

History of Rocketry and Astronautics

**Proceedings of the Ninth, Tenth and Eleventh History Symposia of
The International Academy of Astronautics**

Lisbon, Portugal, 1975

Anaheim, California, U.S.A., 1976

Prague, Czechoslovakia, 1977

Frederick I. Ordway, III, Volume Editor

R. Cargill Hall, Series Editor

AAS History Series, Volume 9

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 4

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AAS Publications Office
P.O. Box 28130
San Diego, California 92128

**Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation**

First Printing 1989

ISSN 0730-3564

ISBN 0-87703-309-9 (Hard Cover)
ISBN 0-87703-310-2 (Soft Cover)

*Published for the American Astronautical Society
by Univelt, Inc., P.O. Box 28130, San Diego, California 92128*

Printed and Bound in the U.S.A.

Chapter 10

OPERATION BACKFIRE: ENGLAND LAUNCHES THE V2^{*}Mitchell R. Sharpe[†]

As World War II drew to an end in Europe, the British Army found itself in possession of a number of V2 rockets and ancillary support and launching equipment, as well as many of the technicians who developed the V2. Also in their hands were some of the German troops who had assembled, checked out, and launched these rockets against England and targets on the European continent. The Royal Army conceived a plan to gain experience in building and launching the rocket from a location in Germany, while carefully documenting all procedures. The British named the project Operation Backfire.

In Operation Backfire, the British sought further to recruit to England German scientists who had developed the V2. But as the project unfolded, other prominent Allied scientists and engineers who would later play major roles in the development of their national long-range missiles and launch vehicles also came to participate; from the United States: Theodore von Kármán, William Pickering, and Grayson Merrill; from the Soviet Union: Sergei Korolev, Yuri Pobedonostsev, and Valentin Glushko.

This paper considers Project Backfire and its implications for postwar rocket development among the Allied Powers.

World War II, in the European Theater of Operations, was for all practical purposes over by mid-March, 1945. Under increasing pressure from Marshall Bernard Montgomery, the German artillery units that had been firing V2 ballistic missiles from sites in northeastern Netherlands and the region northeast of Koblenz began withdrawing into the heartland of Germany. In doing so, they abandoned their rocket weapons and ancillary support and launching equipment. Also, the soldiers who manned the firing batteries began turning up in British prisoner of war camps.

With the growing accumulation of both materiel and the men skilled in preparing and launching the rocket, it occurred to the British that they had a unique opportunity to gain first-hand information and technology on the weapon of

* Presented at The Tenth IAA History of Astronautics Symposium, Anaheim, California, U.S.A., October 1976.

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future wars. The idea of a demonstration firing was proposed by Junior Commander Joan C.C. Bernard, Army Territorial Service, an aide to Major General Alexander M. Cameron, chief of the Air Defense Division (ADD), Supreme Headquarters, Allied Expeditionary Force (SHAEF) [1]. She suggested that the operations should be fully documented by technical reports, procedures, still pictures, and motion pictures.

On 1 May, she approached Cameron and briefed him. A special staff study, made on the following day, was submitted to the Assistant Chief of Staff, G-3, SHAEF, with the recommendation that the project be approved [1,3].

The remainder of the week saw two events take place that would have an important bearing on the proposed firings. On 4 May, SHAEF issued an order that no V2 materiel would be removed from the theater of operations pending further instructions [2]. On the day following, near Reutte, a small village in Austria near the Adolf Hitler Pass, a group of German civilians and army officers surrendered to agents of the Counter Intelligence Corps, of the U.S. 44th Infantry Division [4,5]. Among them were Dr. Wernher von Braun and Major General Walter Dornberger [6]. However, Second Lieutenant Charles L. Stewart was unimpressed by the two and grew increasingly irritated by their constant demands to be taken at once "to see Ike" [6,7].

With tactical intelligence matters more pressing, Stewart bundled the group off to a collection and holding center at Garmisch-Partenkirchen that had been established by the U.S. Army for such important military prisoners and detainees.

In the meantime, Colonel W.J.S. Carter, Assistant Chief of SHAEF's ADD, had been in London. Cameron had sent him there to convince the War Office of the importance of the proposed operation. Carter met with men such as Prof. Charles D. Ellis, Scientific Advisor to the Army Council; Dr. Alwyn Crowe, Comptroller of Projectile Development; and Lieutenant General Sir Ronald Meeks, Deputy Chief of the Imperial General Staff [1].

