Remembering EG&G

We honor the memory of one of the most remarkable scientific, engineering and business partnerships in American History, Edgerton, Germeshausen and Grier.

Remembering EG&G
Presented by Michael Hall
&
Smithsonian Affiliated National Atomic Testing Museum
Executive Summary

Vita:

Using lessons of the past to better understand the present. Central to our mission is preserving the ongoing legacy of the historic Nevada Test Site and nuclear testing. We serve our nation's Cold War era veterans. We also focus on science and engineering themes for our school-based programming. Our Museum provides collection-based exhibits and related learning activities for greater public understanding and appreciation of the world in which we live. Our collections and programming are inseparably linked to serve a diverse public of varied ages, backgrounds and knowledge. Designated by an act of Congress, the National Atomic Testing Museum is charged by Congress to preserve a unique aspect of our nation's history and serve its national community.

Mission:

Educating a multigenerational audience through interdisciplinary programming, engaging exhibits and lectures as we honor the men and women who have addressed the challenges of the nuclear age in war and peace.

Vision:

Preserving, documenting and teaching all aspects related to the United States' adoption of nuclear deterrence, which is the credible threat of retaliation to forestall enemy attack. Addressing current issues of proliferation, emergency response and stockpile stewardship. Striving to expand our mission in 2017 with the unveiling of the new Master Interpretive Plan. Developing creative programming, exhibits and publications dealing with geo-political currents involving North Korea, China, Iran and Russia.

Core Values:
1. Deliver excellent customer service and total access.
2. Remain innovative and responsive to diverse audiences.
3. Provide engaging programming, exhibits and publications.
4. Educate and welcome all who walk through our doors.
5. Pursue growth and responsiveness within our community.
6. Maintain a competitive and efficient business operation with complete transparency.
7. Do more with less.
8. Show passionate and determined energy with a sense of humility.
9. Decision making arrived at through teamwork and consensus.

Brief Institutional History:
The National Atomic Testing Museum opened its doors to the public in 2005 after an extensive fundraising campaign supported by U.S. Senator Harry Reid along with the Nevada Congressional Delegation. It is an affiliate of the Smithsonian Institution and has been designated by an Act of Congress to preserve a unique aspect of our nation's history and serve its national community. The National Atomic Testing Museum represents a key part of the history of this Nation, documenting the nuclear arms race since the dawn of the atomic age in 1945. This museum is critical to our community because many of the people who live and work in Las Vegas today are the sons or daughters or grandchildren of the over 200,000 scientists and engineers who came to this part of the country during the days of atomic testing.

Our Community:
We are blessed to live in a community that serves, on average, fifty-two million national and international visitors per year. Likewise, our Museum is fortunate to be located within an immediate entertainment district which serves those millions of visitors. Our Strategic Plan therefore focuses on serving a large and diverse audience that is in part international in character. We also stress viability.

We continue to analyze our mission and have recently undergone a complete facility review as we draft a new Master Interpretive Plan with the design firm Andrew Merriell and Associates. The review indicates that people who tour the National Atomic Testing Museum leave with a good impression of the general events surrounding nuclear testing and the history of the Cold War. Others glean some useful associated stories from our innovative use of timelines that address many important topics of the Cold War era. Our Museum thus does well in providing a good overall "experience." That experience is appreciated by an extremely diverse audience.

As the new executive director of this Museum, and someone who has managed four museums in four different areas of the country over the past thirty-three years, I am most struck by the uniqueness of our exhibits. We are not a conventional gallery space where visitors spread out and look at areas independently. We instead provide a viewing experience as opposed to a space to be viewed. We tell a story very much associated with a time-line of history, and walking through our Museum is to me similar to walking through a tunnel of time. I thus feel the unique design and layout of our Museum is a tremendous strength given that we are in an area that heavily relies on serving a diverse audience. Our audience, both out-of-town and local visitors, expect a certain entertainment factor as well as an educational experience. It is vital for us to be competitive with a whole host of entertainment venues. We have to actively engage our patrons while we educate.

We run the Museum as a business so as to maximize our ability to carry out our mission of education. While our mission is important to us, we do not always have the luxury of focusing solely on that alone. Unique programming and exhibits that do not always directly relate to the mission of the museum are also valued because they help pay the bills and maintain some of the exceptional professional staff we have.

We are now instituting yearly fundraising events, many of which focus not on our out-of-town visitors, but on our local patrons who founded this museum. We are now instituting new family-friendly events such as family fun days to get younger people engaged in our Museum while participating with their families. This is providing a whole new supplemental membership base. Other yearly events like our *National Day of Remembrance* continue to honor our founding spirit.

Over the past thirty years I have seen a lot of fine museums with great adherence to high ideals and a sincere desire to tell a particular story but with an equal passion for inflexibility to innovation. Sadly, most of those museums failed and stand as empty buildings today. The National Atomic Testing Museum is too important to fail, and it will grow and prosper because we are doing important evaluations now while being responsive. We are moving forward.

Beginning long-term strategic planning is thus a part of our commitment to insure a future for the important mission we have. That may involve expanding our mission to create new exhibits on the ever-evolving work at the Nevada National Security Site. Continual ongoing writing and research highlighting civilian and military contributions to the history of the former Nevada Test Site are also critical. Those men and women who worked and served to win the peace of the Cold War represent "our" veterans whom we want to honor.

There are so many associated stories of people and events which can add to our Museum's exhibits and programming. We hope that more key biographical sketches will be on display. Soon temporary exhibits will be implemented exploring current issues in nuclear proliferation. Some of these may be virtually presented on our web page as well as in a new temporary exhibit area. In 2017 we hope to get the first segments of our *World of Radiation Exposure* exhibit on display while retaining an upgraded version of the *Area 51* exhibit based on documented time-lines. These will be displayed in our new dedicated theater space opening in 2017.

As we move this Museum into the future, I am continually struck by the passion of the many veterans of the Test Site who continue to give this organization so much support and guidance. Those men and women who serve on our board and as our stake holders are our greatest asset. They allow us go into the future with steady determination as we value our past.

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Remembering EG&G, Part I
Seeing the Unseen

In the brief time I have been here as the new Director at the National Atomic Testing Museum, I have noticed that one of the most frequent inquiries concerns historical questions about the former contracting firm to the Nevada Test Site, EG&G. Of course we tell everyone that we carry a very complete book in our Museum Store detailing the history of EG&G. The book is authored by Nevada Test Site Historical Foundation Board Member and former EG&G General Manager Peter Zavattaro. This work is an invaluable tool for researchers. Mr. Zavattaro has also provided us a fantastic resource through his donation of a collection of historical documents on EG&G. As a former archivist, I am very eager to give a little publicity and appreciation for this collection. Gleaning these valuable historical treasures, we have put together a brief sketch concentrating on the very early days of EG&G. Hopefully this will provide an example of the high caliber of wonderful research material we have available thanks to Mr. Zavattaro. My brief sketch will be divided into seven parts.

EG&G traces its origin to Dr. Harold "Doc" Edgerton, Kenneth J. Germeshausen and Herbert E. Grier. These three Massachusetts Institute of Technology scientists combined their talents and initials to create the firm EG&G. Known originally as Edgerton, Germeshausen and Grier, Inc., the firm later became known as EG&G. When officially incorporated in November of 1947, the company assisted the newly formed Atomic Energy Commission in "design and operation systems that timed, monitored, photographed and triggered nuclear tests." That's the official line, but a look at the actual personalities involved provide a much more interesting story than corporate facts and figures.

The founding members of EG&G had been active in producing innovative design concepts as far back as the 1930s. It began with MIT professor Harold Edgerton who had been a pioneer in high speed photography since 1927. Known affectionately as "Doc" to all who worked with him, he developed stop motion techniques to study rotating machinery. Dr. Edgerton first used a mercury arc rectifier to produce a powerful flash of synchronized light to master this stop motion photography. Then he devised the strobe light which was a rapid flash created by passing electrical current through a vacuum tube filled with xenon gas. He called it "God Almighty's lighting in a container." By 1931, he partnered with his MIT graduate student Kenneth Germeshausen to found a small technical consulting firm. Germeshausen actually helped develop in collaboration with his mentor the xenon flash tube. He also played a role with Dr. Edgerton in securing patents in a continuing quest to refine high speed photography. Often Dr. Edgerton's inventions originated from promoting an environment among his students in which a free-flow of ideas thrived. Many of his pupils became partners in various enterprises. With a famous crooked grin, Edgerton mentored hundreds of students with an unshakable optimism and a total lack of ego. Outside Doc Edgerton's MIT office an exhibit hall evolved over the years displaying his many inventions which became known as "Strobe Alley."

Dr. Edgerton and Germeshausen were then joined by MIT graduate student Herbert Grier in 1934. Grier helped further refine a powerful strobe unit and became the engineering expertise behind developing specialized instrumentation. The three maintained a very informal consulting group which continued advancements in stop motion photography and did extensive research in strobe flash photography and electronic flash products. Their invention of a small strobe unit called the Strobotac was licensed to *General Radio Company*. Peter Zavattaro writes in his history about this early period: "The three never had a written agreement, nor was there any specific point at which the partnership was formed. They simply pooled their resources and worked together on whatever consulting task or measurement problem came along."

Interestingly, and as a side note, Dr. Edgerton often used his remarkable flash photography system for a personal hobby of his. This involved the study of hummingbirds. His photography captured the first still images of the high-speed wing movements of these birds. After the War he went on to author many articles in National Geographic Magazine on the hummingbird. A popular book by Dr. Edgerton "Flash-Seeing the Unseen" comprised an amazing collection of high speed photographs detailing all sorts of natural everyday wonders. He proved cats lap milk with both the top and bottom sides of their tongue and that the kick of a pistol does not affect a shooter's aim because the recoil does not set in until after the bullet leaves the barrel. Pictures depicting simple images such as water droplets produced amazing sites and even had an artistic quality to them. Today the New York Museum of Modern Art proudly owns some of the stop motion photos of Dr. Edgerton who always shared creative and title credit with Germeshausen and Grier. Famed photographers Edward Steichen and Ansel Adams highly praised Dr. Edgerton's works although he never considered himself an artist, rather an engineer and most of all a teacher. Numerous books by Dr. Edgerton, detailing his photos, are still in print and widely available.

New York Museum of Modern Art, gift by Dr. Harold Edgerton. Edgerton's multiflash photography, illuminating his subject 100 times per second, delineates the details in the movements in the sequence of an Indian club being swung; taken in 1939 and titled Indian Club Demonstration. Gelatin Silver print 13 x 10inches.

By 1940 the MIT team had produced the first portable flash for news photographers and marketed it through *Eastman Kodak*. The stroboscopic instrumentations became a valuable invention used by the United States Army Air Corps during World War Two in night photography. It allowed valuable and timely nighttime reconnaissance without using flares. This photography provided a way to evaluate the daring U.S daylight bombing raids over Germany and is what first brought the scientific team of Dr. Edgerton, Germeshausen and Grier to the attention of the military and thus led to a long association with the United States government.

Dr. Edgerton continued to focus a great deal of his research at MIT on night aerial flash photography which came to be used in both theaters of war. Germeshausen worked with the MIT Radiation Laboratory and concentrated on radar work with his study of thyratrons and modulators. Grier worked in the Draper Laboratory which was the MIT aviation

instrumentation laboratory known as the Confidential Instrument Development Laboratory. That became a connection to the Manhattan project.

By this time, Dr. Edgerton and his colleagues had developed what became known as the rapid action electronic shutter "Rapatronic Camera" which basically utilized a very high-speed, short duration, shutter exposure that allowed exposure times as little as two microseconds. High speed photography has significant uses in scientific research of all kinds. It became very important during the Manhattan Project in researching implosion theory by taking extremely high-speed photos of the troublesome-shaped charges in the explosion tests. Most importantly, the group's first-hand contributions provided technical assistance via their experience in stop-motion strobe pulse rate photography in the timing of electrical pulses that finally made simultaneous detonation possible of the many geometric-shaped explosive charges that were to surround the plutonium core bomb designs.

Mainly under Grier's supervision, engineers used equipment like large electrical capacitors for the detonating process, which the MIT trio had developed for the earlier airborne flash systems. Not only were the electrical discharge systems of the flash systems used but also the very factory in which they were made. These flash systems were assembled in a Raytheon factory near MIT, however, the production line soon facilitated an electrical detonating system for the nuclear "Fat Man" implosion bombs. For the logistics of this work the three men utilized the actual infrastructure of MIT itself, relying on the University's contracting and procurement system that already accommodated a lot of instrumentation made for the war effort.

At that time a fourth person, Bernard (Barney) J. O'Keefe, came into the story. O'Keefe would eventually become a key part of EG&G and compliment the original MIT trio. Peter Zavattaro writes in his history on EG&G:

"Barney O'Keefe was an ensign in the U.S. Naval Reserve. With an engineering background and interest in radar, he hoped to be attached to the Naval Research Laboratory in Washington, D.C., area. Instead, he was given new orders, sending him to Santa Fe, New Mexico, as part of Engineering 'Project Y.' Barney O'Keefe thus became involved with the Manhattan Project in its early phases. He worked on firing systems and later participated in the deployment of nuclear weapons from Tinian Island that were dropped on Hiroshima and Nagasaki. After the war, he was with one of the first engineering teams to go into Japan. . . Although O'Keefe's original assignment was to work on arming radars located in the tail of the nuclear weapon, he became interested in the technical problems of the design of the detonator firing unit for the implosion device. . . [O'Keefe even assisted in test drops of the bomb designs, flying with Charles Sweeney's crew out of Wendover. . . To pursue this interest, he managed to get transferred to the firing group X-5, in the Explosives Division at Los Alamos. Since the time was so short for the design and production of the firing sets at Los Alamos, the procurement people set out to find an existing factory they could commandeer. They found a Raytheon factory in Boston, Massachusetts, that was assembling night aerial photography systems under Herb Grier's supervision."

Basically, that is how Grier and his associates met Barney O'Keefe although the association did not really mature until after the war ended. In the hectic days of trying to get the bomb ready, Grier's contribution proved critical. The production of electrical discharge systems which the team had designed for aerial stroboscopic photography ceased and the Raytheon factory producing them converted the equipment for bomb firing sets. The former employees who worked on the photography units were retained and redirected to make the firing systems although they were not made privy to what they were doing at

the time. Grier and his associates who had already been connected with the photography work contributed to the actual design and construction of the firing sets. As Peter Zavattaro documented, O'Keefe at that time followed the Fat Man bomb all the way to Tinian Island to assist in arming it as an officer in X-5 activities.

I recently came across a copy of Barney O'Keefe's memoirs published by Houghton Mifflin Company in 1983 under the title *Nuclear Hostages*. He provides a fascinating account of his mission to the Pacific:

"The overseas operation was known as Project Alberta, under the command of [Navy] Captain Parsons. Our job would be to do final rehearsals and activate test drops at Destination, assemble the devices, and provide weaponeers to fly the combat missions. On Thursday I was informed that I would be carrying the final top-secret assembly drawings for the Fat Man because the lab did not want to trust anything so important to the regular military courier service. I did not mind that, although it would be a nuisance and meant that I would not be able to go to a bar or leave my hotel room on the way. What was more important that day was that my plane would be delayed going to Los Angles; I wouldn't be able to get to San Diego until after closing time for the payroll office. Parsons and all the senior naval personnel were traveling, so I wasn't sure what to do.

