

# **History of Rocketry and Astronautics**

**Proceedings of the Forty-Fourth History Symposium of  
the International Academy of Astronautics**

**Prague, Czech Republic, 2010**

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**AAS History Series, Volume 41**

**A Supplement to Advances in the Astronautical Sciences**

**IAA History Symposia, Volume 30**

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AMERICAN ASTRONAUTICAL SOCIETY

AAS Publications Office  
P.O. Box 28130  
San Diego, California 92198

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

*First Printing 2014*

ISSN 0730-3564

ISBN 978-0-87703-607-4 (Hard Cover Plus DVD)

ISBN 978-0-87703-608-1 (Soft Cover Plus DVD)

Published for the American Astronautical Society  
by Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198  
Web Site: <http://www.univelt.com>

Printed and Bound in the U.S.A.

## Chapter 6

# A. V. Cleaver, OBE, (1917–1977)— A Biography\*

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### Abstract

Val Cleaver was a prominent British rocket engineer who is best known for his work to promote European space access based around the Blue Streak missile and his role in developing its engines. Arthur C. Clarke once described Cleaver as the man who should have been the British Wernher von Braun. Like von Braun, Cleaver was interested in the wider horizons of space travel and much of his life was spent championing this cause.

Cleaver was born on 14 February 1917. After elementary schools, he attended Acton Technical College for three years, beginning in 1931. From 1934 to 1939 he continued his education at evening classes, working for a degree in engineering, but the war interrupted his studies before he could complete his final examinations. He joined the propeller division of de Havilland in 1936 and during the war was responsible for establishing the standards used to evaluate air-screw performance. At the end of the war he became the Chief Project Engineer for the de Havilland Propellers company before transferring to the de Havilland Engine Company.

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\* Presented at the Forty-Fourth History Symposium of the International Academy of Astronautics, 27 September – 1 October, 2010, Prague, Czech Republic. Paper IAC-10-E4.2.02.

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Because of his special interest, Cleaver became the Special Projects Engineer, with a brief to study rocket feasibility and subsequently became responsible for the development of the Spectre liquid propellant rocket, which was the first application of a closed cycle rocket engine. In 1956 he joined Rolls Royce as Chief Engineer of its rocket team, where he developed the RZ2 engine for the Blue Streak missile. The engine worked perfectly on all of its 11 launches. Cleaver was also closely involved in the development of the ELDO\* launcher and was tireless in his attempts to promote an effective European space entity. His disappointment at the lack of support from the British Government for a European venture had a profound effect on him. He was, however, awarded the Order of the British Empire (OBE) in recognition of his part in the Blue Streak program.

Cleaver was an early member of the British Interplanetary Society (BIS), joining in 1937, and became Chairman, in 1948, for three years. Cleaver used the BIS to promote his vision of space travel, and one of his most significant publications was collaboration with Les Shepherd in the *Journal of the British Interplanetary Society (JBIS)* on "The Atomic Rocket" (1948–1949), which was the first published paper in open literature to propose the use of nuclear-powered engines with hydrogen as the working fluid. He died on 16 September 1977 at age 60.

## Early Life

Arthur Valentine (Val) Cleaver was born on 14 February 1917 (which accounts for his second name) in Conway, North Wales, into what appears to have been a dysfunctional family. On the birth certificate, his father Percival's (Percy) occupation was given as a newspaper inspector, although Val says he was the proprietor of a local newspaper, and his mother Mildred was presumably a housewife. Both parents were of Oxfordshire stock. Val had two elder siblings: a sister Lottie, nicknamed Mick (why is unknown), whom he much adored throughout his life and who was 17 years older; and a brother Robert, who was 14 years older. By all accounts Val did not have a high regard for his brother. They both worked at de Havilland in later years, although Robert worked on the shop floor side.

When Val Cleaver was two, the family moved to London, to Lichfield Grove, Finchley, in the first of many moves. There is anecdotal evidence that Percy had left the family by this time, making Val part of a single-parent family

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\* European Launcher Development Organisation.

in an era when social benefits were not as generous as they are now. In 1921 they moved to Reading; in 1924 from Reading to Horspath, Oxfordshire; and in 1926 to South Kensington, London. It was here, at the age of nine, that Val began his formal education at the Holy Trinity Boys School, Chelsea, although he does not seem to have suffered from this early lack of formal education (in 1927, the Headmaster of Holy Trinity Boys School wrote to the London County Council asking for a scholarship for Val). The itinerant lifestyle and his father's activities appear to have affected Val emotionally. In a biographical note to the BIS, written in the early 1960s, he said:

[I] had a disturbed childhood because of family troubles, didn't go to any school until I was 9, and attendance was irregular thereafter.

In 1928 the family moved to Missenden, near Amersham, after Val had finished only the first part of his scholarship at Holy Trinity. In the same year, Val's sister married and moved to Durham, becoming Mrs. Kift. His father returned in 1929 and they again moved, this time to Kilburn, with another change of school for Val.



Figure 6-1: Val Cleaver at school, 1930, back row, second from left. Credit: BIS.

This era appears to have marked a turning point in Val's life, as he started taking holidays. He went to Devon and Cornwall with his father in 1930, beginning what would become a lifetime hobby of travel and visiting friends and colleagues. The year 1929 also provided the first evidence of what would become another lifelong passion—space exploration. When only 12 years old, Cleaver submitted an article "Shooting to Space" to the British *Meccano Magazine*. Although it was turned down because, as the Magazine said, there was nothing original in the article, it was the first of many articles to flow from his pen. In 1931 Cleaver obtained a Middlesex County Council scholarship to study engineering at Acton Junior Technical College, and this scholarship was extended so that he could take his London University Matriculation in 1934. While Val was studying at Acton, his father spent a spell, in 1932, "at His Majesty's Pleasure" in Wormwood Scrubs prison, London, for bankruptcy, and Val moved into single room lodgings with his mother.