Carter very concisely told the group that such a demonstration then would save Britain countless man-hours of research and testing in weapon technology that was sure to dominate wars of the future. He was at once supported by Crowe, probably the only scientist in Britain who had been actively involved in rocket research prior to and during the early years of the war [1].

Not wanting to lose time, since they were certain that the project would be approved by SHAEF, Cameron's people moved out rapidly. By 19 May, all captured military personnel who had knowledge of launching the V2 had been identified and interrogated. A fortnight later, a select number of them were segregated into a special prisoner of war camp near Brussels [3].

Cameron's staff went on to compile a list of all materiel that would be required to assemble, check out, fuel, and launch the V2. In addition to the locations of such equipment revealed through questioning of prisoners and knowledgeable civilians, the British knew of sizable but unknown quantities of the weapon in two locations, both destined to be included in the Soviet Zone of Occupation. These

were the huge underground manufacturing plants for the V2 at Niedersachswerfen (near Nordhausen), in Turingia, and the maintenance depot for the same weapon and its support equipment at nearby Klein Bodungen. Additionally, the names of manufacturers of components for the V2 system in Germany, France, Denmark, and Belgium also were known [9].

With the final approval obtained, Carter dubbed the project Operation Backfire, and the pace of activity, great as it was, increased further. On 26 May, the British 307th Infantry Brigade Headquarters, commanded by Brigadier L.K. Lockhart was assigned the mission of supporting Operation Backfire. Its primary function was to assist in finding a suitable location for the launchings and then providing the requisite administrative and logistical support to accomplish the mission [3].

Selection of the site by Cameron and Carter was not too difficult a problem. It had to be within the zone of the 21st Army Group. Furthermore, it had to be conducive to the siting of radars for tracking the V2s. The former Krupp Naval Gun Range, at Altenwalde, some 8 km south of Cuxhaven on the Schleswig Peninsula, was ideal. It was completely fenced in, had a good road and railway access and possessed several large buildings. From it the rockets could be launched along a northern azimuth to a target in the North Sea, while radars from the Elbe River to the Danish border tracked them [3].

With the good news of approval for Backfire, there also came some discouraging bad news. Practically every V2 under British control was lacking the critical guidance and control unit. The reasons why were various. It was the component first destroyed by the troops forced to abandon their weapons. Also, the unit was in short supply generally because of the effectiveness of Allied bombings of production plants. Additionally, as the war grew towards its end, raw materials for manufacture of the unit became increasingly scarce; thus, few were produced [19].

Nevertheless, Cameron put every man he could recruit to work on the problem of rounding up V2 materiel. Special teams were formed that included German-speaking English officers and, sometimes, German soldiers who knew where such equipment had been deserted. In all, these parties covered some 716,800 km in 6 weeks. The booty they found filled 200 trucks and 400 railway freight cars. To round out the initial logistical effort, 70 aircraft loads of special tools and equipment were flown in from England [3].

As the materiel accumulated, refurbishment of the range at Altenwalde grew apace. Ultimately, 2,500 British military troops and civilians were involved in Operation Backfire.

On 22 June, General Eisenhower issued Backfire Instruction No. 1:

The primary objective of this operation is to ascertain the German technique of launching long range rockets and to prove it by actual launch ... In addition to the primary objective, the operation will therefore provide opportunities to study such certain subsidiary matters as the preparation of the rocket and ancillary equipment, the handling of fuels, and controls in flight [3]. (One German engineer later suggested that the real purpose of the project was to familiarize the British with the originating end of a V2 trajectory.)

As the range preparation progressed, German scientists and engineers, including von Braun and Dornberger and many of their former colleagues from the rocket development center at Peenemünde, on the Baltic Sea, were interrogated by the British, with the consent of the Americans. The purpose of questioning these men at Garmisch-Partenkirchen was really two-fold. Primarily, it was to determine who among them would be of value at Operation Backfire. The other, and less successful one, was to identify personnel who for various reasons might prefer to work for the British rather than the Americans in pursuing their craft in rocketry. Dornberger, at the request of his interrogators, wrote an extremely helpful treatise on the safety aspects of handling rocket propellants associated with the V2 [9].

Curiously, the British were not interested in having von Braun participate in Operation Backfire. They knew quite a bit about him from their excellent intelligence services, as did the Soviets. Indeed, both countries knew far more about the man than did the Americans, who depended largely upon the British for strategic intelligence early in the war.