I had an appointment that afternoon with Oppenheimer. He was making it a practice to have a final talk with each person leaving for the Pacific. He greeted me warmly, shook my hand, gave me a little pep talk, and asked me if there was anything he could do for me before I left. I said: 'Oppie, I have a problem. I hate to bother you with it, but all my superior officers are traveling and I didn't know what to do. Because our Navy group on the Hill is so small, we get paid out of the Eleventh Naval District headquarters in San Diego. I have to get to San Diego to pick up my pay accounts so I can eat. My plane is delayed, so I won't get there until after the office is closed. Peer de Silva has given me the Fat Man assembly drawings to carry with me; I am sure they'll be unhappy if I spend the weekend in San Diego.' Oppie Grinned. 'I'll take care of it.' I then realized the power of the Manhattan District's priority. He picked up the phone, dialed a number in Los Angeles, and identified himself by a code name. He told the person on the other end my problem. He then said, 'Have a plane ready at the Los Angeles airport to fly Ensign O'Keefe to San Diego and wait for him while he picks up his pay accounts and fly him back to Los Angeles. Call the admiral in San Diego and tell him to keep the office open until O'Keefe gets there.' 'That should do it,' he said as he shook my hand. 'Good luck!' . . .

With my Top-Secret documents, I was able to get a seat on the Pan American Clipper across the Pacific to Hawaii. . . From Hawaii I took a military air transport to the Marianas. . . When we arrived on Guam, I accompanied Parsons to Admiral Chester W. Nimitz's headquarters. The place was teeming with admirals, but Parsons was treated with special consideration. We met the great admiral and General Curtis E. Le May, commander of the Twenty-First Bomber Command, to which we would be attached. It was then I learned we were going to Tinian, one of the northern islands in the Marianas, 1450 miles from Tokyo. . .

The harbor was loaded with ships landing supplies for the invasion, now only 120 days away. Night after night, hundreds of B-29s plowed down the four runways, loaded with fire bombs and high explosives, the gasoline tanks filled to take advantage of the last foot of solid earth. . . On March 25, one thousand aircraft participated in a massive fire-bombing of Tokyo, which left 125,000 dead. . .

The men of the 509th were not highly regarded on Tinian. First, there was the secrecy. The area was tightly guarded, with the planes under special surveillance. To the thousands of men on the island, what could be so secret? They were living from day to day, from mission to mission, under constant observation by the hundreds of uncaptured Japanese on the island and thousands more on neighboring islands that had not been taken by the Americans. Every move they made, every new outfit that came on the island, was announced the next day on the radio by Tokyo Rose. If something new would shorten the war, why not use it? Every day, every hour was important to them. . .

When we arrived at our base, we worked around the clock getting our compound ready. We didn't have any operating firing sets, only dummies to be used for ballistic drops. I flew a number of missions with the dummies. . . As the month of July rolled on, operational sets began to arrive, but we were not

able to test the first one until August 1. . . On July 12 Parsons flew back to New Mexico to fly as an observer over the Trinity shot. . .

A few days later people started coming in from Los Alamos with sensational stories of the magnitude of the Trinity blast. Parsons returned and took me with him to a meeting on Guam. Admiral Nimitz was there; so was General Carl 'Toey' Spaatz. . . General LeMay was present, as were Tibbets and some of his pilots. Here I was, a lowly ensign, listening to Spaatz and LeMay talk about what Truman has said to Stimson and what Marshall had said to Eisenhower. It was very impressive. Since the senior people were aware of the success of Trinity, Parsons was treated as some sort of conquering hero, even though the test was not mentioned. Spaatz and LeMay had wanted Kyoto as the primary target, but had been overruled by Secretary Stimson, who felt that Kyoto, as the former capital and the holy city, should be spared. Everyone then agreed on Hiroshima as the primary target, with Kokura as second and Nagasaki as third. All were military targets in addition to being large enough cities for effects to be widespread.

On July 26, the cruiser Indianapolis arrived with the uranium and the gun for the first weapon. . . My own group had nothing to do with the assembly of the gun-type weapon. . . Parsons was the mission commander [for arming the Little Boy bomb]. He decided to complete the final assembly of the bomb after takeoff. . . In the Fat Man assembly hanger, we worked around the clock. The original date for the first combat implosion weapon was August 20. Toward the end of July the date was rescheduled to August 11. The biggest problem was still the firing sets. We knew that the basic design was sound because it had functioned properly on the tower at Tinian, but we still didn't have enough flight data. Back in the States testing was still going on at Wendover. It was not until the end of July that sufficient firing sets had been tested to confirm their safety with high explosives; the first explosive -filled Fat Man with an active firing set was tested at Wendover on August 4, and we tested the first explosive-filled Fat Man with a firing set from Tinian the day before the device was used in combat. . . By ten o'clock on the night of August 7, the sphere was complete, the radars installed, and the firing set bolted onto the front of the sphere. . . I was to come back at midnight for the final checkout and to connect the two ends of the cable between the firing set and the radars. . . When I returned at midnight, the others in my group left to get some sleep; I was alone in the assembly room with a single Army technician to make the final connection."

O'Keeffe made a hair-raising discovery that night when he found that the connecting cable to the firing sets in the bomb had been installed backwards with the wrong end facing outwards. Changing the cable out would have meant removing hundreds of bolts. Such a problem could have held up the tight schedule of the second mission by days under any normal circumstances. Yet, O'Keefe was an engineer and engineers can adapt quickly. He solved this problem on his own initiative by soldering on a new cable connection. He never even had time to tell anyone, and the mission went according to schedule. O'Keefe was scheduled to fly on the third nuclear mission, but the surrender of Japan came on August 14th. He then served on a special scientific mission to Japan headed by Dr. Philip Morrison. Their mission was to see if the Japanese had tried to develop its own nuclear program. That team eventually turned

their findings over to MIT president Karl Compton and his brother Arthur Compton who both served as General MacArthur's scientific advisors. It amazed O'Keefe on his trip how Japan could have waged such a savage war with the West. The more he traveled around the country the more he realized how rural and non-industrialized most of the nation was. He described Japan as basically a collection of small pockets of modern civilization among a preponderance of primitive agriculture comparable to the seventeenth century. Amazingly, Japan's scientists had cleared more technical hurtles than Germany did; however, the taskforces that investigated both countries after the war concluded that neither country came close to marshalling the resources needed for a Manhattan style project. O'Keefe felt as if the bomb definitely ended the war in a timely fashion and thus saved many American, as well as Japanese lives. Nevertheless, he remained horrified at the terrific casualties and wounds caused by the very bomb he had worked on just weeks earlier.

Remembering EG&G, Part II
Forming EG&G

After the War in 1946 O'Keefe left the Navy and received an appointment from MIT President Karl Compton as a research associate. O'Keefe served in Dr. Edgerton's Electrical Engineering department and as an associate project manager in Grier's classified research work. By then Grier had been contracted to redesign the firing sets originally produced at the makeshift assembly operation in the war-time Raytheon factory. Those early firing sets, developed from the electrical high voltage discharge systems for aerial stroboscopic photography, sufficed to fire the first atomic weapons, but a more refined design needed to be developed. Grier was tasked with that and O'Keefe assisted him in that work since he had actually been the one to oversee finally armament of the Fat Man on Tinian.

While working at MIT with the original trio, O'Keefe also pursued private consulting activities. One of those ventures involved a former associate from Los Alamos, Donald Hornig, who had invented a radiation measuring device for infrared spectroscopy that was being built in the Cambridge laboratory. They later formed a partnership and then a corporation called the Radiation Instruments Company. However O'Keefe continued all along to work simultaneously at MIT. O'Keefe and Hornig later sold their company and O'Keefe went to work for EG&G when it was formed. The experience O'Keefe initial gained in forming his early company greatly assisted Dr. Edgerton, Germeshausen and Grier when they formed EG&G.

From 1945 to 1947, Dr. Edgerton, Germeshausen and Grier handled many classified weapons development projects at MIT. The classified work at MIT actually centered more on Grier. In actuality, Dr. Edgerton liked to focus the majority of his time on electrical measurement studies, serving as a professor of that department at MIT. Germeshausen wanted to continue his work begun during the War on his inventions of the hydrogen thyratron and modulators for radar as well as the team's strobotron. Simultaneously, these men were retaining their interest and apparent entrepreneurial dappling in the field of high-speed commercial photography. O'Keefe became more and more of a protégé of all these men as time went on and his innate business sense became a valuable resource for them.

These of course were logical people to call upon after the war as nuclear research continued in the wake of the growing Cold War. Logistically, the formation of the Atomic Energy Commission in 1946 became the "government conduit" to engage such brilliant people. This was a critical move because by forming the AEC, President Truman took nuclear weapons out of the hands of the military and to this day they remain under civilian authority. In 1947, Norris Bradbury (successor to World War Two Manhattan laboratory leader Dr. Robert Oppenheimer) went to MIT to visit the scientific trio. Bradbury asked the men to build special firing triggers for the upcoming tests to take place in the Pacific. Accepting the job however soon overloaded the MIT contracting and procurement system which had previously been set up by Grier to handle just such sensitive government contracts. At this time MIT administrators were actually looking to focus more on aeronautical research and more non-military related pursuits. So Grier suggested that he and his partners form a corporation to take over their own sensitive and highly specialized work. They decided to move their new firm and its work offsite from MIT. That at any rate is one version of the story. The exact details depend on which source you read.

Whether this new postwar work in nuclear testing was the only reason for the formation of EG&G as a company has never been clearly documented; however, it is highly likely. Basically, EG&G was formed because MIT simply could no longer facilitate the work. Nor did it seem they wished to. In his unpublished autobiography, Dr. Edgerton claimed it was the AEC who requested that MIT establish a comprehensive test system at Enewetak with Grier in charge. However according to Edgerton, MIT gave a firm "no." At the time, MIT President Karl Compton was faced with the challenge of reversing the huge wartime direction in military research which the university had engaged in during World War Two. He wanted MIT resources to focus more on pure research. Compton's successor in 1948, James Killian, supported this and started a strict re-deployment of research for peace. Both Edgerton and O'Keefe recorded in their memoirs that the unofficial partnership which the three scientific wizards already enjoyed served as the convenient inspiration for forming the EG&G corporation. EG&G would take over MIT's unfulfillable commitments to the AEC and O'Keeffe would go to work for these three founding men.

Unique photo of Dr. Edgerton

Barney O'Keefe's memoirs state:

"In the summer of 1947 I was called to a meeting at MIT with Norris Bradbury, the new Los Alamos director, and Alvin Graves, his test division leader. They were planning a series of weapons development tests, to take place in 1948 at the atoll of Eniwetok, two hundred miles east of Bikini. Since those in our MIT group were the principal designers of the firing sets, we were asked to design a special version for the Eniwetok tests. When we agreed, they asked the next question: Would we design a system of signals to actuate unmanned instrumentation and coordinate them with the firing signal? We said we would, but pointed out that, among other things, we would have to procure several million dollars' worth of underwater signal cable to string around the atoll. Our MIT contract was funded at only $200,000 total. Money was no problem, we were told. At the time, the MIT director of research programs heard about the proposed tenfold expansion of our little project, he balked, saying that MIT was trying to get out of military research, not into it. He suggested to Grier that he and his partners form a corporation to take over the government business and move it off campus. . . We moved to an old garage on Brookline Avenue in Boston. We were also asked to do a neutron measurement because we were also experts in fast pulse measurements."

It is true there was always an underlining emphasis by the three founding scientists to concentrate on specialized instrumentation which they did via their consulting firm prior to EG&G incorporation. Accounts at the time characterize the pre-EG&G business association as a "patent holding partnership" in which the three men "enjoyed a good business." However, it was much more on paper in the form of patent rights than in actual hands-on work. That would change when EG&G formed. From that point on, the trio had their hands full with fulfilling contracts for the AEC in atomic testing. Along with Barney O'Keefe, they did literally role their sleeves up at that point to actively run the fledging EG&G company. Some evidence suggests they soon had other non-nuclear related classified contracts, possibly on work they had already been involved with through MIT.

O'Keefe's memoirs give some fascinating insights into that time and the first nuclear test that EG&G became involved in which became known as Operation Sandstone:

"The Atomic Energy Commission inherited a confused and deteriorating atomic establishment. Things had pretty much ground to a halt after the Japanese surrender, not only because of personnel departures, but also because of lack of direction from the top. No one thought it would take sixteen months of wrangling before a decision could be made on domestic policy; no one thought that international policy would make no progress, much less move backward in that period of time. The sheer logistics of the transfer were staggering – dozens of facilities, hundreds of thousands of people, records in poor condition because of wartime haste, personnel changing rapidly – all making orderly transfer very difficult.

Los Alamos was more fortunate than most. Although the very continuance of the laboratory was in doubt for many months, Norris Bradbury, the new director, began to forge a strong organization. A reserve Navy commander during the war, he understood both the military and civilian points of view. Recognizing that the laboratory would be shorthanded for years, he placed a good deal of confidence in his contractors, such as our group at MIT. Improved weapons concepts and systems, ideas that had been around the laboratory but had not been incorporated because of time pressure, were brought out, dusted off, and put into practice. The stockpile, if you could call it that, was woefully small. New designs promised to double the efficiency of the implosion, effectively doubling the size of the stockpile at one stroke. Bradbury began planning for a series of tests on the new designs.

One series of tests had been conducted by the military in the summer of 1946. Called Operation Crossroads, it took place at Bikini Atoll, a coral formation roughly circular, twenty-five miles in diameter, located in the Marshall Islands, twenty-seven hundred miles southwest of Hawaii and two hundred miles north of Kwajalein. The inhabitants of Bikini were moved to Rongerik Atoll, 130 miles away, to become wards of the American government.

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The purported purpose of the tests was to determine the ability of the naval vessels to survive an atomic attack, but I think the real purpose was to convince senior military, particularly Navy, personnel that the bomb was not just another piece of ordnance. The tests were poorly conceived and inexpertly executed. Some ninety Japanese and outdated U.S. warships, including battleships, aircraft carriers, submarines, and landing craft, were anchored in the lagoon. A Nagasaki–type bomb was exploded in the air above the fleet in the first test, another detonated below the surface of the lagoon as the second. They were conducted during the height of debate in the United Nations about the Baruch plan and provided beautiful propaganda fodder for the Soviets.

On the first test, an error in the operation of the radio-controlled timing system prevented crucial instrumentation, such as high-speed cameras, from operating until fifteen seconds after the device had detonated; much valuable data were lost. Five ships were sunk, but a demonstration of this type over the open sea could not have nearly the effect of the devastation caused at Hiroshima and Nagasaki.