### First Work

In 1934, Val Cleaver left fulltime education and moved to what he called "an unofficial apprenticeship" at Westminster Engineering Company, Willesden, in London. This was a small engineering company, whose main product was electric welding gear, although it did a variety of other work including, according to Cleaver, a "submarine periscope attack teacher" (whatever that was). There are, however, two plans in the archives, traced by Val while at this firm, showing plans for a Colnbrook Aerodrome and a Sipson Aerodrome, both sites close to what would become Heathrow Airport. He also continued his education at night school, initially at Acton Tech, studying for a London University External Bachelor of Science (BSc) Engineering Degree. In 1936 he left Westminster Engineering to devote more time to private study and sat and passed his Intermediate BSc exams.

In July 1936, Cleaver joined de Havilland Propellers Division, Stag Lane Aerodrome, Edgware, as a Junior Draughtsman, continuing his evening class studies at Northampton Polytechnic, which, despite its name, was in London. He passed his Part 1 Finals in 1938 but, partly because of the nervous problems he suffered early in 1939, he decided to take two years for his Part 2 Finals. Unfortunately World War II intervened when Cleaver was about to start his final year and, despite his future management and technical achievements, Val never acquired a formal qualification, a fact he regretted throughout his career.

The Stag Lane Aerodrome had been the main base of the de Havilland Aircraft Company since 1920, but when the airfield was sold for housing in 1933,

the company retained a 15 acre site as a factory and offices for the Engine Division. It was here that de Havilland Propellers was formed in 1935, when the Company acquired a license from Hamilton Standard in the United States for the production of variable pitch propellers. Cleaver's career at de Havilland soon blossomed, and in November 1939 de Havilland received a certification that Val was working on important matters and could not be called up.

In 1941 Cleaver became Chief Technical Assistant and by the end of the war, at 28 years of age, he was Chief Project Engineer. This was, as Val says, a misleading title, and he was really the Number 2 in the Engineering Section, reporting to a W. Snell. Although he worked mainly on the performance, production instructions, development, and flight testing of the variable pitch propellers, including flights in the famous de Havilland Mosquito, Cleaver also became involved in many other studies, including the jet engine, revealing a diversity that he retained throughout his life. In 1944 Val made his first trip to the United States, visiting its propeller industry on behalf of the Ministry of Aircraft Production. As he noted in his autobiographical list—this was the year the V-2 arrived.

### **De Havilland – Special Projects**

By the end of the war, Val Cleaver had moved out of the various family homes and was living at 47 Parkside Road, Edgware. He was also making a reputation as a social animal, organizing parties and dinners for departing military staff and others with whom he had worked in the propeller industry. A good example was the Battle of Britain reunion dinner he ran on 12 January 1946 at Pimms Red House in Bishopsgate—this appears to have been a favorite haunt of the de Havilland staff.

Although Cleaver produced several papers on airscrews during the war, his real interest remained in rocketry and spaceflight. This, according to Val, had been sparked by several visits to see Fritz Lange's *Frau in Mond* before the war, reading reports on the German Society for Space Travel (Verein für Raumschiffahrt, or VfR) experiments, and from early American science fiction magazines. In 1937 he joined the British Interplanetary Society (BIS), a hotbed of ideas and the haunt of science fiction writers, including Olaf Stapledon. It was here that Val met his lifelong friend, Arthur C. Clarke. He describes the BIS at the time as:

...a bunch of the most delightful and stimulating people I have ever met (except for the Technical Director, who over-awed me at first, until I realised he was nuts).

When the BIS closed for the period of the hostilities, Val kept in close contact with Arthur C. Clarke throughout the war by frequent letters and became a major player in its reincarnation in 1945.



**Figure 6–2:** Val Cleaver the socialite, on the left, in the late 1940s. Credit: BIS.

Cleaver’s strong personal interest in rocket propulsion and space was well-known at de Havilland, and he was consulted on German rocketry, including the V-2, during the war. In 1943 he had given a talk on “The Present and Future Possibilities of Rocket Propulsion” to the City and Guilds Engineering Society and, in 1945, had a two-part article “Bombers and Rockets” published in *Flight Magazine*. So when, in 1946, de Havilland was beginning to look at rocketry as a future business area, it was natural that it should turn to Val Cleaver. He was invited to join the de Havilland Engine Company as Special Projects Engineer, with a view to assessing German wartime achievements and probably starting a rocket group within the firm. He was soon joined in the group by Wilf Neat, a close friend and colleague who had worked with him in the Propellers Division. This was to be a fruitful partnership for the next 10 years of rocket development at de Havilland.

One of his first tasks was to prepare a report on “The Theory of Rocket Motors” for de Havilland. One can imagine Cleaver’s enthusiasm and possible relief at this turn of events in his professional life. At last he was able to devote



his time to a subject so close to his heart, and he must have seen this as a great opportunity. Wilf Neat, in an appreciation after Cleaver's death wrote:

Major Halford invited him to spend a year just "looking into rocket engines." Val often claimed that this was one of the happiest times of his life—no dates to be met or programmes to be achieved—just reading and talking and understanding one of his greatest interests.

Cleaver was realistic enough to understand that, at this time of austerity in post-war Great Britain, the country was not in a position to undertake any large-scale projects relating to space exploration. However, as an optimist, he did realize that even small projects on rockets would allow the evolution of design teams and the growth of knowledge and experience, which could be built on in later years.