The reason why von Braun did not particularly interest the British is best explained by Carter, who years after the war, wrote:

"It may interest you to know that we always regarded von Braun as more of a visionary and front man than a scientist and technician. This may have been unfair because obviously he had great scientific and technical flair. I have in my notebook an extract from an intelligence report which was made in the very early days of the war, which reads as follows: 'This gentleman, despite his Nazi convictions and the fact that he often appeared in a uniform suggesting that he held some form of honorary SS rank, was not greatly enamoured of the operational possibilities of the A4 (i.e., the V2). He regarded it more as a medium for stratospheric and meteorological research and as a necessary stepping stone to bigger things' [10]."

To command the troops actually launching the missiles, the British already had in hand the one man in Germany best qualified to do so. He was Lieutenant Colonel Wolfgang Weber. At the end of the war, he had been commander of V2 Tactical Group, South; and he had learned his trade under the tutelage of Dornberger and von Braun at Peenemünde as the commander of the provisional firing unit established there in 1944. As the operation progressed, Weber found himself joined by 591 prisoners of war and German civilians, largely from Peenemünde, as well as 400 other Germans in a provisional labor unit.

By the beginning of July, the basic plan for Operation Backfire had to be modified. Despite the dedication of the search parties that had combed a good part of western Europe, there simply were not enough electric batteries, rate gyroscopes, and control amplifiers to outfit more than eight rockets. Originally the plan had been to have 30 V2s on hand in such condition that 9 could be fired [3]. Thus, the decision had to be made to launch the rockets in a purely ballistic mode; and there was no way to evaluate the performance of the all-important guidance and control unit.

On 14 July, SHAEF was formally dissolved; and Germany was divided into the various Allied occupation zones. Yet, the impact on Operation Backfire was minimal. The British War Office simply took over control of the project and redesignated Cameron's organization as Special Projectile Operations Group.

To work with Weber's former soldiers, the British selected 85 of the scientists and engineers being held at Garmisch-Partenkirchen [2]. They arrived in Altenwalde on 26 July and were divided into two groups. One group, under Dr. Kurt Debus, who would later become director of the Kennedy Space Center, was to provide technical assistance to Weber's men. The other group was sent to the nearby village of Brockeswalde. These two groups along with Weber's men denominated themselves the Versuchskommando, Altenwalde, and drew up an impressive organizational chart. (A year later, in the deserts of Texas and New Mexico, these same Germans found their names on a similar chart [11]. An American engineer assigned to work with them upon seeing it for the first time said, "My God! an organization with a president and 120 vice presidents!")

Not completely trusting the Germans under Debus, the British planned to use their colleagues at Brockeswalde as hostages in case something happened to the group at Altenwalde. The effort was futile, and though the British could not have known at the time, foolish. Neither group had any reason or motivation to dissemble or sabotage the project. They were, after all, once again working at their trade and happy to being so employed [13,14,15].

The former men of Peenemünde arrived at Altenwalde and Brockeswalde with inadequate clothing and a minimum of baggage allowed. For example, Karl Heimburg arrived literally without his shoes. Due to a mix-up, he had wound up at Schloss Kransberg, near Nauheim, a special camp for high-ranking German civilians. At once humble and puzzled to be in the company of men such as Albert Speer, Fritz Thyssen, Hjalmar Schacht, Alexander Porsche, and Hermann Oberth, he assumed that he was in for a long stay. Philosophically, he sent his shoes out to a cobbler. When the British located him at last, they sent him packing for Altenwalde barefooted [12,16,17].

To relieve the lack of clothing, the British quartermasters fell back upon the local economy. They found a warehouse filled with Nazi party uniforms and distributed them to the civilians at Altenwalde and Brockeswalde. The majority of the Germans, who had been party members, found the uniform a great joke. The nearby villagers did not. They assumed that their fellow citizens were former party members facing a British noose or firing squad. The good villagers were astounded by the refusals of the men behind the fence to offers of help in escape [1,12,15].

The hostage party at Brockeswalde did little other than sunbathe, swim in the nearby North Sea, play chess and skat, and meditate upon their future. Dieter Huzel, for example, was asked to write a lengthy memoir upon his days on Test Stand 7 at Peenemünde [4]. Lieutenant Colonel Wilhelm Zeppelius, Dornberger's officer in charge of propellants for the V2, was asked to write all he knew about such activities. He dawdled, asked for a typist, and generally proved that he was much more adapt at converting raw ethyl alcohol into schnapps.