The second bomb, according to the Civilian Evaluation Commission created by Truman, 'caused a deluge of water loaded with deadly radioactive elements over an area that embraced ninety percent of the target array. All but a few of the target ships were drenched with radioactive seawater and all within the zone of evident damage are unsafe to board.' This was the first indication to the military of the problems caused by radioactivity. The ships were still afloat but uninhabitable. The contamination was so great that a scheduled third test had to be cancelled. The world became aware, as it had not from the Japanese bombings, that the effects of nuclear weapons were not confined to the blast, shock, and fire.

The next series of tests, Operation Sandstone, was planned to be of an entirely different character. Because of the contamination at Bikini, they were moved to the atoll of Eniwetok, a slightly smaller coral configuration two hundred miles to the west. They were developmental in nature, planned to test the new designs, as opposed to the Crossroads effects tests. Another group of natives had to be evacuated, perhaps never to return.

The Trinity test had been instrumented with detectors and measuring equipment for neutrons, gamma rays, X-rays, visible light, and shock wave. The possible range of yields and partition of energy at Trinity required a wide dynamic range of instrumentation, with resultant loss of accuracy and sensitivity. Furthermore, precise measurements were of second order importance; the big problem was whether the implosion technique would work at all. Sandstone was different. Four implosion devices

had worked remarkably well: Trinity, Nagasaki, and the two Crossroads tests. (Except for special purposes, the gun-type weapon had been abandoned.) The problem here was to test the efficiency of the new designs that had been developed since 1945. Wide varieties of instruments were used to measure the output characteristics, some up close, some on distant islands. The primary job for our company was to turn on instrumentation after the area had been evacuated and, for measuring devices with short operating times, to start them in the final seconds between the remote arming and the firing of the device. This was the task for Grier and me. Edgerton headed a small group responsible for an optical technique to measure the multiplication of neutrons. Germeshausen stayed home to 'mind the store.'

We had the responsibility to operate instrumentation automatically during 'dry runs' to check out timing installations after the islands had been evacuated, to serve on the arming party with the test director, and to operate the equipment that armed and fired the devices.

A nuclear weapons test is a massive undertaking. Thousands of people and hundreds of ships, boats, motor vehicles, and aircraft were organized under the military command of scientific task groups. All equipment, to the last nail and screw, was assembled months before the test and transported thousands of miles to these remote Pacific islands. Towers, hundreds of feet high, were built as platforms for the devices to approximate air burst conditions and minimize ground contamination. Additional towers were constructed to house photographic operations in distant islands, to keep the field of view of the cameras above the salt spray of the lagoon. Heavy concrete bunkers covered with sand were needed to protect instrumentation from blast and radioactivity. Miles of underwater cable were laid to connect the various instruments to the timing and firing system. Aircraft for atmospheric measurements and cloud-following aircraft to sample the characteristics of the mushroom cloud and track its direction of travel were based on the larger atoll of Kwajalein, two hundred miles away.

On the day before the shot, all personal other than the arming and firing party were evacuated to the ships in the lagoon. Every individual had to be accounted for – no mean task with thousands involved – before the test could proceed. Late in the evening the firing party traveled by small boat to the tower housing the device to make the final connections. Sometimes the final connections were delayed until a few hours before dawn if personnel were unaccounted for or the weather was questionable. For the first Sandstone test, Grier and I had spent the previous two days checking every screw, every wire, every connection in the crucial arming and firing circuits.

On that last evening, after all others were evacuated, we joined the test director and proceeded to the tower containing the explosives. We then rode up the construction elevator, clanging and banging, to the two-hundred-foot-high cab, swaying slightly in the twenty-knot trade winds, which blew constantly. It was an eerie feeling in the pitch-black silence where for weeks, day and night, construction workers and scientists had swarmed about the tower. Bomb assembly people had long since departed, with the device left in the custody of heavily armed Marine guards nervously peering into the blackness of the surrounding ocean.

I had not been close to an active device since we prepared the Nagasaki weapon on Tinian. I thought of the misassembled cable and my dilemma of the evening, but this time there were no radars or outer casing or tail fins. There was only the steel sphere crisscrossed by the dozens of coaxial cables leading to the multiple detonators from the firing set. As we plugged in the final cables and threw the connecting switch, I felt a little more worried than I had on Tinian. There the bomb had been self-contained. No one could set it off externally. Here it was connected to miles of underwater cable, where there was always the possibility of short circuits from the movement of the cable on the sharp coral reef, of misconnection we had not uncovered in our two days of checking, or of tampering after checkout. Finally, there was the Russian boogeyman.

The Cold War was at its height in the spring of 1948. All negotiations for international control had collapsed. The Russians were truculent and intransigent all over the world, particularly in Berlin. In February, they had marched into Czechoslovakia. After the spy scares of 1946, the American press and public were convinced that there was an atomic secret; the price of compromise on the Atomic Energy Act had been a ridged, overcautious security provision. The atomic energy commissioners had been appalled at the condition of the stockpile of weapons and the lack of trained weapon assembly teams. At one point, they considered cancellation of the Sandstone tests for fear that a Peral Harbor-

type raid on Eniwetok would wipe out our scientific group, which represented the bulk of the country's atomic bomb handling capability.

There was also the possibility that the Russians would come ashore from a submarine and literally steal the bomb. What better way to steal the secret? Security was very jittery. I was worried more about trigger-happy Marine guards than I was about the bomb.

To satisfy security, we were required to dismantle the elevator and remain at the base of the tower until the guards had made a final screen of the area and left. Then we could take our twenty-mile, small-boat ride back to the control tower on the island of Parry. The tests were carried out thirty minutes before sunrise to have a dark background for photography on the ground and daylight at thirty thousand feet so that the cloud-tracking aircraft could navigate visually. Time stood still in the silent control room as the lights and meters signified the operation of measuring equipment all over the atoll, the arming of the device in the final thirty seconds, and the familiar countdown of five, four, three, two, one, zero.

Although I had been working on nuclear devices for years, I had never seen one explode. Because we had to watch the control panel until the last second in the event of a malfunction, we could not wear welders' glasses to protect our eyes; we kept our backs to the windows and our eyes glued to the panels.

The flash of light coming in the small window reflecting from the gray metal panel boards was blinding as the image of the meters froze my vision for seconds, then gradually turned to motion as the lights flashed crazily on and off and meters bent their needles against their stop posts from the force of the electromagnetic pulse traveling down the submerged cables with the speed of light. The pulse was so powerful that one of our engineers, halfway around the world in Boston and knowing the scheduled time of the explosion, was able to detect it with a makeshift antenna and an oscilloscope, the world's first detection measurement.

Turning to the window, I watched the fireball rise from a darker stem of explosive debris to a dull blue, with some green and orange at the periphery, and finally to a variety of reds as it cooled and rose and expanded in diameter, then whitish and colorful again as it became high enough to reflect the rays of the rising sun. In ninety seconds the shock wave hit with a sharp crack, over before it would be sensed. Since we were indoors, we could feel the longer duration of the negative pulse behind the frontal shock wave sucking the air from the building with a *whoosh* that lasted several seconds. The rising plume had now reached the inversion layer in the upper atmosphere, where it flattened and spread horizontally in a mushroom shape, which seemed to cover the entire western sky. Our job was done. . . Twice more the scene was repeated, vaporizing towers on the islands of Biiziri and Ruunitto, each a little closer to the control island, each a little more spectacular because of its proximity. Then back to the States and a year of data analysis.

As we worked in the quiet seclusion of our laboratory, the state of the world worsened. Soon after our return, the Soviets blocked the corridors to West Berlin, forcing the United States to counter with the Berlin airlift. Tensions were growing. A substantial number of Americans saw a real danger of armed conflict. As the year wore on, the corporation negotiated our contract with the Atomic Energy Commission, superseding a temporary agreement made in 1947, when the company was formed. By the end of the Sandstone series, our original group of six had expanded to twenty-six. Edgerton had returned to his professorship at MIT. Germeshausen and I began to plan for commercial activities; since I had already operated one commercial business, I was eager to prepare again for a future not tied completely to nuclear weapons."

O'Keefe's eagerness to explore commercial opportunities would have to wait. Grier wanted to concentrate on defense work. Certainly no one forced them to go into this highly classified and technical work for the government. Nor were they daunted by the dangers. Later company histories similarly stress that prior to forming EG&G, "the three men had found financial stability, technical recognition and an unchallenged position as inventors in flash photography." Interviews of colleagues of these men have stressed that in the end it was patriotism and not profit that inspired the official formation of EG&G in 1947. Patriotic seems to be the best way to characterize all three of these gifted scientists. As

Barney O'Keefe recorded in his book, the profit margin for those contracts on the early tests was very low. He stated: "In that first year of corporate existence we had sales of slightly over a half million dollars and earned the princely sum of six thousand dollars."

Barney O'Keefe stated the mood aptly in his memoirs:

"From the very beginning the American public could not comprehend the complexities of the subject. Away from Los Alamos and the military, I was extremely disappointed in my discussions with friends and in reading the press to realize how poorly equipped we were as a nation to grapple with this most important subject, this happening that had changed the world forever. Most people didn't want to think about it at all."

Remembering EG&G, Part III
The Cold War

Today it is very hard to understand the perspective of those early Cold War years that Barney O'Keefe alluded to in his memoirs. The Cold War shaped the development and refinement of nuclear weapons because that period spurred further technical development. The weapons used against Japan were actually very primitive. All those veterans of the post-World War Two period who had been involved in the continued development of nuclear weapons research after the close of the Manhattan Project have described the early devices very much as a "science project." This means simply that the first atomic bombs were not practical from the standpoint that they could sit in storage in an arsenal. This was due to their extreme fragility and complexity. The early bombs could not even be assembled until they were ready for use and were still very inefficient and crude in comparison to what would be developed in later years. However, these early weapons could not be refined without extensive testing and large scale testing could not happen until a whole series of events had transpired.

Prior to that no real perceived need existed to build a large arsenal. The concept followed that America had refined the science that made an atomic weapon possible, and in the early days following World War Two that appeared to be enough. Around thirteen atomic bombs had been created in unassembled devices by 1947, and it seemed adequate at the time. America had a monopoly, and if another great threat ever emerged there would be time to rearm. The problem was time gradually slipped away.

Some historians have even phrased the gradual rise of a Cold War from 1945 to 1949 as a period in which "We never saw it coming." Recent research shows Franklin Roosevelt had an inkling of what was to come in the two months just prior to his death, immediately following the Yalta conference. A harsh series of final correspondence between FDR and Stalin prove Roosevelt felt great disappointment in the Soviet leader. This is a fact seldom told as most armchair historians prefer to blame Roosevelt and Churchill for naively giving into the Soviets.

Leading Russian scholars today attribute the rapid deterioration of relations between the USSR and their wartime allies in 1945 to a deep-seated paranoia by Stalin. This same paranoia had led to a great series of internal purges before the War, and only the German invasion of Russia forced Stalin to ease his totalitarian rule; although, it was still based on a leadership style of fear and intimidation. After the victory in Europe, front-line Russian officers were once again subject to close scrutiny by the Soviet regime which encouraged them to act defensively and cautiously to all foreigners wherever East met West. Stalin became committed to securing buffer states between the West and the Soviet Union.

Evidence of this postwar mindset is reinforced by a telegram sent to Under-Secretary of State Dean Acheson on March 6, 1946 from George Kennan, a US diplomat stationed in Moscow. His telegram accurately pegged that Soviet psychology of suspicion. Kennan's 5,450 word analysis would influence U.S. policy on the Soviets for decades.

This sense of chilling tensions had already been defined a day before on March 5, 1946, when responding to an invitation from President Truman to speak in Fulton, Missouri, Winston Churchill brought the phrase "Iron Curtain" into use again. "From Stettin in the

Baltic to Trieste in the Adriatic, an iron curtain has descended across the Continent." At different times in history both Kaiser Wilhelm II and Joseph Goebbels had bantered that metaphor around, warning of a growing threat from Russia. But this time history proved Churchill right.

As an interesting side note, a number of years ago, I had the great pleasure to oversee the restoration of the United States Presidential Rail-car *Ferdinand Magellan* which took Truman and Churchill to Fulton, Missouri for that historic speech. The railcar actually served numerous presidents all the way from Herbert Hoover to Roosevelt to Truman and even Ronald Reagan.

Although, the most significant event to take place on that train-car concerned the famous journey to Westminster College. While the Iron Curtain Speech (actually called The Sinews of Peace Speech) was being finalized by Churchill on board the Magellan, a very foretelling incident occurred. Just before the trip, in the aft observation lounge of the Magellan, Truman had commissioned a miniaturized version of the presidential seal to be prominently installed on the leather-paneled rear facing wall. The President had proudly redesigned the seal himself by turning the eagle's head away from the talons of war, to instead face toward the olive branch. Truman took great pride in this in hopes of a prosperous postwar period.

More the skeptic, and in his seasoned characteristic manner, Churchill made a telling comment while the two men sat and chatted in the Magellan's lounge on that trip to Fulton. With the still unfinished speech sitting in draft form on his lap, Churchill looked up at the new presidential seal and frankly told Truman that he should have the eagle's head put on a swivel. This he said, would allow the head to face either way, depending on the way the winds of world events changed.

A day after delivery of the Sinews of Peace speech (ever since known as the "Iron Curtain" speech), Churchill gave a similar talk to the Virginia General Assembly in Richmond. Churchill was accompanied to the Virginia capitol by General Eisenhower who had become US Army Chief of Staff. A few days later Churchill found his way to New York City. There, newly appointed US Ambassador to the Soviet Union, Walter Bedell Smith, paid Churchill a visit. Churchill was in a plush Manhattan hotel suite soaking in a hot bath when he

received Smith. The flamboyant Churchill, as usual, paid little attention to formalities. They commented only about a group of demonstrators just outside protesting the harsh rhetoric of his Fulton speech. Smith, General Eisenhower's ulcer-ridden, hard-driving, wartime chief-of-staff and future CIA director, paid little attention to the picketers. He agreed with Churchill that those same crowds in a year's time would be applauding the former British Prime Minister.

Indeed, they soon would. Churchill was by then temporarily out of office but had the same premonition about the Soviets that he had over the Nazis a decade earlier. He was then watching his beloved Britain institute bread rationing in order to export enough grain to keep food riots from erupting in Allied-occupied Germany. That was a hardship English citizens had not even had to endure during the darkest days of the War. Subsequent pressure on Parliament led Britain to abandon efforts to check Communist expansion in the eastern Mediterranean. President Truman felt America had to fill that vacuum.

To drum up Congressional support for aid to Greece and Turkey as well as aid to Europe, the Truman administration intentionally exploited public anxiety. The battleship Missouri sailed to the Mediterranean as pre-CIA-like operations were conducted out of the State Department with former OSS agents to check the Communists in the Italian elections. As the Truman Doctrine and Marshall Plan were on the drawing board, real fears over a blockade of Berlin were already in the news.

On St. Patrick's Day, March 17, 1948, President Truman went before a joint session of congress. He asked for immediate passage of the Marshall Plan which had endlessly been debated for over a year. He also called for a reinstatement of the draft, an unprecedented move in an election year. For the first time, he identified the Soviet Union as the one nation blocking peace in Europe. That same day Eleanor Roosevelt received a personal letter from Truman. In it the president stated, "It is the most serious situation we have faced since 1939, I shall face it with everything I have." The Russian blockade of Berlin was then just four months away.