Cleaver's chance came in 1947, when the Company was awarded a contract to develop the Sprite rocket engine. This was designed as a rocket assisted take off (RATO) unit. De Havilland had, in fact, already had some previous experience of RATO when, in 1947, it used borrowed Walter 109-501 units to give assisted take off to the Lancastrian aircraft.

The requirement for a RATO engine came about from the necessity of boosting the take off speed of the Comet jet airliner, when operating from hot and high climates. This was because the Comet's Ghost jet engines did not have sufficient power under these circumstances. As the rocket engine only had to fire for a short time, the result was the development of the Sprite mono-propellant rocket engine, which had a thrust of 22.2 kN and a burn time of around 12 seconds. The engine operated as a "cold" engine using hydrogen peroxide with a solution of potassium permanganate as a decomposition catalyst.

Although many successful flights with the Comet were carried out at Hatfield beginning in May 1951, in the end, events overtook the development of the Sprite. Due to the increase in the all-up weight of the Comet, it was fitted with the more powerful Avon jet engines, which allowed the aircraft to take off from the hot and high airfields without rocket assistance.

However a requirement for another RATO unit soon appeared, in the guise of the first British V-bomber, the Vickers Valiant. A similar thrust was needed, but a longer burn time, of about 40 seconds, was necessary: to carry that amount of peroxide as a mono-propellant would have resulted in a far too heavy system.

This led to the design of a bi-propellant "hot engine," which utilized kerosene with hydrogen peroxide at a 20:1 mixture ratio. This was called the Super Sprite and was similar to the Sprite, except that it carried around its thrust chamber nozzle an annular tank containing kerosene. Both the hydrogen peroxide and the kerosene were pressure fed by nitrogen. Potassium permanganate was re-

placed by a silver-plated gauze catalyst, which had the added advantage of producing a clean exhaust. In June 1956, the Valiant was flown with the Super Sprite and the unit proved reliable. After firing, the Super Sprite was dropped via parachute so that the units could be reused.

### **Involvement with the BIS and IAF**

It was during this time that Val Cleaver wrote, with Les Shepherd, a series of pioneering papers on nuclear propulsion in space.<sup>1</sup> These articles were seminal in understanding the rudiments of nuclear propulsion. This also marked a period during which he became more involved with the BIS and was its Chairman from 1948 to 1950. Val was the head of the BIS delegation present at the first meeting in Paris in 1950, which set the criteria for the establishment of the International Astronautical Federation (IAF). The British Interplanetary Society was able to circulate a draft constitution in May 1951, four months ahead of the second conference that was held in London in September. This was due, in no small measure, to the efforts of mainly Val Cleaver and Guenter Loeser of the German Society for Space Research (Gesellschaft für Weltraumforschung GfW). Val's influence in this task was considerable and must earn him the right to be considered as one of the founding fathers of the IAF. Subsequently Cleaver withdrew from direct participation in the running of IAF affairs, but he remained a staunch supporter and a frequent attendant at the Congresses.

By now rocketry and space travel were being taken far more seriously in the UK, and Cleaver recognized that such bodies as the BIS had enormous potential to publicize the ideas of astronautics. He had always enjoyed the BIS as a place to meet like-minded people, but after the war, he could take advantage of the fact that such organizations were operating on a much more professional level than had been the case before the war. After his term as Chairman of the BIS finished in 1950, Val continued on the Council until he left in 1951. He did however continue to be involved with, and support, the Society in his ongoing crusade for astronautics in the UK.

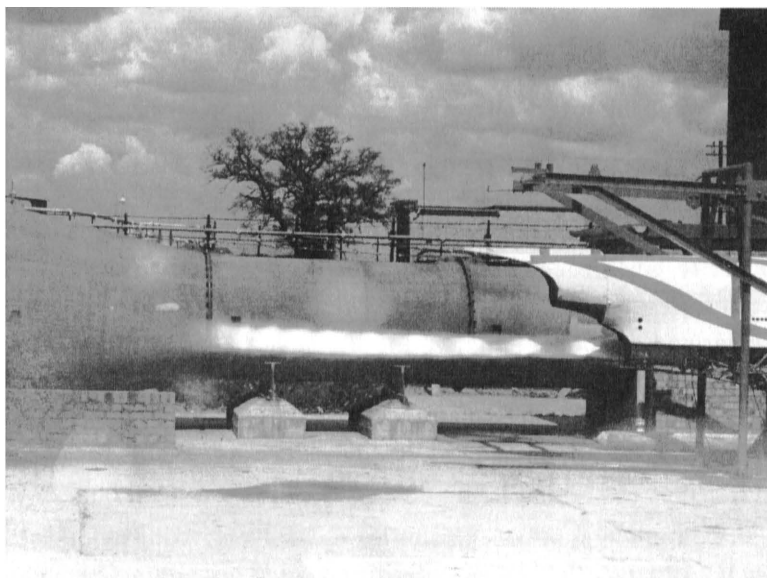
### **The Spectre Rocket Engine**

The third rocket engine to be designed and developed at de Havilland was the Spectre. This arose out of a requirement for a fighter interceptor that used a mixed propulsion system, consisting of a rocket engine and a turbojet engine. At that time, the bomber's best defense was height, and in order to attack a bomber,

an interceptor fighter could either loiter at high altitudes (which gave limited endurance) or reach these heights as quickly as possible. The latter was the preferred option, but the jet engines of the day were not powerful enough to do this, hence the requirement for a dual propulsion system—the rocket to boost the climb and the jet engine to carry out the rest of the mission.