Zeppelius had a roommate who was also of marginal value to the project. He was kept strictly segregated from his German colleagues, military and civilian. However, he cooperated in establishing the management of the German side of Operation Backfire, as the British requested him to do. Dornberger, for so he was, went

from Cuxhaven to the famed "London Cage" for high-ranking German prisoners in London. From it, he was subsequently sent to Wales, where he languished for two additional years [18,20]. Thus, Operation Backfire seemed to have provided the British with a means of insuring that Dornberger wound up in one of their prisons for some time at least. (He was told by Major Andrew P. Scotland, at the "London Cage" that he would be held for trial in place of SS Obergruppensfuhrer Hans Kammler for the use of the V2 against England, a charge so flimsy that the British did not seriously press it.)

Liquid propellants for the V2 of Operation Backfire were no problem so far as ethyl alcohol was concerned. However, liquid oxygen was a more serious matter. Major C.W. Lloyd, Cameron's staff officer in charge of providing the propellants, had his difficulties. There were no storage facilities at the launching site for the highly volatile oxidizer. Additionally, very few liquid oxygen transport trailers from tactical firing units had been recovered. However, Lloyd found a plant at Fassberg, some 190 km away, that could produce about 4.4 metric tons of liquid oxygen per day and store about 62 tons of it. By 7 August, he had located another plant at Braunschweig, about the same distance away to the southeast. With the production facilities thus available and what limited means he had for transporting it, Operation Backfire was secured in that area [2].

On 11 August, the War Office issued Cameron a restated mission for Operation Backfire:

- a. Information on testing, assembling, and filling of the German A4 rocket.
- b. Detailed knowledge and experience of the German technique for launching long range rockets.

The intention is that you will collect this information by carrying out the operation of assembly and filling in Germany, using German disarmed personnel supervised by British technical experts, and that the successful completion of the operation will be proved by firing of a number of A4 rockets. Observations of the trajectory and photographic records will be taken as far as possible and the drill employed for firing the rockets will be recorded in detail [3].

By mid-August, Operation Backfire had resolved itself into two major efforts: the production of the V2 rockets and the recording of the process; and the preparation of launching procedures and means for tracking the missiles in flight. This latter phase was largely to be done by five SCR-584 radars loaned by the U.S. Army, the only tangible American contribution to the project [20].

On 21 August, Cameron received welcome news when a dozen V2s were found near Aachen and Hannover, one in almost mint condition. The discovery meant that eight rockets of high quality could be assembled for Backfire [21].

As the month continued the U.S. Army asked for 26 members of the von Braun team be returned to Garmisch-Partenkirchen in preparation for removal to America. The reason given was patently absurd: they were needed for use in the war against Japan. The British reply was only a little less absurd: their loss would jeopardize Operation Backfire. A compromise was reached when 14 of the men were returned [12].

In early autumn, the project was rapidly reaching culmination.

All items of ground support and launching equipment were on hand and in working condition. In some ways, the collection and assembly of such materiel was an even greater task than that of finding and rebuilding the V2s.

A target was selected in the North Sea some 75 km southwest of the village of Ringkoebing in Denmark. The firing azimuth was 365 degrees 51 min. true north. However, the range was set at only 240 km since a maximum range of 320 km would have sent the missiles out of radar tracking capability [22].

On 1 October, the first V2 was on its launcher awaiting the firing command from the concrete blockhouse that had been built near the launching pad. The safety-minded British had decided to employ it rather than the Feuerleitpanzer, a mobile launching control station built into a tank [23]. (Figures 1, 2, 3 and 4 depict various aspects of the preparations on that day.)

When the firing command was given, nothing happened. The British were disappointed and even suspicious of sabotage. The Germans, however, were quite used to such occurrences and merely shrugged. The ground-power connector had failed to eject. One of the German technicians donned a raincoat to protect himself from the drizzle of alcohol still in the combustion chamber of the rocket and stood up inside it to check its interior. Having found nothing amiss, he retired to the blockhouse, and the firing command was given. Again nothing happened. The pyrotechnic igniter had failed to operate. No further attempt was made to launch V2 on that day [22].