Simultaneously, a paranoia over communism developed in the United States just as it had in the 1920s in America. However, I feel too much emphasis has been given to a battle between communism and democracy. The roots of the Cold War are far deeper and more pragmatic than that although during the McCarthy period tensions over this political difference were very intense.

There is also the Peral Harbor mentality which is with us to this day. The nation let its guard down on December 7th, 1941 and in the years leading up to that date a policy of isolationism left our military horribly underfunded and ill-equipped. A paranoia almost akin to the one developing over communism motivated liberals and conservatives alike to never let their guard down again.

A lot has been written about the Soviets testing their first nuclear weapon in 1949. That certainly made the Cold War a reality. It definitely is a more visible marker for a formal start to a Cold War. Maybe it was the actual start of a Cold War, but it had been long in the making. Russia's mastery of an atomic weapon led to a whole series of events that also lead to the establishment of the Nevada Test Site in 1951.

That series of events were not welcomed nor anticipated by President Truman or those who had originally worked so feverishly to develop the atomic bomb. They had not foreseen the Cold War and probably did not realize its long-range implications. In the months following the Second World War there existed a far different perspective of nuclear weapons and related security than we now have. The events of the Second World War changed almost every concept of war. The invention of the atomic bomb changed it even further. Some modern-day revisionists claim President Truman never understood the full implications of the atomic bomb, simply viewing it as a new type of a big and exotic explosive. Research disproves this. Admittedly in 1945 few could have known a new arms race was about to begin.

As a whole, Truman always marveled over nuclear energy and in his speeches strongly promoted peaceful applications, stating it could be the "greatest boon that humanity has ever had". He initially searched for a peaceful application or umbrella organization for all nuclear related issues. A month after the defeat of Japan, Secretary of War Henry Stimson urged Truman to consider a three-power covenant between the US, Great Britain and the Soviet Union to "control and limit the use of the atomic bomb as an instrument of war."

Truman knew he had to establish a long-lasting policy and he certainly did not want the perception that war was the only application for nuclear energy. In part the Atomic Energy Commission emerged for that reason in 1946 under David L. Lilienthal as a civilian arm of the government. President Truman insisted on civilian control of nuclear energy under the authority of the presidency. He got his wish. On December 31, 1946, the AEC took over the nuclear weapons program from the armed forces. Understandably, prior to that it had been run under General Leslie Groves' direction since the wartime Manhattan Project.

Later, the newly appointed head of the equally new Strategic Air Command, General Curtis LeMay, objected to this concept of civilian control as early as 1947 when there were only thirteen nuclear weapons in the stock pile and the AEC kept them all dismantled. Many years later LeMay wrote in his memoirs in wonder how exactly he would have actually been able to get a hold of these weapons if a war broke out. Of course, he did not realize that the idea was then that he was not supposed to be able to easily get control of a nuclear weapon without extensive high-level consideration. The tense hair trigger days of the Cold War when SAC bombers were on constant standby and on station were still some years off. The Cold War had as yet not heated up to that level of intensity even though the Berlin crisis was only a year off.

In those still relatively peaceful postwar years President Truman set a lasting precedent for having total authority over any military aspect of nuclear weapons. This meant a complete say-so over the nature of weapons to be made, where and when a weapon can be test detonated and even setting the annual goal of the bombs produced.

Truman, however, became pessimistic about his earlier plan to seek some sort of effective international control via a United Nations agreement. In 1946 he had recruited Bernard Baruch who had served as a trusted advisor to both President Woodrow Wilson and Franklin Roosevelt. Baruch working with Lilienthal conceived a dramatic concept. Known as the "Baruch Plan," it proposed to the United Nations an international control of atomic energy, and turning the United States' own weapons over to international control on the condition that all other countries pledge not to produce them and also agree to an adequate system of inspection. The Soviets, however, rejected this plan on the grounds that the

United Nations, in their opinion, was dominated by Western concerns and thus biased. They proposed instead that America eliminate its nuclear weapons all together, before even considering any proposals for a system of controls and inspections.

Barruch's proposal was considered unrealistic if not outright utopian even by many American statesmen. Truman's creation of the Atomic Energy Commission, however, had a lasting and practical legacy. Truman retained confidence in recommendations from the Atomic Energy Commission and usually agreed with their suggestions for production. He always firmly rejected Defense Department efforts to obtain military control of the weapons. This shift from the procedures of World War Two days, gave the AEC complete control of the plants, laboratories, equipment, and personnel. With the Baruch Plan dead in the water the AEC regulated the entire field of nuclear science and technology. It closely controlled and or prevented any transfer of technology between the United States and other countries. Yet the race to build bigger and better nuclear weapons had not yet begun in earnest.

The most relevant perception of all in the late 1940s as it relates to atomic testing concerned the question as to when the Soviets would acquire their own nuclear weapon. After all, there really was no urgent rush to advance the technology of nuclear weapons as long as America had a total monopoly of the technology. The most astute experts felt it would be a decade and probably two before the Soviet Union could acquire a nuclear device. General Groves said it would be a generation. The father of all scientific coordination in World War Two and head of the Research and Development Board after the War, Vannevar Bush, speculated it could take as long as two decades before Russia had the bomb. He was then the most respected scientist in the western world,

Likely for that reason, the Joint Chiefs of Staff under their new chief, Dwight D. Eisenhower, strongly opposed a stateside test site in 1946 and 1947. This was supported by Eisenhower's wartime chief-of-staff and the ambassador to the USSR from 1946 to early 1949, General Walter Bedell Smith. He stated that even if the Soviets acquired the atomic bomb it would take them ten years to mass produce it. He would later become the director of the CIA and would live to change his mind.

Atomic tests did take place in 1946 at Bikini Atoll and in 1948 at Enewetak by which time EG&G took an active role there in Operation Sandstone. During that period, there was not, however, a perceived urgency about nuclear weapons research. The Bikini Operation Crossroads tests utilized World War Two plutonium type bombs. The two tests mainly concerned issues of interservice rivalry between the Navy and soon to be independent United States Air Force over the effectiveness of fleet operations in the so called atomic age. The 1948 Operation Sandstone tests at Enewetak were more of a refining of the current bomb technology. Many plans were on the table for much more efficient nuclear fission weapons of higher yields. A certain faction under Dr. Edward Teller also wanted to develop a "super" or Hydrogen fusion bomb. That however would take a long series of tests and as yet there was not a dedicated stateside test site nor the urgency to proceed.

That perception dramatically changed in August of 1949 when the Soviet Union tested their first atomic bomb. It took place on August 29th when "Joe 1" detonated at Semipalatinsk in Kazakhstan with a yield of 21 kilotons. No one knew it then, but the Soviets had with the aid of espionage pretty much copied our WWII-era Fat Man bomb design just as precisely as they had put into production a working copy of an American B-

29 bomber which they seized during the War. To add to the sudden revelations, in September of 1949 Mao Tse Tung consolidated communist control over all of mainland China.

All of this proved a very embarrassing position for the United States Government. That summer Secretary of State Dean Acheson had just told a large meeting of senior senators and congressmen only days before the detonation that the Soviets were still three years away from getting the bomb. It proved such a shock to US officials that Secretary of Defense Louis A. Johnson refused to believe it for a period of time. However, airborne sampling proved the Soviet test beyond any doubt.

A detection process had actually been refined from the recent Operation Sandstone tests in 1948 which EG&G (Grier and O'Keefe) helped to develop. That Pacific test as well as the two prior tests in Operation Crossroads around Bikini Atoll in 1946 had comprised the entire testing program to date. There were many problems with testing in the Pacific which included expensive logistical considerations of moving scientists and testing equipment thousands of miles from universities and the central lab at Los Alamos. Tropical humidity and unpredictable weather conditions were another negative factor. The State Department complained about the perception nuclear testing in the Pacific had on Asian rim countries as well as the unpopular necessity of moving native populations off the islands involving the tests. On the other hand, AEC Chairman Lilienthal himself thought popular opinion weighed heavily against the establishment of a stateside test site.

Yet, by the end of the 1940s atomic tests proved their value, so the questions soon posed were not so much if testing should continue but where. A project organized under the code name "Nutmeg" to recommend an area for nuclear testing. This was headed by Navy Captain Howard B. Hutchinson who as a trained meteorologist understood the significance of the study at hand. The final three sites under consideration were the Dugway Proving Ground-Wendover Bombing Range in western Utah, the Alamogordo-White Sands Missile Range near the initial Trinity Site in New Mexico, and finally, the Las Vegas Bombing and Gunnery Range. Only the latter proved far enough away from populated areas to be practical.

When a hot war broke out in Korea in June of 1950, perceptions changed even more along with a greater sense of urgency. The times now favored a more convenient and practical solution to nuclear testing than far off Pacific locations. By that point Gordon Dean had replaced Lilienthal as chairman of the Atomic Energy Commission. Dean became more agreeable to a stateside test site and met with President Truman to discuss the issue. The President asked at that meeting for yet another search for an appropriate test site headed this time by the National Security Council. Locations were even considered in the American East and South; however, the remoteness of Nevada still favored them all. It would be perfect for refining the existing fission weapons and making them more efficient.

Everyone realized that with a new move underway to develop a thermonuclear or "H-bomb" device, that those more massive tests would still have to be carried out in the Pacific. However, utilizing 1,375 square miles of the World War Two-era Las Vegas Bombing and Gunnery Range proved an ideal solution for most of the development work needed by Los Alamos. A short plane ride from Albuquerque, southern Nevada proved a very convenient place for nuclear testing compared to the remote locations of the Pacific Ocean.

By 1953 the newly elected President Eisenhower, who had been a more cautious skeptic a number of years earlier, now valued the Nevada Test Site as a tool to keep the Nation competitive with an ever-unpredictable world situation. In the 1950s and 60s America would have to contend with a full-blown Cold War and it is a simple fact of history that nuclear testing proved critical to East and West maintaining viable deterrents. Others can argue the pros and cons, but deterrents have insured peace ever since the nuclear genie escaped the bottle in 1945.

Dr. Edgerton, Germeshausen and Grier with their protégé O'Keefe went on to enjoy the confidence and patronage of the United States government for many years as EG&G engaged in some very highly classified work. In the 1950s and 60s, EG&G greatly expanded as a company, being extensively used at the Nevada Test Site for weapons-testing development and high-technology military testing at Nellis AFB. EG&G shared operational responsibility with a second new lab in California, Livermore Labs, as well as Raytheon, Reynolds Electrical & Engineering and other firms.

During the 1970s Bernard "Barney" O'Keefe went on to lead EG&G. O'Keefe is affectionately thought of as the fourth musketeer to this highly gifted group of patriot scientists. The youngest of the men, he eventually diversified the company to more non-military associated endeavors in papermaking, automotive testing and marine studies. A successor company became widely diversified in medical, aerospace, digital photography and automotive technologies.

Today the company no longer exists; however, its DNA of sorts can be traced to many leading corporations, few of which even remember the history of EG&G. Most of the questions the Museum receives about EG&G involve historical inquiries about how the Nevada Test Site formed and what role technical contractors like EG&G played in those early years. That is what Part Two will deal with in our next Reflections installment. We will specifically look at the early Boston-based EG&G firm and the founding of their Las Vegas office in the 1950s.

Remembering EG&G, Part IV
Pioneering Days

Many remember EG&G as a huge contracting and engineering firm employing thousands of people with subcontracts, associated business partners and firms. It did become that picture of power and complexity; however, EG&G's beginnings were humble. The noted firm started in an old converted parking garage on Brookline Avenue in Boston in late 1947. Initially, the three founding scientists had a total of six employees, including Barney O'Keefe. That soon grew to fifteen with one security guard who sat at an old wooden desk in the corner of the garage work space. The founding Dr. Edgerton, Germeshausen and Grier were the key decision makers and remained so for many years.

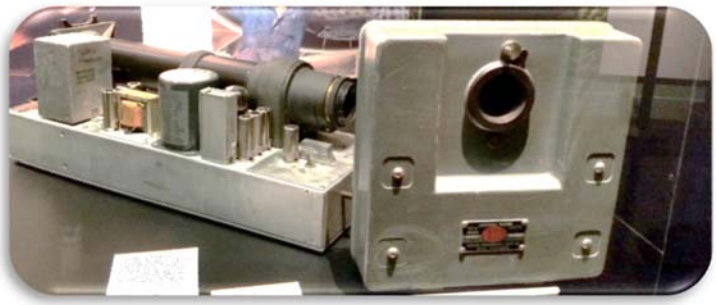
When the company formed, Grier became project director of nuclear testing work and the chief executive officer of the company. Dr. Edgerton served as the chairman of the board because he wanted no business responsibilities, preferring to stay as free as possible for his passion for research. Germeshausen took the post of vice president and treasurer and ran things at home in Boston when Grier got heavily involved in their first big project, the Operation Sandstone tests in the Pacific in 1948. Germeshausen would later be active at many of the tests when the Nevada Test Site opened in 1951. Barney O'Keefe became a key engineer and assistant to Grier in those early days, and as mentioned, O'Keefe would much later come to head up the entire company. He always seemed to be the key partner with the business intuition and drive for expansion.

Most of the year 1948 kept the young company busy with Operation Sandstone. In fact, those far-off Pacific equatorial tests so overwhelmed everyone with the vast logistics involved with working thousands of miles away that little time had initially gone into organizing a company structure. On Enewetak atoll, deep in the heart of the Marshall Islands, Grier, Edgerton and O'Keefe had significant responsibility for the timing and firing of the three tests conducted over a two-month period. They personally oversaw many dry run tests and checked out timing and installations of complex cable arrangements right up to the time that the islands were evacuated before each test. They then served on the detonating parties and operated the equipment that armed and fired the devices.

In the early years it seemed that it was all EG&G could do to keep up with such requests for technical assistance by the Atomic Energy Commission. Germeshausen and O'Keefe, however, did plan and begin work for expanded commercial business operations which over the years served EG&G well, although the need never ceased in those early years for a priority to be given to the nuclear weapons tests. O'Keefe claimed it would have been much easier to just build a specialized commercial business, but there was much more to these founding men than the bottomline.

Soon the War in Korea had created even more urgency over the growing Cold War and subsequent concerns for securing a proper nuclear defense stockpile. At that time America's atomic weapons cache accounted for about fifty devices. Put simply, maintaining and designing a nuclear arsenal meant the actual testing of nuclear devices. There was then no other way to develop and maintain nuclear weapons without testing. At the same time the decision had been made to pursue development of a strategic thermonuclear or H-Bomb. Parallel to this, smaller tactical nuclear weapons needed to be developed.