Two development contracts were let for this aircraft. Saunders Roe started development of the prototype SR 53 in 1952, using the de Havilland Spectre engine, and A. V. Roe began work on the Avro 720, using the Armstrong Siddeley Screamer rocket engine, which used liquid oxygen (LOX) and kerosene, although this aircraft was canceled before it flew. The Spectre was the first application of a closed cycle rocket engine, and in this regard it was technically ahead of any other engine of its day.

The final design of the Spectre engine had a 10:1 continuously variable thrust up to a maximum of 35.7 kN and a topping cycle turbopump. The new engine used the well-tried and tested peroxide kerosene bi-propellant propulsion system. It also had Barske high speed open impeller centrifugal pumps, regenerative peroxide chambers, cooling with pump stages upstream and downstream, gauze catalyst packs, a low loss internal flow turbine, and the use of straight kerosene fuel.



**Figure 6-3:** Spectre firing in the SR 53. Credit: BIS.

In December 1951, Cleaver had asked for the Spectre to be given priority, because it was becoming obvious that the manned rocket-propelled aircraft was

becoming an interim measure until guided weapons were available and therefore haste was required. By July 1952, Val was reporting that the design for the Spectre would be complete by September.

In the early part of 1953 Val had to deal with a possible cancellation crisis, due to defense cuts. This was a situation he was to become quite familiar with during his career. During a period of about three weeks, from mid-January to the first week of February, the Spectre project was under threat, though in the end the program survived. At this time, he was living at Lyndhurst Gardens, London, and Cleaver's writings of the period show the stress he was feeling.

It was also during 1953 that the first sign of Cleaver's frustration with de Havilland began to manifest itself, although it is clear that he had not been happy with the situation at de Havilland for some considerable time. In a letter to Frank Owner, in March 1953, Val wrote that, from 1941 to 1946, his professional life was like:

...one of those horrible dreams in which one can foresee events without being able to prevent them.

He went on to say that he was right to foresee, over five years earlier (1948), the desperate situation the Engine Company would get itself into if it did not expand its staff and facilities. A report, dated March 1953, illustrates his passion:

...I personally cannot continue working under the present conditions indefinitely. At times I have even been led to feel, [which I should not have believed possible] an actual distaste for a job which I have wanted the chance to do for no less than twenty five years.

Cleaver went on to make the point that with the Spectre, he was not dealing with an auxiliary device, but something historically equivalent to the change from propeller to gas turbine propulsion. Such quantum leaps in technology required far more resources than were being delivered by de Havilland. Val also asked for clear and direct responsibility to the Board and the creation of a separate Rocket Division.

It would appear that the situation had not improved during the next six months, because on 2 November 1953, Val Cleaver tendered his resignation to de Havilland. It seems likely that he was asked to put down his thoughts in writing since, on 11 November, Cleaver sent a report on "Rocketry at de Havilland" to Mr. Brodie, the Engineering Director.

In this report is a personal statement from Cleaver, which is extremely revealing in giving an insight into Val's personality and state of mind at the time. It is worth quoting quite extensively from it:

I doubt whether I really deserve the description of a temperamental, highly strung, “touchy” individual. Also, as proof that I can get along well with people I would cite the excellent relations I have always succeeding in establishing with the MOS (Ministry of Supply)..., outside firms and establishments and the internal departments and individuals with whom we work in closest collaboration. However I apologise in advance for the freely admitted fact that my self-control is not always equal to the following situations.

a) Being lectured now about the serious nature of the large development problems ahead of us when I have been sick with worry on this score, and have frequently drawn attention to them both verbally and in writing.

b) Being lectured on various basic facts of engineering procedure of which I am very well aware...

c) Being accused of practices which are just the opposite to those I always follow. For example, within my own department, I delegate far more responsibility to my staff than is usual in this Co.—not less...

...When on Nov. 2 I offered my resignation it was in no way a fit of pique.

The Spectre means a great deal to me and I believe it can also mean a great deal to the RAF and de H's. The future of the project would be adversely affected if I remained in charge of it without enjoying the full confidence of the management (and vice versa)—in administrative as well as technical matters...

...The offer, [of my resignation] was therefore entirely serious and based on much prior consideration... It remains open, if you come to feel that you can resolve the situation in no other way.

Comments from various people who knew Val very well would explain how he could upset individuals:

He would speak his mind ... was forthright and always wanted to be the boss ... was very critical of experienced people who made proposals of a naïve nature ... was not egotistical but could get very vexed.

However set against these traits are the following views:

Generous to a fault, he could always be relied upon for good advice and counsel, especially if you were young and aspiring ... ran the team more like a family rather than an impersonal management structure ... he had a very good understanding of people and their personal involvements...

It would seem that some people at de Havilland were simply not up to the job and were perhaps just a little too hypersensitive to criticism.

There may be another reason why Cleaver was so strident in his feelings. A man who is just a good, competent engineer, and who viewed his job very much as one of mere problem solving, would probably not have reacted in the same way as Val did. The fact that Val did react with such emotion to these problems

shows that he was more than just an exceptional engineer. He had a far reaching vision of space travel, which distinguished him from the run of the mill technician. Almost by definition, visionaries are intolerant of real or perceived pedantic mutterings. He must also have felt that he was becoming sidelined and drifting away from his great dream of artificial satellites and manned space travel. His angst would also have been further fueled by developments in the United States, where Wernher von Braun was well on the way to launching the Redstone missile, a vehicle that had definite space launcher possibilities. Von Braun was also making considerable headway in publicizing the future of space travel and finding a receptive audience in America.