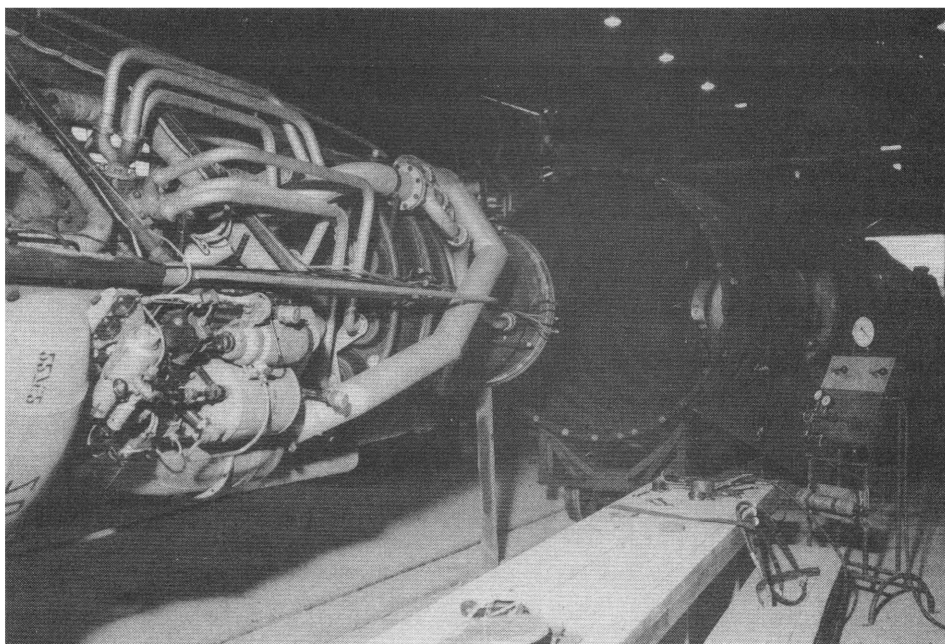


Figure 1 Pressure checkout of V2 propulsion system, Project Backfire, Krupp Proving Grounds, Cuxhaven, Germany on 22 September 1945.

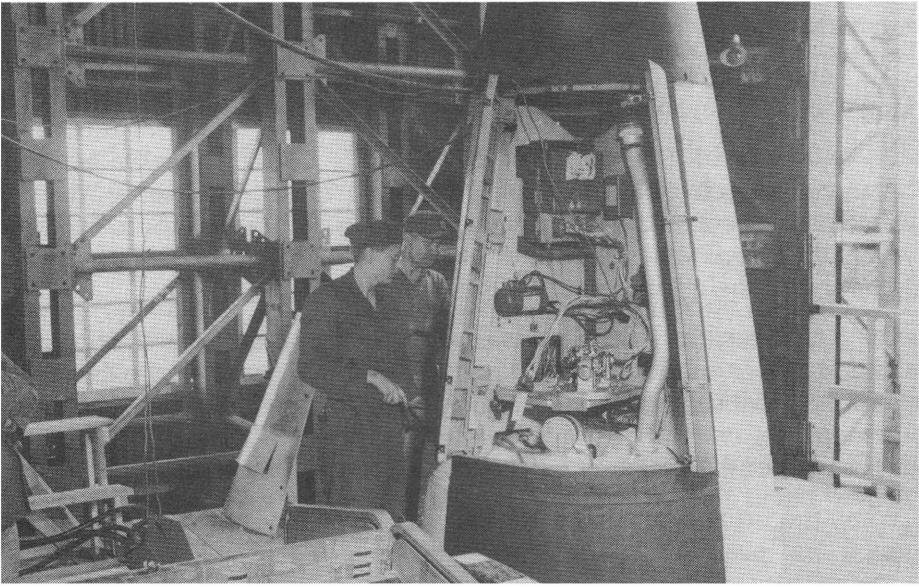


Figure 2 Vertical checkout stand for the V2 rocket, 27 September 1945, Cuxhaven.



Figure 3 Electrical checkout of V2 prior to launch attempt on 1 October 1945, Cuxhaven.



Figure 4 Loading hydrogen peroxide from tanker into V2 at Cuxhaven, 1 October 1945.