Thus, this changing political climate led to a more favorable environment for nuclear testing which soon allowed the AEC to establish a state-side nuclear testing facility. In 1951 the Nevada Test Site opened and EG&G's expertise in photography became critical to documenting the tests and measuring yield data from the blasts. Data analysis at that early point was facilitated by high speed photography using Rapatronic Cameras like the one pictured above from the Museum's collection. These men had pioneered and patented such vital equipment. Grier and his associates would also remain key figures in the triggering of the atomic weapons. In fact before the Test Site even opened, key people from Los Alamos were on a plane to Boston in late 1950 to consult with Dr. Edgerton, Germeshausen and Grier, as well as O'Keefe, about the first five tests planned, to be called Operation Ranger.



O'Keefe wrote in his memoirs detailing the unfolding events which brought EG&G to the Nevada desert:

"In June 1950, the Korean War broke out. A country willing to go to war to save South Korea was in no mood to stop the development of the hydrogen bomb.

The decision changed the direction of activities at our little company. Bradbury put Los Alamos on a six-day week; all the contractors followed. Our plans to balance out the government work with commercial activities had to be scrapped, at least for the time being, while we grappled with plans for the upcoming test program, now advanced to the early months of 1951. Because of the shortage of people and housing at Los Alamos, more work was contracted out. In addition to our timing and firing work, we were asked to do the technical photography on the upcoming tests, of which high-speed photographs of the rate of growth of the fireball were most important. The rate at which the fireball grew in the first thousandths of a second depended on the yield or magnitude of the explosion. Measurement of that rate of growth with high-speed cameras was the primary measurement of yield; thus, it was one of the most important tests performed. This extra work meant doubling the size of the company, now up to fifty people. We were working long hours developing instrumentation and preparing equipment for the voyage to Eniwetok [for Operation Greenhouse] when another load of work hit us from the military. Two series of events brought it about.

One was the development of small low-yield devices. New implosion techniques and better detonators had made possible much smaller diameter devices than the five-foot-wide Fat Man, devices that could be carried by a light bomber or fighter planes, or possibly in an artillery piece. Better knowledge of plutonium characteristics and better designs of tamper, which enclosed the plutonium and reflected back escaping neutrons, had made possible designs of lower yields than the Nagasaki weapon, some as low as the equivalent of one kiloton of TNT.

At the same time an interservice dispute had arisen in the military. Atomic strategy, as it had developed at the turn of the decade, called for massive air strikes with high-yield weapons carried out by Air Force bombers. This left no nuclear task for the Army and Navy, who wanted a piece of the action, and fast. A war was going on in Korea; the Army and Navy requested small, low-yield nuclear explosives that could be delivered by carrier planes or fired from an artillery piece, so-called tactical weapons. The Defense Department agreed and laid a requirement on the Atomic Energy Commission for development and testing of such devices.

But the AEC and its laboratories were deeply involved with preparations for the upcoming Pacific tests. A task force had already been organized, this time under the command of Lieutenant General Elwood R. (Pete) Quesada. The Defense Department and the AEC together asked the President for

authority to establish a continental test base, which would not have the logistic problems of the Pacific atolls.

The President acquiesced; Quesada was directed to locate a site. An Air Force pilot, Quesada knew just the spot. He had flown many times from the Nellis Air Force Base in North Las Vegas, Nevada, to the Las Vegas Gunnery Range, a huge tract of government-owned land a hundred or so miles to the northwest. It was bleak, uninhabited desert with dry lake beds surrounded by mountains, which would cut down the blast effects. The site, 1350 square miles in area, was turned over to the AEC to become the Continental Test Range. In September another crash program was authorized to carry out the first tests before the Greenhouse operation.
As soon as the program, Operation Ranger, was approved, Quesada and Alvin Graves flew to Boston to visit us to describe the program. There would be five shots, with yields ranging from one to twenty kilotons, air-dropped over a dry lake in the new test site, with no firing requirement. They asked Grier and me to coordinate the timing signals and do just enough high-speed photography to determine the yield.

We had no time to design new equipment, borrowing instruments scheduled for the Pacific. For photographic stations we bought secondhand trucks, installed the cameras, checked them out in our converted garage, and had them driven to Nevada."

From that point on a long association began for the fledgling company with what soon became known as the Nevada Test Site. During the first Operation Ranger tests in January and February of 1951, Germeshausen personally supervised the photography. Soon, as more testing continued after Operation Ranger, nuclear devices were fired off from towers on the Test Site just as they did at the original Trinity test in New Mexico. Grier and O'Keefe were hands-on and boots on the ground with the timing work for those tower detonations. There is a noted picture from that time of Grier at the Test Site giving countdown instructions, and it is said that with few exceptions through the history of nuclear testing that EG&G remained the "voice" for the countdowns.

It should be added that in those early years the El Paso, Texas, firm of Reynolds Electrical and Engineering Company (REECo) became another key contractor at the Site. They complemented the growing EG&G workforce which had then swelled to over fifty. REECo, however, soon grew to thousands of workers as they became responsible for building and maintaining much of the infrastructure which literally had to be built from scratch.

Memoirs of those times recount very challenging working conditions. The logistical demands, although far less challenging than operating all the way out in the Pacific, were still significant. The Test Site was chosen after all for its extreme remoteness, so the understandable lack of existing support facilities presented huge obstacles. For example, out of necessity and improvisation, the first control room (called control point) for the

nuclear tests was nothing more than a simple portable wood frame building with external supports. (Pictured above.) Everyone lead a Spartan existence in those early days with living quarters in metal Quonset huts. Those were located in Indian Springs, far out from the Test Site and farther from Las Vegas. Of course, Las Vegas itself was not a very sizable city at that time, only about 50,000.

At this point it is appropriate to take a little sidebar to provide an idea of how much work was actually required to get the Test Site up and running. This sidebar thus demands a little deeper look at Reynolds Electrical and Engineering Company. Some of this will be somewhat repetitive because the next few paragraphs form a section of history I recently wrote on REECo. The Reynolds Electrical and Engineering Company had been associated with atomic testing almost from the start. When the Cold War heated up and the push began for a continental testing site, contractors were needed to bring the plans into reality. REECo became a logical contender, just as the experienced team of MIT scientists making up their fledgling company of EG&G became critical.

Many others firms took part; however, those two companies played a very special part in the history of the Nevada Test Site. EG&G concentrated on highly specialized work for the actual tests themselves such as timing and firing the nuclear devices as well as gathering diagnostic information. However, there was far more to the tests than the actual detonations. A whole infrastructure was needed to support the testing and every bit of it had to be built from scratch. That was the work REECo eventually excelled at, creating an infrastructure on the land carved out of the Las Vegas Bombing and Gunner Range which made up the over 1,300 acres of the Test Site.

Work at what became the Nevada Test Site actually began as early as the fall of 1950 when the Atomic Energy Commission sought contracting firms to assist in laying out the logistics. The AEC selected a joint venture group of Reynolds Electrical and Engineering Company, the Robert E. McKee Company, and the Brown and Olds Plumbing and Heating Company. The very first documented requirements of REECo centered around the laying of electrical cables for gathering electronic data on tests.

O'Keefe wrote in his memoirs about REECo and he and Grier's participation in the first Ranger tests:

"Grier and I flew to Los Angeles, bought two English Land Rovers, and drove across the desert to the site. It was a dry lake bed, called Frenchman's Flat, with nothing but dirt roads leading down into it from the mountains. We knew that there would be a good many vehicles driving around the desert near test time, so we were reluctant to string our timing cables underground for fear of having them severed. [These timing cables were for their own contract to document the first tests with high speed cameras.] We asked to have a set of telephone lines strung overhead the fifteen miles from the control room to ground zero. Reynolds Electrical and Engineering Company was hired to do the job."

Construction of test towers was also vital, although, all that took time and the first tests could not wait. They were hurried along in those very first months of 1951 because Los Alamos bomb designers realized that possible flaws existed in the devices scheduled to be tested during the Greenhouse Operation planned for later that year in the Pacific. So they needed several tests to be made prior to those far-off experiments on Eniwetok. That became the initiative behind the first series of Operation Ranger detonations at the Test Site in early 1951.

So little infrastructure was in place at that point that those first bombs were air-dropped from a B-50 out of Kirtland AFB in Albuquerque, New Mexico. The Air Force provided important support on the first Ranger tests because the Atomic Energy Commission simply did not yet have enough working infrastructure in place. The Air Force even had to provide barracks and a mess building at their facility at Indian Springs. This was the primitive state of things in 1951, and the reason REECo, the McKee Company, and the Brown and Olds Plumbing and Heating Company were rushed into work. The McKee Company initially worked out of a vacant garage in Las Vegas as a base of operations.

For Operation Ranger, some structures had begun to take shape for support, but most of these were simple wood-framed buildings. Some electrical and communication cables had been laid for the Ranger tests which primarily facilitated diagnostic measurements to determine yield. A REECo electrical engineer by the name of Joe Lopez assisted in laying some of the first cables to collect scientific data on other early tests at Frenchman Flat. Veteran workers from those days stress that this was desert wilderness and the nearest water facilities were over 40 miles away at the Indian Springs Air Force Base.

A base of operation on the Site itself was therefore needed. The Haddock Engineering Company became another prime contractor in 1951 which played a role in that. They were responsible for constructing some of the first buildings at the entrance of the Test Site which became known as "Mercury," a valuable support center pictured above circa 1959. Mercury serves the Test Site to this day as the key support center.

Haddock also built underground concrete bunkers and testing towers, although they encountered major cost overruns in that work. The overruns may have led to Haddock's exit and greater reliance on REECo for continued construction work. So the contract with Haddock was canceled and REECo was given responsibility over all the maintenance starting in 1952. Jim Lopez was named the General Manager of REECo by 1952 when a series of new tests took place. One important point that may not be obvious to those of us in the private sector is that work at the Nevada Test Site required security clearances. REECo and The McKee Company, which had also done work at Los Alamos, were in a particularly good position with experienced administrators with the necessary clearances. More and more people filtered to work at the Nevada Test Site as the contracting companies and their responsibilities grew by leaps and bounds.

On January 7, 1952 Frank Rogers came to Las Vegas to become the Deputy General Manager of REECo. The Mercury administrative complex had just taken shape with offices and sleeping dormitories. It was far from elegant and consisted mainly of plywood paneled structures. Oil heaters were the only source of heat and bathroom facilities were in separate huts. Existing power and communication systems built by Haddock would not cope with the growing infrastructure. Drilling for a closer water source was also a priority. Communications became critical, and so mobile radios were installed in many vehicles. As the tests ran into more tests and then more tests, additional infrastructure became required. Roads, phone lines, electrical plants, and wiring followed. The challenges were immense.

REECo became tasked with a great deal of administrative duties in those pioneering days in making a viable facility. This would be an ongoing role that would span the next five decades. A lot of that early work fell on Frank Rogers. One of his first tasks involved assembling a fleet of vehicles, most of which initially had to be rented from agencies in Arizona and California. The first fleet he assembled consisted of about 200 pickups and sedans; however, heavy equipment of all kinds was needed. Rogers also had to negotiate union agreements. Rogers had to manage a large labor force, much of it being drawn from Clark County which meant he had to follow Nevada labor regulations. Harold Cunningham, a close associate of Frank Rogers and a later REECo Deputy General Manager, and then General Manager, stressed the immense complexity of those labor relations.

In 1954 Harold Cunningham moved to Las Vegas. He had worked on and off at the Nevada Test Site since 1952, but in 1954 he worked with REECo on building some of the first support structures and hangers at what became known as Area 51 on the dry lake bed of Groom Lake. This was all in preparation for the first Skunk Works efforts with aeronautical engineer Kelly Johnson of Lockheed and tests of his early U-2 spy plane design. Mr. Cunningham recalled this legendary area, named for a map coordinate, and recalled that it first acquired the nickname of Watertown. That was a sarcastic way of indicating that Area 51 was a very challenging location to find wells for drinking water which was always a most urgent task for REECo. Mr. Cunningham later managed REECo workers on the Nuclear Rocket Development Station or Rover program during much of the testing moratorium from 1958 to 1961. Later when Cunningham became Deputy Manager of REECo, he helped oversee with EG&G personnel the building of an Air Force base in Tonopah in the early 1980s where the F-117 Stealth Fighter was eventually tested. Harold Cunningham later became General Manager of REECo from 1976 to 1986 and was followed by our Nevada Test Site Historical Foundation Board Member Dale Fraser who served as President and General Manager.

Over the years REECo continued to grow as the Test Site increased operations. In 1967 EG&G acquired REECo. In 1968 the original joint venture between the Robert McKee Company and the Brown and Olds Company dissolved. By that time REECo with EG&G and other key entities were employing large numbers of men and women who were establishing homes and raising families in Las Vegas. This provided the foundation for that still relatively small city to grow by leaps and bounds. Just as nuclear testing spurred the building of vast infrastructure at the Test Site, it also did so to some degree in Las Vegas. In other words, the jobs created by nuclear testing via more than 120,000 employees of associated contractors brought huge numbers of people to Las Vegas over the years which required more infrastructure in roads, schools, hospitals, utility systems and the like.

In 1950 the Las Vegas valley area had 44,600 residents which went to 127,000 in 1960, 273,000 in 1970 and 463,000 by 1980. That in part led to a foundation that this 21st Century world-famous tourist destination is now built upon today which has over two million residents in the Las Vegas valley/Clark County area. Furthermore, a great many professional people in Las Vegas today are the sons and daughters and grandchildren of those many thousands of people who came to this part of the country years ago as EG&G and REECo employees. The companies definitely left an enduring legacy. It is a legacy to which our National Atomic Testing Museum needs to give more focus.

Beginning in the 1950s REECo thus assumed administrative responsibility for what became a huge maintenance and administrative workforce that grew by many thousands as each decade progressed. We now have an idea of the backdrop EG&G came into during the early 1950s. Aside from the rather primitive conditions at the Test Site, EG&G was also faced with the challenge of working out of Boston as its only headquarters. Because of the logistical problems of being so far from their home turf, Grier decided to establish an office in Las Vegas and then a laboratory site. Over the years a young Las Vegas community would grow alongside the young company as well as other contractor companies. Grier, in fact, soon moved to the area himself and built a house. He also dated a Los Alamos secretary during those early days who was one of only two women involved in the first tests. Dorothy Whitcomb—soon to become Mrs. Grier, recounted in her oral history interviews the great level of adventure and excitement everyone felt in those years. (Mrs. Grier's interview, and others from this period, are on the UNLV website and provide a wealth of information: http://digital.library.unlv.edu/ntsohp/.)

Meanwhile Grier and O'Keefe had been occupied with the first preliminary thermonuclear-related tests in Operation Greenhouse and then later Operation Ivy far back out on Enewetak. So, by 1952 Grier chose an enterprising technician to take on new duties. His name was Alfred O'Donnell and Grier tasked him to initially organize the setup of the Las Vegas office. This may have been a good choice because as Peter Zavattaro recalls, O'Donnell's strengths were in administration. The young Bostonian and Manhattan Project-era veteran had initially become one of the company's experts on arming, timing and firing nuclear devices. Grier had trained him at MIT in1946 for the task of firing the detonation in the underwater Baker test in Operation Crossroads. However, like many early EG&G employees he had responsibility for a very large assortment of duties that evolved into more administrative matters. It seemed there was no task that some of the pioneer EG&Gers did not have to do at one time or another. Mr. O'Donnell's duties soon included recruiting people for the Las Vegas office. Becoming a jack of many trades, O'Donnell recalled about that period in Las Vegas:

"We got on the phone and started calling military bases in New Mexico; made trips to San Francisco, doing interviews. We were hiring people on the phone. The first to join EG&G's new office were six radio technicians employed by Reynolds Electrical Engineering Co. By the end of 1952, we had recruited a staff of nearly 50 people in the area. By 1968, there were more than 8,000 people on the EG&G payroll here."