**Figure 6-4:** Val Cleaver in the latter half of the 1950s. Credit: BIS.

In his report of 11 November, Cleaver also went into considerable detail as to how the situation could be improved and, most important of all, repeated his request that a separate rocket division should be formed. It took another year, but Val's wish for a separate Rocket Division became a reality on 1 January 1955.

### **De Havilland – Rocket Division**

The new Rocket Division was still within the Engineering Division, responsible to Dr. Moulton and Mr. Miller for technical and administrative matters,

respectively. Otherwise it would function "with as much autonomy as possible." Val Cleaver became Chief Engineer (Rockets), with Wilf Neat as his assistant.

This was probably not the ringing endorsement that Cleaver would have wished for. A completely separate division (not one embedded in the Engineering Division), and one with direct responsibility to the de Havilland Directors, would have been his aim, as stated in his original report of March 1953. Notwithstanding, he must have been reasonably pleased that at least some acknowledgment had been made as to the importance of rocket propulsion.

The Spectre was fired for the first time in the autumn of 1953, but the tight development schedule was causing concern. Val blamed some of these problems on the failure of not building the engine as a research project at the start of the program.

One development which would have given heart to the team was the issue of a type approval certificate for the Super Sprite in January 1955. This was the first liquid propellant rocket engine to pass a service type test for aircraft take off assistance in the UK. In September 1955 the Spectre was given priority over other projects for the next three months.

A development of the Spectre, called the double Spectre was also produced in the UK for the Blue Steel standoff missile. This was simply two Spectres mounted on a common thrust frame: the system was used to power the development rounds of the missile. Unfortunately for de Havilland, the Armstrong Siddeley Stentor was to become the eventual propulsion unit for the Blue Steel.

In May 1956 Val had to inform Maurice Brennan, the Chief Designer at Saunders Roe, of two unsuccessful attempts with Special Category Tests which, if successful, would have given clearance for the Spectre for experimental flight. It was therefore not possible to give a definite date on delivery of the first flight engine. The problem was due to chamber fractures near the throat, which were associated with combustion "zoning" or hot gas streaks in the chamber. The letter was very apologetic, expressed in the spirit of "our agreed policy of complete frankness," and reflects the fact that Val and Maurice Brennan had formed a close friendship.

In the end perseverance paid off, and, after flight testing in two Canberra bombers, flight approval was given in the autumn of 1956. However, it was to be another six months before the SR 53 flew with the Spectre, to be precise on 16 May 1957. Thirty-nine flights, operating to Mach 1.33 and to altitudes of 55,000 feet, were made with the SR 53. In the end the SR 53 was cancelled because (as was also the case with the Comet) turbojets had become powerful enough to do without rocket assistance and also because of the arrival of surface-to-air guided weapons.

However well before the first flight of the SR 53, Cleaver had left de Havilland behind. His resignation became effective on 31 September 1956, the result of Val being:

...completely disheartened by the inadequate experimental manufacturing facilities at the de Havilland Engine Company.

In a letter to Maurice Brennan, among others, Val described the circumstances of his resignation:

Early in June the Board opened discussions with me regarding their plans for the Rocket Division during the next couple of years or so. In all good faith they made proposals concerning my own future position which were in many ways extremely attractive. However, in equal good faith I felt bound to tell them that I had already decided to leave the firm as soon after the SR 53 flew as was mutually convenient.

...After further friendly discussions the Board decided if we were to part they would sooner it should be with a clean break and as quickly as possible. They have treated me with fair generosity...

At the time of his departure he had nearly 200 staff under his direct control.

## **Interregnum**

Val cashed in his pension fund holdings with de Havilland and had five months off. He took a holiday in Madeira, and by December 1956 he was back in the UK, thinking over an offer of employment from Rolls Royce. From September, he was living with his sister in Durham.

Rolls Royce had been very persuasive, and Cleaver had also been subjected to a great deal of friendly pressure to stay in the UK from people in the Ministry and Industry. Val was in no immediate hurry, being careful not to repeat his experience at de Havilland. He finally accepted the offer from Rolls Royce in late January 1957.

Not surprisingly, during this hiatus, Cleaver had offers of work from America. In a letter to von Braun in January 1957, written after he had accepted the Rolls Royce job, he said:

I still say "expect," because (as you must know better than most people) there is currently a review of the British Defence programme.... I have negotiated a contract tied to the job I want to work on (though Rolls would have liked me on a broader basis), so must just hope it will not have disappeared ... before I arrive all bright and eager.

As you will guess I do not expect this to happen, otherwise I would not have accepted. However if it does, I shall almost certainly be on the market



for an American job, and if the Huntsville opportunity had materialised and you still wanted me, then I'd very probably be most interested.

There is some degree of qualification in the above. The phrases "almost certainly" and "very probably" strike a chord, and indeed in the next paragraph Val is somewhat contradictory and shows a certain reticence to leave the UK:

I have been under a considerable amount of friendly pressure ... to stay over here... This (coupled with personal inclinations that differ from my purely rational career motives) really decided me to stay if possible—together with a feeling I must admit, that this isn't quite the time to clear out.

This reluctance to move away from Great Britain was later further endorsed after a visit to California in the summer of 1958, when it was his lack of empathy with the American way of life, rather than just an attachment for the home country, that told him that the United States was not for him.

### **Rolls Royce – Blue Streak**

Val Cleaver took up his new post as Assistant Chief Engineer (Rockets) in early March 1957 under Adrian Lombard, who was then Technical Director. When Lombard became Engineering Director, Val became Chief Engineer (Rockets).