On the following day, however, it was a different story. At 1443 hours, the V2 roared from its launcher and into a cloudless sky. In only 4 min. and 50 sec., it impacted just 80 meters to the left and 1.6 km short of the target [20]. Present in the blockhouse was Joan Bernard, whose idea it had been in the first place. (A German engineer also there stated that it was only the second time that a woman had been so present during a launch. The first was Eva Braun, later wife of Adolf Hitler [1].)

The second launch found the original, balky V2 up again. And again it demonstrated the inherent perversity of complex electromechanical things. While the rocket left the launcher, it traveled only 24 km because of an engine malfunction [20].

A decision was made to fire only one more missile and to invite Allied officers and members of the military press to observe the launching. The firing was called Operation Clitterhouse, and set for 14 October. The weather was ghastly. Beneath low-hanging clouds, there was a steady ground wind of some 12 meters per sec. [3].

Despite the weather, the launching went off spectacularly enough for the observers. The rumbling noise, flame, and smoke were very impressive to the men assembled. Most, who had any acquaintance with the V2, were used to a devastat-

ing explosion and wholesale destruction followed a few seconds later by the sound of a large missile headed for the area.

From the viewpoint of accuracy, the last V2 fired in Germany left something to be desired. It impacted 18 km short and 5.6 km to the right of the target [20,24].

Among the American and Soviet observers were men who had a vested interest in long-range rockets and were to varying degrees familiar with them, if more in theory than in first-hand experience.

From the U.S.A. there was Dr. Theodor von Kármán, in the crumpled uniform of an army colonel. A consultant to the U.S. Army Air Corps in rocketry, he was also a member of the National Advisory Committee on Aeronautics and Director of the Jet Propulsion Laboratory. Near him was Dr. William H. Pickering, Assistant Professor of Electrical Engineering at the California Institute of Technology and later Director of its Jet Propulsion Laboratory. Also close by was Dr. Howard S. Seifert, Chief of the Liquid Rocket Section of the Jet Propulsion Laboratory and later Director of Advanced Planning for the United Technology Corporation. Not far from those two men stood Lieutenant Commander Grayson P. Merrill, a naval officer later to become the Project Director for the Polaris missile.

Literally rubbing elbows with the three Americans were three Soviet officers, two of whom were very familiar with rockets. They were Colonel Yuri A. Pobedonostsev, leader of the Special Technical Commission (Rocket) in Berlin and later deeply involved in his nation's space program. With him was Colonel Valentin P. Glushko, currently in charge of refurbishing the engine test stands for the V2 at Lehesten and later chief designer of rocket engines for the first Soviet long-range missiles and space vehicles, and a General Sokolov [8].

Two additional Soviet observers showed up unannounced and uninvited. Cameron remained firm in not permitting them on the premises, and they had to be satisfied with watching the firing from beyond the pale.

The two were Lieutenant Colonel Sergei P. Korolev, in the uniform of a captain, and an unknown companion.

Korolev was perhaps the most interested of all the Soviets. He was currently the deputy of General Gaidukov, who was responsible for getting all V2 production and testing facilities in the Soviet Zone back into operation. Specifically, Korolev was in charge of refurbishing the underground plant at Niedersachswerfen, vacated by the Germans only six months earlier. He was particularly frustrated at not being able to see the assembly and checkout facilities at Altenwalde, as some other Allied officers were permitted to do.

Korolev had good reason to be frustrated. Within a fortnight to the day, two years later, he had to be ready to assemble and launch V2s in his own country from a proving ground near Kapustin Yar, some 190 km to the east of Stalingrad (now Volgograd), the components of which were currently being produced in his plant at Niedersachswerfen and the engines of which were to be test-fired at Lehesten by Glushko, who stood inside the fence.

The friendly Pobedonostsev engaged a young American lieutenant in what at first appeared to be casual conversation. Later, First Lieutenant H.S. Hochmuth would recall:

"He knew my name and that I had been there [Niedersachswerfen]. He told me the stuff [V2s removed from the plant by the Americans in July] was going to White Sands [Proving Ground in New Mexico]. This was supposed to be a secret. We began to discuss engineering. I asked him how things were at Nordhausen [i.e., Niedersachswerfen], and he said he was having a hell of a time because we had cleaned the place out. He was a very technical guy and said if they were able to see White Sands we could see Peenemünde [27]."