O'Donnell goes on:

"The first EG&G office in Las Vegas was another old garage, this one at 1622 S. A St., now Commerce. The firm later built a facility on Sunset Road, which was demolished for airport expansion. The sterling reputations enjoyed by Edgerton, Germeshausen and Grier among scientists, plus the fact that all the research was into largely unexplored areas, was a powerful inducement for recruiting. Even before the first bomb was exploded in January 1951, Las Vegas was the hub through which all the building materials flowed to the new Camp Mercury, the test site headquarters. In the first year of testing, the payroll for construction alone was more than $4 million. In 1952, Truman declared the Las Vegas Valley a 'critical defense area.' The designation made the valley eligible for more Federal Housing Administration loans, as well as funding for schools, utility improvements and roads. The move to Las Vegas created a sort of snowball effect among other high-tech firms, who also wanted to involve themselves in the new field of atomic energy. Among those were Holmes & Narver, Raytheon and Bechtel."

One other quote of O'Donnell is of note:

"If anybody who was critical of what went on out there were to sit in on the weather briefings, and the logistic briefings among all the heads and brains that come together before we shoot, they wouldn't criticize. If just one thing doesn't meet the criteria to shoot, then nothing happens."

EG&G continued to grow rapidly although the original players remained hands-on for a number of years. In 1952 EG&G participated in eight tests at the Nevada Test Site in Operation Tumbler-Snapper and then the first thermonuclear test and the largest fission test in Operation Ivy on Enewetak. During 1953 Grier along with O'Keefe were involved in eleven tests or "shots" at the Test Site. The bombs they tested were not really finished weapon designs as yet and were therefore not called bombs. They were called "devices."

Around that time, the two men had an extremely startling experience. At a tower-shot, right at the moment of planned detonation, the firing system failed. The party consisted of Jack Clark, the test director; John Wieneke, a Los Alamos physicist; Grier and O'Keefe. Experiencing a countdown to zero proved nerve racking enough. To reach the anticipated moment of detonation and have nothing happen was unprecedented as well as outright frightening. Instrumentation was then still very basic so there was nothing to do but to physically examine the bomb to try to determine why it did not go off. There was no way to remotely disarm it or disarm it at all until a detailed examination could be made. Grier and O'Keefe flipped a coin to see who would make the dangerous trip out to the test tower. O'Keefe ended up going with John Wieneke. They took two jeeps, just in case one broke down. Associates told them to

keep their goggles ready and the jeep's visor down in case the bomb suddenly went off. O'Keefe sarcastically recounted that after a short while they decided if the bomb did chose to go off that it really would not make much difference.

Upon arriving at ground zero they realized the elevator to the 200-foot tower had been dismantled prior to the test. (This was a security precaution because there were fears of Soviet espionage.) Thus, the only access to the bomb at the top of the tower was by a metal ladder attached to the structure. O'Keefe made the climb with John Wieneke.

This story demonstrates how these company executives were not sitting in a board room back in Boston as would be the case in many other firms. True, these men had the contract for detonating the device. There was no one else for them to call in; however, at the same time few could have blamed them for walking away from that unpredictable situation. It took a lot of nerve to go out to that tower, but they always stood by their work. This story also proves the point made in the first installment—that the early EG&G founders and associates were professionals and patriots first and businessmen second. Their work was not just work, rather they felt a sense of urgency in their contracts at the Test Site because they were playing an important part in national security. (O'Keefe claimed this episode occurred in1953 however it was likely the Operation Snapper, Fox shot on the early morning of May 20th, 1952 involving an eleven-kiloton device in Area 4.)

Barney O'Keefe recalled in his memoirs another unique event on May 25th, 1953 in Operation Upshot-Knothole in the Grable test of a fifteen-kiloton device in Area 5:

"Another event occurred on that test series that I will never forget. The Army, anxious for its piece of the action, had designed a 280-millimeter artillery piece to handle a tactical nuclear weapon for which Los Alamos had designed the warhead. Two hundred eighty millimeters is just a little over eleven inches; implosion lenses had been designed to be much smaller than the original five-foot-diameter Fat Man, but nothing small enough to fit into that diameter had yet been designed. They were forced to use a gun-type design, much improved over the Hiroshima weapon but still not as efficient as the implosion devices. The Army planned a test during 1953, but wanted to do everything themselves. The Yucca Flat site was busy with weapon development tests, so the Army took over the old Frenchman's Flat site used during Operation Ranger in 1951. The artillery piece was set up at one side of the dry lakebed. The projectile was to be fired six miles over to the other side of the lakebed; it would contain a seventeen-kiloton warhead, designed to explode fifteen hundred feet in the air. The test was lightly instrumental; the main objective was to make it "go boom." On the day of the test most of our group was pretty busy; I was supposed to be leaving for Boston. Jack Clark asked me to stay over another day to witness the test as a representative. I had no interest but reluctantly agreed.

I was disconcerted when I arrived at the gun site. A 280-millimeter gun is an enormous piece of machinery. I had never seen anything that big, even in the Navy. Only twenty-five people witnessed the test, all army artillery officers. For protection, they had built a five-foot-deep trench fifty feet on either side of the gun. I expected to see an elaborate electronic control system, but, no, this was being conducted under battlefield operating conditions. Once the device was inserted, the block would be screwed closed and the officer in charge would fire the gun by pulling on a lanyard, as with any other artillery piece.

I couldn't believe it, after all our elaborate safety precautions. I wished that I had turned Clark down and gone home. But fire it with a lanyard they did, and then everyone jumped into the trench for protection. (I was already in the trench.)

This time I had nothing to do, so I put on dark glasses. I had never been this close to an exploding weapon before; we usually kept a wider distance. When it went off it was a sight to behold. Snatching off my dark glasses at the earliest possible moment, I watched the fireball churning its way thousands of feet up into the sky, visible for fifty miles around, the familiar mushroom cloud identifying it to all the world as a nuclear explosion, then the shock, very powerful in the trench, rattling windows in Las Vegas, ninety miles away; I was aghast. I had never really believed in tactical nuclear weapons anyhow. I have always felt that if one were used on a battlefield, the war would escalate immediately to full-scale nuclear warfare. Here was proof! I, of course, knew what was coming.

My dark glasses protected my eyes against the first flash. What of the soldiers on a battlefield? The first flash would sear the eyeballs of anyone looking in that direction, friend or foe, miles around. Its intensity cannot be described; it must be experienced to be appreciated. The electromagnetic pulse would knock out all communication systems, the lifeblood of a battle plan. In addition to its effect on troops in the vicinity, everyone for fifty miles in any direction who lived through it would realize that it was a nuclear explosion. It would seem like the end of the world, and it probably would be, for any man who had a similar weapon under his control, who had a button to push or a lanyard to pull, would do it instinctively.

Never again was a tactical weapon fired into the atmosphere. I wonder if any of the twenty-five people who witnessed that event thirty years ago, are alive and active today, listening to the academic arguments about the possibilities of a limited nuclear war."

Remembering EG&G, Part V
Bravo

In early1954 the EG&G team took part in what would prove to be the most challenging test of them all. Their emotional story, which once again took them back out to the Marshall Islands in the Pacific, deserve a section of its own. This involved the first United States test of a dry fuel hydrogen bomb in the Bravo test of Operation Castle. Their adventure is told best from the memoirs of Barney O'Keefe:

"Although there had been a successful thermonuclear experiment in 1951 and a full-scale thermonuclear explosion on November 1, 1952, Edward Teller and Ernest Lawrence were still not happy with the progress of H-bomb development. They felt it should be given the highest priority. However, Los Alamos had other responsibilities. It had to worry about production problems with the stockpile, the development of the half-megaton fission weapon, and the development of the lower-yield tactical devices for the Army and Navy. Tensions built up between Teller and Norris Bradbury to the point where Teller did not attend the 1952 test. There had been considerable agitation in Washington, particularly from the Joint Committee on Atomic Energy and the Air Force, to open a second weapons laboratory. In October 1952 a second lab was established under the aegis of Ernest Lawrence of the University of California's Berkeley Laboratory. The new weapons lab was located in the small town of Livermore, thirty miles east of Berkeley. It was a good compromise. Los Alamos was clearly overworked; the University of California would run both laboratories; Berkeley had been the center of cyclotron research and electromagnetic uranium separation. A cadre of scientists from Berkeley, headed by Herbert F. York, the new Livermore director, had worked at Eniwetok on the Greenhouse tests. Although Teller became chief scientist, the laboratory was not organized soon enough to play a significant part in the first thermonuclear weapon explosion, scheduled for test at Bikini in 1954.

While the opening of a second laboratory calmed down the scientific bickering, it had no effect on a larger battle going on in Washington. As the emphasis on thermonuclear research increased, the importance and power of the Air Force grew with it. If the big bombs were to be used, they would be used by the Air Force, particularly the Strategic Air Command, with its new bomber, the B-36. Although tactical weapons were being developed, they were not yet available, nor was there any means of delivering them. The Army and the Navy were being squeezed out. The first public indication of this interservice rivalry came in 1949 with the "revolt of the admirals" when the Navy publicly protested overreliance on the B-36 as opposed to the super aircraft carriers they wanted to build.

The admirals' revolt was quickly stifled, but the controversy continued inside the Pentagon. For the most part, hearing and reports were classified and unavailable to the public.

It flared up again in the hydrogen bomb controversy, where the pivotal character became J. Robert Oppenheimer. He was not directly involved in the battle between the services, nor was he in a position to influence the allocation of budgetary resources. But he was able to exert influence over the size and purpose of the atomic weapons being designed. He was convinced that atomic weapons with smaller yields could be designed for armed services other than the Strategic Air Command, and for conflicts short of total war. He believed that atomic weapons had a potential tactical as well as strategic role. This conviction by Oppenheimer and others led to the fateful recommendation of the General Advisory Committee, chaired by Oppenheimer, that a crash program for the development of the Super weapon not be pursued. The big bomb men saw Oppenheimer as an enemy.

Within the White House, the new President, Dwight D. Eisenhower, was having budgetary difficulties. He had campaigned on the pledge of a balanced budget, but his Treasury Secretary told him that to

balance the budget he must not only end the Korean War, but make a drastic cuts in the peacetime services. The quickest and cheapest way to his objective was to emphasize the cheapest and most powerful weapon, the atom bomb. Secretary of State John Foster Dulles conceived the concept of the 'massive retaliation,' where any provocation would lead to a full-scale atomic blitz. It was effective because the Soviets had not yet built up their atomic arsenal, nor did they have delivery capability comparable to our B-36. It was cheap; nuclear weapons cost only a fraction of the cost of a standing army or a fully equipped navy. But it was a dangerous doctrine. A simple border clash could bring about total war. Only a man of Eisenhower's reputation could convince the people that massive retaliation made sense. The Air Force had won the battle.

Even though the administration policy seemed solid on the outside, it was not so tranquil in the secret world of military planners and their science advisers. Tempers grew short and tolerance narrowed. Nine days after Truman announced the Russian explosion, Senator Joseph R. McCarthy, in a speech at Wheeling, West Virginia, stated:

While I cannot take the time to name all of the men in the State Department who have been named as members of the Communist party and members of a spy ring, I have in my hand a list of 205 that were known to the Secretary of State as members of the Communist party who nevertheless are still working and shaping the policy of the State Department.

The witch hunt was on.

As time went on, the internal battle continued; externally, McCarthy's witch hunt widened. A jittery President saw the investigations spread into his beloved Army. Scurrilous articles against Oppenheimer appeared in the press. Finally, William Borden, the former staff director of the Joint Committee on Atomic Energy, composed a letter to J. Edgar Hoover, accusing Oppenheimer of being an espionage agent for the Communists. A copy was sent to the Joint committee.

The system moved quickly. Hoover brought the letter to Eisenhower, who ordered a 'blank wall' between Oppenheimer and classified information. He instructed the Atomic Energy Commission to investigate. A three-man board of inquiry was set up to investigate the charges.

Oppenheimer never had a chance. The opposing attorney, a skilled prosecutor, was given full security clearance, with fifteen years of documentary evidence in the form of classified material, bugged telephone calls, and taped conversations at his command. Oppenheimer's attorney, a courtly labor relations lawyer, had no courtroom experience, no clearance, and no access to data. The data on the old Communist associations were clear and undenied. There was no specific proof on the H-bomb controversy; it was a question of Oppenheimer's veracity.

The inquiry, the closest thing to a trial for heresy ever seen in American politics, was a travesty. Oppenheimer had said: 'The very least we can say is that, looking ten years ahead, it is likely to be small comfort that the Soviet Union is four years behind us… The very least we can conclude is that our twenty thousandth bomb… will not in any deep strategic sense offset their two thousandth.'

This completely contradicted the traditional doctrine that national security lies in the attainment of military superiority. This was heresy, for which the penalty is excommunication. Dozens of witnesses spoke for Oppenheimer, to no avail. The damaging testimony came from the military, Air Force chief scientist David Griggs summed it up: 'I have been involved in… a number of pretty strong controversies in the military, and it is a fair general observation that when you get in a hot enough controversy, it is awfully hard not to question the motives of people who oppose you.'

To a lesser extent, Teller's testimony constituted a second element of tragedy at the trial. Teller never questioned Oppenheimer's loyalty; he did question his judgment. Teller was passionately opposed to secrecy, never believing in it, never understanding its purpose, willing to go along because it was the law. His final answer to the chairman of the Personnel Security Board, for which he earned the opprobrium of the scientific community for a decade, was as much an expression of uncertainty of the basis for security clearance as it was an indictment of Oppenheimer. 'I believe,' he said '…that Dr. Oppenheimer's character is such that he would not knowingly or willingly do anything that is designed to endanger the safety of his country. To the extent, therefore, that your question is directed toward intent, I would say that I do not see any reason to deny clearance.' Then he went on, puzzled: 'If it is a

question of wisdom and judgment, as demonstrated by actions since 1945, then I would say one would be wiser not to grant clearance…'

The board chose the latter interpretation. Oppenheimer was excommunicated as a heretic against the dogma of massive retaliation.

With massive retaliation firmly established as policy, the test series at Bikini Atoll scheduled to begin on March 1, 1954, took on added importance. The Greenhouse George test in 1951 had been a "thermonuclear experiment," showing only that a deuterium-tritium reaction could occur. Ivy Mike in 1952 had been a full-scale, ten-megaton thermonuclear explosion, but it was a sixty-five ton monster with liquid tritium and deuterium cooled to a temperature close to absolute zero, certainly not a weapon. Bravo shot, the first in Operation Castle, had two major revisions that made it the prototype of an aircraft-deliverable device. It used lithium deuteride, a solid with the tritium derived by neutron bombardment of the lithium. It also used the 'Teller-Ulam' configuration, an assembly scheme that held the weapon together an extra hundred-millionth of a second until the hydrogen isotopes could fuse.

