maintaining peace or in winning a future war. Simultaneously there were assurances from the Atomic Energy Commission of the ever-increasing power and number of atomic bombs. The doctrine of scarcity was weakened by the early part of 1949. A few months later it was evident that Russia, too, had mastered the technology of atomic energy. From then on no one could deny the absolute necessity of an extensive USAF atomic energy program, and SILVERPLATE and CROSSROADS came into their own as the initial phases of a new epoch in air power.

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