In the letter to von Braun quoted above, Val wrote about the contract being tied to the job he wanted to work on. That job was the development of the engines for the Blue Streak missile. These engines were to be developed under a license agreement with the American Company Rocketdyne. Cleaver was well aware of this impending agreement while still at de Havilland: in his opinion, de Havilland might have got this agreement instead of Rolls Royce, if the Company Board had shown some initiative when the opportunity offered itself and which he urged on them.

There is some irony in the fact that it was de Havilland that was given the contract to build the missile, under a license agreement with Convair. The overall responsibility for the Blue Streak program was with the Royal Aircraft Establishment (RAE). Blue Streak was a strategic missile with a range of about 2,500 miles, delivering a thermonuclear warhead. It was to be powered by two Rolls Royce RZ2 liquid oxygen/kerosene rocket engines.

The starting point for these rocket engines was the Rocketdyne NA3 engine, which was developed for the Navaho booster. For Blue Streak, a considerably more powerful and lighter engine had to be developed. The first engine to be built was designated RZ1 by Rolls Royce, but this was little more than a copy of

the American unit. Its main purpose was to gain experience in manufacturing and testing, while the design of the lighter RZ2 engine was proceeding.

Rolls Royce used two sites to test the engine systems: the Rocket Propulsion Establishment (RPE) at Wescott and a new site built at Spadeadam, in Cumbria, east of Carlisle. A great deal of early test work was carried out at Wescott by Rolls Royce and, by December 1957, RZ1 turbo pump running had been achieved on the engine test stand at the P2 site. On 21 May 1958 the first static firing of the RZ1 was carried out, for a duration of 4 seconds, and by June this had been increased to 25 seconds. In July the maximum thrust level of 135,000 lb had been achieved. Other sites at Wescott were used to develop the gas generator and turbo pumps. In total six RZ1 engines were built. The first RZ2 firing was also at Wescott, in March 1959, for it was not until August of the same year that Spadeadam was ready for engine tests.

By January 1958 Val was living at “comfortable lodgings” in Carlton Road, Derby, and was finding the firm “first class.” He was obviously extremely busy during this period, but he was beginning to find the prevailing governmental politics sufficient of a worry to once again question the future of rocketry in the UK. In February 1959 he wrote:

All this disenchantment is, no doubt the result of my past 13 years in British rocketry. RR is fine, and the job has not gone off badly so far, technically speaking. But... official policy vacillates worse than it did on the rocket fighter, and inter-Ministry and inter-service politics are terrific and although the expenditure is very high—it is not large enough.

In the same letter he called himself “the tired crusader” and was conscious of becoming a mere spectator, even though his interest in space travel was as great as ever.

In 1959 Cleaver was nominated by the BIS to serve on the Founding Committee of the International Academy of Astronautics (IAA). When the Academy was formally instituted, at the 11th Annual International Astronautical Congress in Stockholm, in August 1960, he became one of the founding members in the Engineering Sciences Section. By this time Val had moved to new lodgings in Stenson Road, Derby.

Blue Streak required a double engine assembly, designated RZ12, and testing of this began in March 1960. By May 1961, nearly seven hours of RZ2 testing and more than two hours of RZ12 testing had been accomplished, which illustrates the pace of the program. In addition, some 23 hours of component testing had also been undertaken to back up the engine development.

Val’s misgivings about the commitment of the UK Government to Blue Streak were finally realized when, on 13 April 1960, Blue Streak was cancelled.

The project was about to enter a very costly phase, which the Government felt the country could not afford, and this was a major factor in the cancellation. The United States offered the Skybolt air launched missile, but this, in turn, was cancelled due to technical difficulties: Great Britain's nuclear deterrent eventually became the responsibility of the Royal Navy in the form of Polaris.

Cleaver was not surprised at this turn of events and was fairly philosophical, hoping that a new role for Blue Streak could be found in a British space program. Since the late 1950s, some thought had gone into how the UK could launch a satellite. The main proposal that emerged was the use of the Black Knight or Black Arrow rockets as a second stage, atop a first-stage Blue Streak.

At Rolls Royce, firings were still going on at Spadeadam and Wescott, but at a reduced rate, and rocket engine manufacture was being run down as fast as was convenient. Cleaver was resigned to losing some of his staff to other Rolls Royce departments and to other companies. In May 1960 he wrote about the prospects for a British program based around Blue Streak:

It is my personal and unofficial guess that we have about a 70% chance of obtaining approval. If we do I shall see the thing through to the bitter end in spite of a strong emotional urge to say, "the hell with it."

Despite Cleaver's optimism, the British Government felt that an independent UK satellite launcher on the scale envisaged was as much beyond the financial capacity of the country as was a ballistic missile. However, a considerable amount of material and facilities were already available for satellite launcher development, which would have to be scrapped if it were not redirected to this cause. Thus the idea of European cooperation was conceived and, with it, the birth of the European Launcher Development Organisation (ELDO).