Operations had shifted back to Bikini after the Mike detonation had erased the island of Elugelab in Eniwetok Atoll from the face of the earth. Bikini was large enough to allow twenty miles' separation between the shot island of Namu and the control island of Enyu. The firing party could stay ashore in a heavy, sand-covered concrete bunker, eliminating the need for radio-controlled ship-to-shore firing mechanisms. Once again our company, now employing 150 persons and operating simultaneously at the Continental Test Site in Nevada, was awarded a contract to do the timing and firing and the technical photography.

Because of the complexity of the experimentation, the Joint Task Force carrying out the operation this time numbered over ten thousand men (no women) commanded by a lieutenant general in the Army. Typically, there were four task groups: Army, Navy, Air Force, and scientific. Alvin Graves, veteran nuclear physicist from Los Alamos, was scientific director and deputy task force commander. His deputy, William E. Ogle, also from Los Alamos, commanded the scientific task group. The nucleus of the firing party, now veterans of many tests, included Jack Clark as firing party director, Herb Grier, and me.

This was my fourth journey to the south Pacific in addition to my wartime experience. I expected it to be the last for which I would have a major responsibility. I was training a replacement so that I could devote most of my time in Boston to the company's commercial activities; Grier was preparing to devote his time to the Nevada operations, which now continued year-round. The previous Pacific test had been relatively short, with only two shots – the thermonuclear and the high-yield fission tests. We had been able to bring our families to Hawaii, relieving the strain of time away from home. This time the operation would be a long one; we decided to split it up. I came out with the preparation party and had already spent weeks in the field by the time Grier arrived. I was to return home immediately after Bravo, with Grier continuing on. We would overlap only for this experiment.

I was anxious to get it over with. Important though it was, the experiment was routine for us. It was predicted that the yield would be smaller than that of the Mike device, seven megatons rather than ten; also the logistics would be less difficult. Nevertheless, we carried out our preparations with the same meticulous detail as always. Notwithstanding the island base, it was tougher than Nevada, where we could move around in Jeeps or trucks, get into Las Vegas, and go home frequently. At Bikini we were five thousand miles from home, a four-day journey at best; we island-hopped to our timing and photographic stations by small boats in tossing seas, Piper Cub aircraft from postage-stamp runways, or helicopters still in the developmental stage. Instrumentation was difficult to maintain in the tropics; special care had to be taken with our high-speeds cameras in the salt-laden air. It was no South Seas paradise.

As we finished our arming preparations that last day of February, I was looking forward to the trip home. Up all night before the predawn firing, we would be "off duty" as soon as the shot went off. We had keys to the meat locker, plenty of gin and vermouth in our tents, and time to take a nap before the fleet arrived back in the lagoon. As soon as the airstrip was cleared, I would take off with early records from the experiments, fly to Eniwetok, then to Kwajalein over-night, on to Hawaii the next day, finally San Francisco and home. The group in the firing party included five others in addition to Clark, Grier,

and me. Dr. Harold Stewart, a Naval Research Laboratory expert in spectroscopic measurements who would be doing some experiments from the control bunker; Lieutenant Douglas Cochrane, a career naval officer assigned to our company as communications officer; an air-condition expert from the construction company and two Air Force sergeants to operate radios.

The morning tasks went smoothly, the late winter tropical sun not too strong, the trade winds a pleasant twenty knots. By noon all construction personnel were evacuated, leaving only the helicopter crew, one scientist from Los Alamos, and the firing party. The fleet steamed out of the lagoon, to be safely out to sea before we made our final connections – no point risking ten thousand lives if we had an accident. We were to arm the device in the early afternoon, then fly to the control island to give the helicopters plenty of daylight to rendezvous with the fleet. We'd have time for a leisurely meal, which we would cook ourselves, then a few hour's sleep.

The first snag hit at noontime. Dr. Gaelen Felt, the Los Alamos scientist, was making some crucial experiments, which required that his instruments be in a helium atmosphere at time zero. He normally had a twenty-four-hour supply, but discovered at the last minute that the pipes from his helium tanks were leaking. We calculated the leak rate and decided that if we delayed opening the valves until 11:00 P.M., there would be sufficient gas left by 7:00 A.M. to conduct the experiment. We radioed for permission to delay the arming. We weren't eager to fly helicopters at night with no landing lights or ground crews, but it was either that or postpone for a day. Al Graves agreed; the helicopter crews, not too happy, flew off to get some food, which had been left by construction workers on another island. We invited Felt to stay with us in the bunker, which he preferred to rejoining the fleet after dark, so our party grew to nine.

It made no difference to me. I found an old cot and took a nap besides the bomb rather than in the bunker on Enyu. At 11:00 P.M. we opened the helium valves and armed the deice, then flew the twenty miles to the control island, the pilots using the phosphorescence of the surf breaking on the white coral shoreline to guide us around the lagoon. We arrived at Enyu about midnight. The men who had been checking equipment at the control point took our places in the helicopters, which then scooted off to join their ships, already forty miles offshore.

Everything was ready: Ships in place, aircraft for cloud sampling, submarines for underwater measurement, destroyers and patrol craft on alter for possible hostile action or sabotage, all instrumentation checking out perfectly.

Technicians in Operation Castle.

The one last question was the weather. On the surface, it was perfect: light trade winds, no moon, puffy tropical clouds with less than 10 percent cloud cover, and a beautiful sunny day predicted for the first day of March. The radioactive cloud, however, would rise hundreds of thousands of feet, where wind shears could take it in different directions. Measurements of upper atmosphere winds was difficult because aircraft could not fly high enough. The primary measurements was taken by weather balloons released in the first few hours before dawn, but in this section of the vast Pacific there was little real estate from which to launch balloons, so late measurements were necessarily crude. On the other hand, there was room for a wide margin of error. Bikini was chosen as the site because there were not many people around Kwajalein was two hundred miles south, Rongelap Atoll with eighty-two natives was one hundred twenty miles

to the southeast, and Rongerik Atoll, with a couple of hundred inhabitants, was two hundred miles away, also to the southeast. There was an area about ninety degrees wide where the cloud could move to the north and east with no danger. In the bunker, we felt secure. We had three-foot concrete walls, ten feet of dirt on top, a moat surrounding us as protection against water waves, and a watertight door should the wave wash over the moat.

About 3:00 A.M., four hours before zero, the last weather balloons were sent up. At 4:00 A.M. the final weather briefing was held aboard the command ship. At 4:30 we heard from the scientific director.

'We've just had the weather briefing. Everything looks normal. Start the countdown.'

Grier was pushing the buttons. I was making the time announcements. *'Ten seconds…five…four…three…two…one…Now. The time is H minus two hours. Next time announcement at H minus one hour. Next time announcement at H minus one hour.'*

At the exact instant that the clock had registered zero and I had said 'now,' Grier had deftly pushed the red button marked TWO HOURS, had satisfied himself that all was well, and was back in his chair before I had finished talking. I rechecked the meters on the control racks, flipped the switch on my radio transmitter, turned and nodded to Jack Clark before reaching for my cup of coffee.

The minutes dragged on in agonizing slowness. We were a little sleepy now at five o' clock in the morning. The room didn't help a bit. The concrete walls were bare and ugly with the damp ugliness of new cement, hardly cured before we moved in with the tight time schedule of the whole operation. They were ready to drip water at any moment; they would be dripping now if the massive air condition in the next room were not audibly sucking all moisture from the windowless walls before it had a chance to appear. The ceiling and floors were also unpainted concrete, rough, with the lights, yellowish, with metal poolroom-type reflectors, added to the gloom. No fancy quarters these.

Along the back wall were workbenches, roughhewn, unpainted. Mixed along the tops of the electronics trade-soldering irons, radio tubes, bits and pieces of wire, tape cans used as ash trays. Two beer cans stood empty and unappetizing, left by technicians enjoying a last drink before evacuating to the forced prohibition of a day aboard ship. One side wall held a tool rack; on the other side hung a huge blackboard—the one symbolic reminder of the scientific and academic backgrounds of the inhabitants. The blackboard was the Aladdin's lamp that loosened the scientific tongue. Give the shyest, most inarticulate scientist a blackboard and a piece of chalk and he immediately transforms himself into an orator of Churchillian loquacity. Now the blackboard stood dusty and unused, a few half-erased equations and a notice that there would be no laundry service this week scrawled across its face.

In the middle of the floor, in gleaming contrast to the general shabbiness of the room, stood the control cabinets, called racks—the reason for the presence of these nine men at five in the morning. There were twelve racks in decorous gray and shining chrome, pompous, self-assured, and incongruous as Cadillacs in a blacksmith shop. Ten thousand people waited in the middle of the Pacific Ocean; manned stations all over the world were on the alert. The fate of nations hung in the balance, anticipating the story that these racks with their bewildering complexity of electronics gear would tell. It had taken a year to design and build them, and this building that housed them had been constructed with walls three feet thick, half-buried in the sands of a tropical island as protection against the tremendous power they would control.

The racks were connected by slender, tenuous wires many miles in length to an object capable of releasing the most tremendous forces mankind had ever known, a shapeless, nameless device waiting to expend the energy of millions of tons of TNT within a split second two hours from now. They were connected to hundreds of thousands of other wires sampling the heartbeat of a myriad of experiments to diagnose the operation and measure the effects of this explosion. For the next hour, these racks of inanimate electronic equipment would be the eyes and ears of Joint Task Force Seven, telling the Task Force Command the condition of its fearsome weapon and of the complex equipment waiting to measure its destructive force. Monitored and controlled by the men in the bunker, they would set it in motion, with ponderous, deliberate ease, the vast multitude of events necessary to the orderly performance of the experiment in their proper chronological order and, when and if satisfied that all was ready, would send the signal to the object at the other end of the line to unleash its force and send a Pacific island into vaporous oblivion.

An hour passed and the countdown signals were repeated; then the forty-five-minute signal and the thirty. At fifteen minutes Grier would push the button to make everything automatic – no trusting human reactions in the last grueling minutes and seconds.

After the thirty-minute signal, a final check was made on aircraft. One by one the far-flung aircraft reported to air control. For the next fifteen minutes the radio networks belonged to the airplanes. Hours before, while the rest of the people were sleeping, they had taken off, sluggish with fuel, from the woefully short runways allotted to them by the cramped geography of the small islands. They made an awesome sight, with jets flaming and exhausts roaring, using every inch of the runway as they strained for altitude, their fuel loads calculated so closely that they must skim the whitecaps for miles before rising into the pitch-black sky. Now their load lightened by hours of cruising, they had lost their sluggishness as they settled into the final flight pattern, which would put them at their assigned distance in the split second of detonation.

In the control room we could hear them plainly as all traffic ceased. Each man betrayed his tension by calling and checking more often than was necessary. On the surface, the betrayal of tension was watched for and welcomed. From now on, no man could afford to be casual. This was no place for the fly-boy or the fifty-mission cap. Each of these pilots was experienced, seasoned. Most wore the scrambled eggs of seniority. They were confident of their ability and proud of their aircraft, but each of them respected the force with which he was soon to come into contact. No man who failed to be awed by the prospect of the explosive force of millions of tons of TNT belonged in a position of responsibility in the air, on the sea, or on the ground. The Task Force Command had seen to it that none were there.

By 6:35 all had reported in with no difficulties. Each plane was running smoothly, gasoline levels were adequate, and ten solid minutes remained before the fateful order to proceed to final flight pattern for the detonation. Everything was going fine.

In the control room, Clark spoke into the radio circuit to headquarters. 'How did things go at thirty minutes?' he inquired.

'No complaints, Jack,' Ogle's voice replied casually. 'Looks like we'll keep going.' This was good news, although not unexpected to the crew in the control room. We knew that there was no trouble or we'd have had an inkling of it by now, but it was good to have someone say so. Everyone relaxed a little. The fat radio sergeant returned from the communications room.

'How about some coffee, sergeant?' I offered.

'No thanks, not right now,' he replied.

'What do you mean, not right now. In just a few minutes all hell's gonna break loose around this place, and if you don't get coffee now, you'll never get it. After you have your coffee you'd better stand by that radio channel, and if it doesn't work any better than it has been working, the colonel will have twenty pounds off your hide when he gets back.' I poured him a cup of coffee.

'Listen, fella, the colonel can have this job right now and my stripes to go with it. I don't know why I ever volunteered for this job in the first place. I must have been nuts. Are you guys sure you know what you're doing here?' he asked distrustfully.

'You'd better know how to swim, sergeant.' Someone else took up the cudgel. 'The latest reports say its going to knock the island right into the middle of the drink, and this concrete building doesn't float too well.'

'I'm with you bastards.' The fat sergeant took his ribbing for a while, then grinned to indicate he'd had enough and took his coffee back to the radio room. He was a competent technician, as was his associate. They and the air-conditioner man were not regularly part of a firing party, but they stood up well under the strain and did their jobs.

'Who's cooking the steaks, Jack?' asked Felt. 'I'm getting hungry.'

‘One of you boys, I hope,’ Clark replied. ‘After all, I got the key to the meat locker. Somebody else should do the work.’ ‘We’ll cook them.’ Grier volunteered for both of us. ‘How did you ever talked those guys into letting you have the keys, Jack?’

‘Oh I told them that we’d paid our ration allowance and were entitled to breakfast. If they didn’t leave the keys I told them that they’d have to stay behind and cook for us. That did it!’

Grier cut short the conversation by looking at the clock.

‘Let’s get a little work done or we’ll never get anything to eat.’

One by one we got up slowly, trying to appear unconcerned as we started our final round of checks. Cochrane left the room to check aircraft radios, and the air-conditioner man went out to make a final check of all air inlets and ports to see that they were secured against the blast. Clark put on his headphones for final instructions from headquarters; Stuart moved over for a last look at his charts.

I picked up the voluminous checklist I had carried for the last twenty-four hours. Since eight o’clock yesterday morning I had had been checking meters, lights, and switches against this list. Grier and I had journeyed up and down the whole atoll by helicopter, stopping at each little island, checking the condition of every situation in the complex array. Our own engineers and technicians had checked every wire before leaving the island, but just to be sure that no one had deliberately or accidentally touched any adjusting, we revisited every spot after the island had been cleared. Each of the hundred points had been checked dozens of times previously on a dozen dry runs, but there was always the possibility that a bulldozer had inadvertently cut a wire before leaving the island, or that water had seeped into a station after the last rainstorm. Now we were on the last sheet, the most important one. We had already gone over every item at least twice in the last hour, and our minds rebelled against the drudgery of repeating the list. Each of us knew, however, that he could no longer afford to trust his own memory or judgment, since our complete familiarity with the equipment might be enough to lull us into a false sense of security.

Bernard J. “Barney” O’Keefe at countdown during Operation Castle.