Hochmuth reported the offer to his superiors, but it was rejected out of hand. However, at the time, neither party would have seen much of interest. White Sands was an expanse of desert dotted with World War II radars and a few cinetheodolites and a collection of dilapidated wooden buildings, some relics of the Civilian Conservation Corps program of the mid-1930s. Peenemünde, of course, was a shambles wrought from Allied bombing and German demolition.

The Americans present were not upset as their Soviet counterparts. The cream of the von Braun team, including most of those involved in Backfire, were already under contract to the U.S. Army Ordnance Corps. In fact, the British were only able to recruit approximately 20 of the members taking part in the operation.

What, then, did accrue from Operation Backfire?

For the British, largely because of political decisions after the end of the war, little was gained. The nation was financially strapped and had nowhere near the funds needed to establish another Peenemünde. Indeed, one of the Germans, after being asked to consider working in Britain, declined with surprising candor: "We despise the French; we are mortally afraid of the Russians; we do not believe the British can afford us; so that leaves the Americans."

In order to have an arsenal of large rocket weapons, the British unwisely tied their limited funds and participation in such technology to American enterprises such as Skybolt and Blue Streak (a derivative of the Atlas intercontinental ballistic missile). Later, the nation would participate in the more successful Thor intermediate range ballistic missiles before bowing out of such expensive ventures for awhile.

Of the 20 Germans from Peenemünde who went to work for the British, including Dr. Walter Reidel, the highest ranking amongst them, little of real value was gained. They were simply too few in number and not employed as a team with specifically set goals. Additionally, they lacked the resources and facilities to pursue advanced work in the field of rocket technology.

For what it was worth, Operation Backfire did fulfill its primary mission. It produced the only complete set of documents for assembling, checking out, and launching the V2 rocket [3,20,22,23,28].

No such literature existed in German during the war. Military security simply forbade such a collection. Perhaps the most comprehensive book on the V2 was the *A4 Fibel*, a handbook for the soldiers who had to launch the missile. In many ways, it was an innovation in military training literature. Realizing that the soldiers would

not be technically trained, instructions were kept to an absolute minimum. There was no theory of operation. The many cautions and warnings were graphically illustrated with cartoons, especially scantily clad girls who always draw attention [30].

Members of the British military, of course, received a good foundation in assembling, checking out, and launching V2s; however, such training, in hindsight, seemed of limited value.

Perhaps there was an indirect benefit, one the British present could have scarcely anticipated.

As Merrill watched the launching, he immediately wondered if such weapons could be launched from surface ships or submarines. Later he would write: "In looking back, I feel the Cuxhaven launchings had a definite bearing on the genesis of the now famous Polaris program. For example, it impelled me to work with Rear Admiral Calvin Bolster about 1951 to set up programs for adapting the Navy's Vikings to submarines [31]."

Since Britain later based her national defense on the use of the submarine-launched American missiles Polaris, Poseidon, and Trident, perhaps Operation Backfire did produce a tangible benefit for that country.

Obviously, the Soviets gained nothing of value in merely seeing the V2 launched, although it was their first such sight.

The immediate value to the Americans, except possibly for the inspiration given to Merrill, was minimal. They already had the components necessary to assemble 100 V2s in the Texas desert awaiting the skills of the German principals at Backfire. The documentation submitted by Cameron to the British War Office in January 1946, undoubtedly assisted in the preparation and launch of the V2s at White Sands Proving Ground between 1946 and 1950.

However, within the womb of the V2 that lifted off the launcher at Altenwalde on 14 October 1945, lay a technological fetus that would gestate for two decades before being born in both the U.S.A. and U.S.S.R.

Perhaps it is best described by Richard S. Lewis, a journalist for the U.S. Army newspaper *Stars & Stripes*, present at Operation Clitterhouse. Two and a half decades later after having watched the launching of the first men to the Moon, Lewis recalled what he had seen at Altenwalde: "That demonstration marked a transition point in the development of rocket technology in the West. That was the last V2 fired in Germany. The engineering science which the weapon represented was carried off by the victors as spoils of war. In the United States, it was to evolve into an interplanetary spaceship technology [32]."

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30. A photographic reproduction of this very rare document, as well as an English translation are in the archives of the Redstone Scientific Information Center, of the U.S. Army Missile Command, at Redstone Arsenal, Alabama.
31. Letter to the author from Grayson P. Merrill, Virgin Gordo, BVI, 17 September 1973.
32. Richard S. Lewis, *Appointment on the Moon*. New York: Viking Press, 1968, p. 4.