### **Rolls Royce – ELDO**

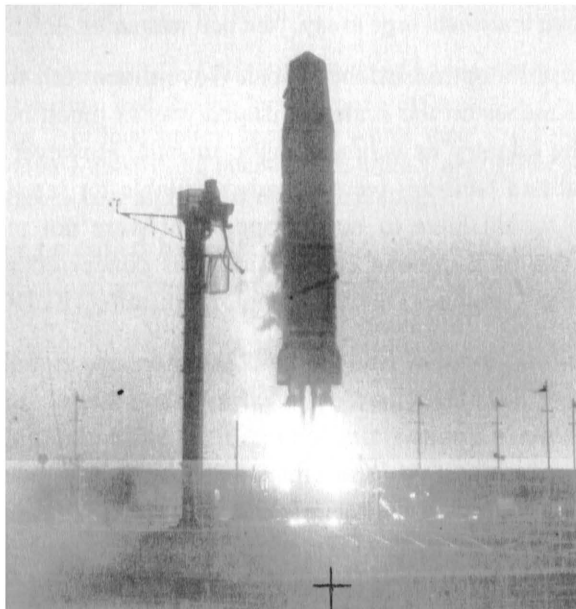
The start of the process to form a European space launcher began at Strasbourg in late January and early February 1961, with the ELDO convention signed on 30 April 1962. The road to form a working launcher organization was somewhat tortuous and, not surprisingly, Val found the whole procedure extremely frustrating. As late as March 1963 he wrote:

ELDO—so far there are few signs of any organisation...must see it through...for next 2 years, (unless ELDO does collapse)...by 1965 I shall know whether ELDO will endure as a worthwhile organisation. Quite frankly as long as there is even a sporting chance of helping Europe to become even a modest third force in space...I would rather stay this side of the Atlantic.

Cleaver was at least taking solace in the fact that he was moving toward his real ambition of spaceflight, and this was his best chance yet of becoming part of the grand adventure. He was quite pro-European in his outlook and saw the European movement as the natural evolutionary path that would lead to stability. His love of Great Britain was definitely cultural and not jingoistic.

ELDO came into force on 29 February 1964, after the Member States had ratified the convention, with the ELDO Council meeting for the first time on the 5–6 March 1964.

The Europa rocket that emerged from all these deliberations was a three-stage rocket with Blue Streak as the first stage, a French second stage, and a German third stage. The RZ2 engines for the Europa vehicle were uprated to 150,000 lb thrust each. The first Blue Streak (F1) was launched successfully from Woomera in Australia on 5 June 1964. One can imagine Val's feelings on that day: relief, pride, and sheer happiness, surely. To add to his sense of achievement, Val Cleaver was awarded the OBE in the New Year's honors list in 1965, for his work on Blue Streak.



**Figure 6-5:** Blue Streak lift off, Woomera. Credit: BIS.

Two more single-stage flights were successful, but then, in 1966, Great Britain attempted to leave ELDO because of escalating costs and slipped schedules, although it was persuaded to stay in the organization. Cleaver was very active in lobbying support for ELDO with Members of Parliament, ministers, and

journalists, to the extent that he was thinking of founding a new professional body, the Institution of Political Engineers! Val felt that the new agreement would take “us up to 1970” and that ELDO was on a firmer basis than at any stage in the past.

In 1966, Rolls Royce took over Bristol Siddeley Engines (of which Armstrong Siddeley had become a part in 1958). As a result, the rocket departments of the two firms were integrated within the Industrial and Marine Division (IMD) of Rolls Royce at Ansty, in Coventry, and Val became a Divisional Director and General Manager (Rockets).

Although, from 1967, Cleaver’s office was at Ansty, he lived in a local hotel during the week and spent his weekends in Derby—an arrangement which continued for the next five years. At that time, he was responsible for about 165 staff at Ansty and 650 at Spadeadam. He also assumed responsibility for the development of the ex-Bristol Siddeley Gamma 2 and 8 (high-test peroxide [HTP]/kerosene) engines for Black Arrow. His department was also working on an experimental LOX/liquid hydrogen, (LH) thrust chamber called the RZ20 for ELDO.

Val was not particularly enamored with taking over the Bristol project, as he wrote in May 1972:

I inherited its engines in the summer of 1967 and all the head aches of brick making without straw.

The Black Arrow was massively underfunded and had been on a three-month holding contract until, reluctantly, in 1966, the go ahead was given for a satellite launch.

The first Europa vehicle with upper dummy stages, (F4), was launched successfully from Woomera in May 1966. The next seven launches involved active upper stages to varying degrees and, although the Blue Streak stage performed successfully, there were problems with the upper stages and the launches overall were not a success. The last launch, (F11), was from Kourou in French Guiana on 5 November 1971.

In 1968, Great Britain decided not to fund ELDO after 1973 and this effectively marked the end of UK involvement in large space launch vehicles. In 1970 Val mused that he could:

...get along as a chauffeur or a village schoolmaster or something.

Further blows to the UK’s space industry came in July 1971, when Black Arrow was cancelled. However one further launch from Woomera was sanctioned and, as it turned out, this was to launch Great Britain’s first completely

independent satellite. Val was led to remark that at least he had the satisfaction of “touching space with his big toe!”

As a consequence of the Black Arrow cancellation, for the next six months Cleaver was preoccupied with the redeployment or redundancy of about 110 people from the ex-Bristol Siddeley rocket team. With the end of ELDO work in sight, he would be faced with another redundancy problem in a couple of year’s time. In January 1972 he wrote:

...which this time will involve myself at age (then) of 57. Too old to be re-employed or too young to retire, at least on any reasonable pension.

Obviously Val was in very low in spirits at this time, and it is significant that he was now starting to think seriously in terms of life after rockets, something that had not been particularly apparent up to then.

There was, however, one engineering compensation during the closing days of ELDO: the RZ20 LOX/LH engine, which was being developed by Rolls Royce as a Europa third stage. A successful firing took place at Spadeadam for 10 seconds, when the performance of the chamber was equal to that predicted. The contract was cancelled the day before this firing!

In early 1972, Val moved into a flat in Coventry and ceased his weekly commute from Derby. He had lived in “comfortable and convenient lodgings” in Derby, but the couple who owned the property had split up and he decided to move. The flat was called the “Penthouse” and was in Binley Road, about five miles from his office. It had a large open plan lounge, with a cocktail bar at one end and two bedrooms, one of which he used as a library.

Val’s prediction of redundancies was unfortunately fulfilled during 1973, as ELDO work was rapidly run down. He had to deal with 332 people over an eight-month period at Ansty and Spadeadam. Much hardware was sold, and the Rocket Division closed down.

## **Rolls Royce – Headquarters**

From 1 January 1974, Val Cleaver was seconded to the Headquarters (HQ) staff of Rolls Royce, as part of the Company Market Directorate. He continued to operate from his old office in Ansty. In January 1974 Val wrote:

...I am told my field of work will be the “application of Company skills and know how in the energy business to market opportunities for the future.” This sounds potentially interesting but I will tell you in about a year’s time whether it is a real job, or just a kindly device to put an old horse out to grass!

Thus began Cleaver's final phase of employment, removed from his first love of astronautics but approaching the job with a resigned realism.

In the event, Cleaver found that he was actually listened to during the next few years, but the money was never available to expand any of his ideas. Among his contributions during this time were a study of large, closed-cycle He gas turbines run from high temperature nuclear reactors; looking at proposals made to the company from outside; representing the company at meetings on energy and general research and development; helping Ken Wilkinson (Vice-Chairman) to prepare his monumental paper on "The Technology and Economics of Air Transport in its Next Phase"; and being the independent chairman of an IMD working party on future policy for gas turbines used in electricity generation. His comment on this work was:

All of which is very interesting ... though less exciting to me personally than rocketry and space. This remains my greatest personal interest but in default of any opportunity to continue in that field, I feel I have been treated very generously by RR over the past two years.

During these years of his life, Val's writings, not surprisingly, become much more reflective and introspective. He still read a lot; enjoyed music, the theatre, and films; and spent most of his weekends with friends rather than in his flat. He spent his Christmases with his sister in Durham.

Val always revealed a lot about himself in his letters, but even more so during this period. In particular, his views on marriage are very interesting. He wrote in August 1976:

Some slight feelings of regret perhaps, all the same because during the last five years or so, and for the first time in my life, I have sensed that lack of support which can come from an understanding wife and family, not least by providing reasons for a continuing personal interest in life. As one's career—activities diminish, for one reason or another one feels like a spectator at some game one used to enjoy playing oneself...

Val had many good friends, Arthur C. Clarke (he was very close to the Clarke family) and Les Shepherd among them. He also liked children and was a "god father or unofficial uncle to at least ten children." All this would have been some compensation to a lonely man.

Cleaver's writings on his career also illustrate how much of a political manager he had become:

Basically of course I am an engineer... However my experience has not been confined to this, but has for a long time embraced duties of an unusual and varied nature: administrative; commercial; international collaboration; even political.



**Figure 6–6:** Val Cleaver and friends at the Post Office Tower, London, 28 August 1972. From left to right, Arthur C. Clarke, Hector Ekanake, Joerg Ruppe, and Val Cleaver. Credit: BIS.

#### Writing about his days at de Havilland:

However this new specialised field was really outside their mainstream activity, so I was left very much to cope on my own—to promote the product, organise and control my new and growing department in every way and handle any political problems which arose... The trend started at de Havilland's, but was accentuated at Rolls Royce.

It was because of Val Cleaver's forceful, multifaceted, and imaginative personality that he was able to take on this political challenge and drive his vision and ideals through the labyrinth of official skepticism and hostility. Overall, he probably enjoyed this aspect of his job because it utilized his undoubted social skills.

Throughout his working life, Cleaver had served on many committees and organizations. Two of the most notable were the Royal Aeronautical Society (RAeS), of which he was a Fellow and its Chairman (twice), and his membership of the Aeronautical Research Council (ARC), where he was a member of the Astronautics Committee.

Unfortunately, soon after he commenced work at Rolls Royce HQ, Val Cleaver was afflicted by ill health. He had a minor coronary in early 1974 and was diagnosed with diabetes in October 1975, although this did respond to treatment. In March 1977 he suffered a mild stroke and was off work for about three



months. By July he was back in his office, although taking it very easy. Val was experiencing difficulty in reading and was very lethargic.

In August 1977, he was looking forward to seeing one of his favorite god sons, Joerg Ruppe from Munich. They arranged to meet on 16 September at the Excelsior Hotel at Heathrow. Val died of a cardiac arrest in the hotel on that date. He was 60 years old.

Thus ended an incredibly rich and eventful life, full of enterprise and adventure. The tributes were fulsome, but the last word is probably best left to Val's old friend, Les Shepherd:

From the standpoint of the full realisation of his personal ambitions he might have judged his endeavours to have failed. He was born and worked in a country that was not able to afford the great effort that was required to put man into space. Had he been a citizen of the United States he would undoubtedly have been in the front line of the assault on space. But he was recognised not only by the honorary membership, not only of his native BIS but also by the astronautics societies of other countries, notably West Germany and the United States, by people who appreciated that pioneering was not just a matter of producing the ultimate hardware. On any reasonable definition, Val Cleaver must be judged to have been one of the true pioneers of Astronautics.

### **Acknowledgements**

The authors would like to thank Alan Bond and the members of the British Interplanetary Society History Committee for their invaluable help in preparing this paper. All source material used in this paper can be accessed in the Library and Archives of the British Interplanetary Society.

### **Reference**

- <sup>1</sup> A. V. Cleaver and L. R. Shepherd, "The Atomic Rocket," *Journal of the British Interplanetary Society* (September–November 1948 and January–March 1949).