‘Main switch on.’… ‘Check’
‘DC voltage.’… ‘Twenty-eight volts.’
‘Sequence timer in ready position.’… ‘Check.’
‘All bypass switches off.’… ‘Check.’
‘Bomb arming lights green.’… ‘Bomb arming lights green.’
‘Bomb firing lights green.’… ‘Bomb firing lights green.’
‘Signal switch number on.’… ‘Roger.’

Each of the switches had been checked three times previously, but this was the crucial check. Fifteen minutes was the break-off point, the point beyond which everything became automatic. The whole system was designed to be untouched by human hands from that stage on. Once this last button was pushed, we could leave the room and the operation would proceed to set up all experiments automatically and fire the bomb at the right instant. Furthermore, if anything went wrong after that time, the system would shut itself down and stop the shot.

Aboard the flagship, the final weather meeting was coming to an end as we worked. Some felt there might be a shift of the upper winds, but the data to substantiate such a conclusion were meager. Clouds from explosions as large as this one rose a hundred thousand feet into the air and spread for hundreds of square miles before starting to break up. Weather forecasts under these conditions were at best an educated guess, but the meteorologists on the job were tops in the business and their record to date had been excellent. One of the classics of weather forecasting had occurred on a previous operation when the forecast had been for sunny weather at zero time. It had rained with tropical intensity all the night before, and when dawn broke, the skies were still black and heavy with rain. Nothing daunted the weathermen were found playing horseshoes in the downpour, insisting that it wasn't raining according to their weather charts and that it would be clear as a bell at shot time. Sure enough, thirty minutes before zero the moon broke through, and fifteen minutes later there wasn't a cloud in the sky. With a record like that, who could say them nay. Certainly not the men in the bunker, after two days of preparation and faced with the prospects of a disarming team, we could no longer be considered unprejudiced scientific observers. Right then and there we could have been talked into firing with snow on the palm trees.

But there must be one unprejudiced observer who would weigh all the variables. Would there be a shift in the wind? If so, how bad would it be and what damage would it do? What were the prospects of better weather tomorrow? Not so good, probably. Would airplanes be ready to fly again at a day's notice? All these intangibles must be assessed and the decision made to shoot or not to shoot. The man to make the decision was Al Graves, the scientific director. In order to be as certain as possible, the decision is postponed until the last possible moment and that last possible moment was selected to be the fifteen minutes before zero. At that time instruments were turned on which could only operate for twenty minutes and would need days of reconditioning before they could be reactivated. Graves knew all these facts and the depths of his responsibility. The decision could be postponed no longer. Graves rose from his seat with the simple expression, 'Let's go!'

'Al says to let 'er go' Clark reported. I went to the microphone now to begin my monotonous litany, dull and uninteresting, but today charged with a doomlike destiny. My throat felt dry, as though words wouldn't come, and I had to say something just to get my vocal cords in order. If I missed an announcement now I knew that I could throw the whole timetable off for the people whose lives might depend on hearing my voice.

'In one minute the time will be H minus fifteen minutes…H minus fifteen minutes.'

I looked around me at the faces of the others. The smiles and the nervousness had gone. Here were men trained to do a job and they were intent on it. Impervious to all else. Clark and Felt had their eyes glued to the meter that would tell them that the fifteen-minute signal had gone out properly. Douglas Cochrane watched the lights on his radio telemeters for proof of operation, while Harold Stewart puffed thoughtfully on his cigarette.

Grier had eyes for nothing but the clock. The bomb would go off exactly fifteen minutes after he pushed the button, since it would be controlled for the rest of the time by a clock that is much more accurate than any human being's reaction. At the time of the detonation a camera actuated by the bomb burst would record the time to a thousandth of a second; any deviation from the schedule burst time would be caused by Grier's reaction in pushing the button. Although human reaction times are on the order of tenths of a second, Grier, through long practice, was often able to come within hundredths of a second of the exact time. He and I often took turns in firing, and a friendly rivalry had grown up over who could come the closest. I removed my finger from the microphone button. Bet you a beer you're off more than a tenth of a second."

'Bet," he replied, refusing to take his eyes off the clock to answer.

'Thirty seconds until H minus fifteen minutes.'

I watched the clock closely now. I had only a short time left to concentrate, after which it would become automatic.

'Fifteen seconds … ten seconds … five … four … three … two … one … NOW!'

As I said now I released my finger from the microphone as Grier leaned heavily on the button that started the automatic sequence. It took only seconds for my eyes to sweep the board and see that all was well. Herb had pushed he right button and the ponderous mechanism known as the sequence timer had started its ominous trip toward destruction. The fifteen-minute meters and lights had indicated correctly, and the big reel containing the tape broadcast had started exactly on time.

I stepped back and listened to my own voice emanating from the radio receiver monitoring the time broadcast.

'H minus fifteen minutes … H minus fifteen minutes.' My own voice spoke to me, for the final fifteen minutes of the broadcast had been recorded on tape and synchronized to the sequence timer. The script had been recorded and played over and over again until planes' crews and ships' companies had every inflection drilled into them and could follow the broadcast with split-second accuracy and no possibility of a missed count or stammered statement throwing them off in the excitement of the last few minutes.

The last fifteen minutes are an eternity. There is nothing to do to relieve the tension except to watch the lights turn from green to red as each portion of the program becomes activated.

Fourteen minutes … thirteen … twelve … eleven … ten.

Ten minutes to go—six hundred of the longest, hardest, toughest seconds a man could experience. They must be used carefully so there are just enough of them to last until zero time with none left over. Some for checking the panels, some for worrying about mistakes, some to plan emergency action in case of trouble, and some to dwell on that wonderfully different future ten whole minutes from now when this would be all over and steaks and martinis would be the order of the day.

Nine … eight … seven … six … five.

Ships were in their final positions, having swung around to face the blast head on; aircraft were in their last turn to station themselves properly for the shock. Aboard the flagship, the meeting of blast experts, meteorologists, and radiologists had broken up after everyone had spoken his piece and the decision had been made to shoot. The advisers and VIPs, the visiting congressmen, had gone on deck to see the shot; the overworked Task Force Command could take a short breather. There was nothing that they, or anyone, could do now; everything depended on the men in the bunker and the adequacy of their preparations.

Four … three … two … one.

The one-minute signal went out, the needle of its meter jumping suddenly from its reclining position to stand proudly erect beside her sister signals, looking like chorus girls with legs kicked high in the air.

'All observers having high density goggles put them on … All observers having high density goggles put them on … All others face away from the blast … Do not face blast until fireball dissipates … Do not face the blast until fireball dissipates.'

The unhurriedness of my own voice sounded less irritating than it had a short time before. With unhesitating obedience, thousands of soldiers, sailors, airmen, and scientists fitted the dark glasses over their eyes as ordered – a little nervous at the unaccustomed blackness. Others turned dutifully away from the blast and braced themselves for the coming shock wave; some, like Lot's wife, could not resist another look and would pay the penalty of temporary blindness when the shot went.

Fifty seconds. At forty-five the needle on the meter assigned to the bomb arming signal snapped into position, followed immediately by the switch of the first of the big green lights to red.
'She's armed,' said Grier tersely.

'Right' I agreed, unable to restrain myself from speaking.

'Bomb armed,' Clark reported into the microphone and moved a step closer to the guarded panel with the big red stop switch, to be ready to push it up to the last second should the word be passed from headquarters.

'I hope nothing goes wrong now.' I spoke to myself, knowing that the problems of a disarming party would be multiplied tenfold should something go wrong after the bomb was armed.

'Thirty seconds until zero time … Twenty-five seconds until zero time … Twenty seconds until zero time … Fifteen seconds until zero time …'

'Fifteen-second signal O.K.,' reported Grier. Clark nodded, but it was too late now for any announcement.

I took one quick sweep of the board with my eyes, my lips counting and my head nodding to the passing of the seconds, arming light red, one-hour signal in, forty-five-minute signal in, all others in down to the fifteen-second signal, which had just come in, firing light still green, all interlocks still green, nothing amiss.

'Ten seconds … nine … eight … seven … six … five'

The five-second meter snapped up and its light went red.

'Four … three … two …'

I could see the firing cam on the sequence timer starting slowly to close.

Not so quickly, I begged it silently. Take your time.

'One …'

Then, as suddenly as a hammer blow, the last light turned red and the needle on the firing meter started to climb. The two were almost simultaneous, but the merest fraction of a second existed between them, almost imperceptible, but in plenty of time to close the last gate between the firing switch and its receiver at the end of the miles of water under the lagoon.
'Zero.'

The shot had fired, it had really fired, it was over with, everything had been really and worked. I began to dance in my excitement as the firing switch began to open as ponderously as it had closed.

I looked around at the others. The air-conditioner man wore the same puzzled look he had worn over the last five minutes, and the two sergeants stood poised, expectant, waiting for something to happen. What's the matter with them? I wondered. Aren't they impressed? Can't they realize what has happened? Suddenly it came to me that they could not. They had seen nothing, felt nothing; they probably didn't realize that anything had happened. The flick of a meter needle, the race between the interlocks and the firing switch, the final victory of the operation as designed was enough to fill me with excitement, to leave me limp with the struggle my mind had gone through, to leave me elated at the result. To the three men who had never seen a test, who were not familiar with the system, the shot was an anticlimax. Buried in his cavern there was no atomic fireball to blind them, no enormous cloud forming in the sky, no shock wave to mark the release of the biggest explosion mankind had ever devised, set off by these men in this bunker.

'Let's get ready for the steaks,' Cochrane suggested. 'I'm getting hungry.' The sergeants smiled and relaxed. This they understood. The job was over, the day was done, it was time to "knock off." They couldn't imagine what everybody was so happy about, but who cared it was all over.

'The shock wave will arrive shortly. The shock wave will arrive shortly. Keep firm footing until shock wave passes. Keep firm footing until shock wave passes…'

Once again, the sound of my own voice intruded on my own thoughts. It intruded on my elation as it had on my tension. I paused, took stock of my surroundings. The clock said that ten seconds had

passed since the detonation. A relay was chattering in back of the racks as the circuit that controlled it opened and closed. Lights were flickering on and off, red and green, with no pattern, indicating violent electrical disturbances up and down the atoll. This was not unusual, but the explosion must have been a big one to cause that much electrical commotion.

Clark was listening on the command channel.

'Bill says it looked like a good one to him," he reported jubilantly. 'The shock wave may hit pretty had. Let's get ready for it.'

I looked at the clock and calculated that the shock wave wouldn't arrive for another forty-five seconds at least, so I ignored the warning and turned to talk to Cochrane.

I started to tell him of my plans to go home, but as I talked his attention wandered. His look of flushed pleasure had slowly changed to one of puzzlement, then his expression changed as his face turned white with concern. I felt it too as I talked, the words coming more and more slowly and finally stopping as all thoughts of home quickly vanished.

Something was wrong!

Grier spoke the words first, as he reached out to steady himself at the workbench.

'Is this building moving or am I getting dizzy?'

'My God, it is. It's moving.'

Grier reached for the bench to steady himself as I stood bewildered in the center of the room. The whole building was moving, definitely now, not shaking or shuddering as it would from the shock wave that had not arrived yet, but with a slow, perceptible rolling motion like a ship's roll, I began to feel a nausea akin to seasickness.

I was completely unable to get it through my head that the building could be moving. The building is made of concrete, I told myself. The walls are three feet thick. It's anchored like a rock on this island. Besides, the shock waves can't be here yet.
But it was moving! The motion was unmistakable as it built up. Objects were beginning to slide on the workbench. My initial period of astonishment must have lasted about five seconds before I could move over to the bench to hold on and steady myself against the strong rolling motion. Subconsciously, I pushed back a screwdriver, which was rolling back and forth in a narrow arc on the bench. Then I realized what it was.
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'It's the ground shock,' Clark and I yelled simultaneously, I had never felt it before, but it was due to the fact that the shock wave from the blast traveled much faster through the ground than it did through the air. Generally, the ground shock was never felt, as it died off more rapidly than did the shock wave through the air, the fact that this one was evident at all was an indication that the explosion had been one of tremendous force. A force that could move this heavy concrete building so many miles away so that it felt like it as resting on a bowl of jelly must be wreaking terrific havoc with this whole Pacific atoll. From the way the building felt at this moment, it might just as well be floating in the middle of the Pacific Ocean. For all I knew, maybe it was!

This was a subject we had joked about for years, that one of these days an explosion would be strong enough to shear the top off the atoll and send it plunging down into the depths of the Pacific Ocean. Norris Bradbury, the Los Alamos director, and Carson Mark, head of the theoretical division, had mentioned that it might 'go big' in a conversation in Jack Clark's tent two nights ago. If this one was a mistake, it sure was a beaut, I thought to myself.

The same thoughts must have been running through everyone else's minds as all stood there in silence. The lights had dimmed for a second and were flickering occasionally but were still on. The only sensation was that slow, weird oscillation as the building rolled back and forth, back and forth. At any moment, I expected the walls to crack and the ocean to come pouring in or for the whole building to start sliding, intact, on the two-mile journey to the bottom of the ocean floor. But the walls didn't

crack and the building didn't slide, it just kept rolling back and forth with the dame deliberate motion. The whole thing couldn't have lasted more than fifteen seconds before it began to subside. Maybe we will live through this after all, I thought.

Grier was the first to break the silence.

'At least we're on the part of the island with the power plant,' he commented wryly.

I had to smile as I realized that the lights were still on and the island must still be intact. I took another look at the clock and realized that the air shock had not arrived yet. We weren't going to slide into the ocean from the ground shock, but the danger wasn't over by a long shot!

Crash!

There it was like a thunderclap, the steel door and the concrete walls reverberating like drumheads; next the suction phase – here it came –a slow sucking whoosh as the air found its way out after the shock wave had passed. I held on to the bench, ready for it, but it was all over before I could react; my body waited for the sharp clap, the quick such of air, and the soft, gentle return, recognizing the three phases before my senses could catch up. One of the men, not quite ready, staggered to his knees before he could steady himself. In the corner of the room a cloud of vapor began to rise. I could hear the sputter of the electric batteries and see sparks from where I stood.

'Water! Water! There's water coming in,' someone yelled. I had been rooted to one spot since the ground shock had started. The roll of the building had unnerved me, but the fact that the air shock had not been so bad gave me some reassurance. Here was something I could understand and do something about. It is only the unknown and unseen that one worries about; if water was coming in on top of the batteries, I wanted to see it. I ran around to the back of the racks, my legs till a little rubbery.

'It's too early for a water wave, unless the whole ocean has erupted,' I told myself. 'A water wave could not travel fast enough to be here for five or ten minutes yet.'

It must be water forced through the electrical conduits by the shock wave. This was not too serious, but it could mean that the air shock had been much stronger than we had realized in the protected building. That's what it was, water that had been in the pipes, blown through by the force of the blast. No permanent damage; the sputtering stopped and we wiped off the tops if the batteries.
The radio was alive with sound. Every circuit as chattering madly as the air shock hit the ships of the task force. Aboard ship the ground shock went unnoticed. Headquarters was clamoring for a report from the control room.

'Where is the water?' Ogle's voice was excited and worried. He had heard the initial cry of water and had heard nothing else for the last sixty seconds.

We nine men in the control room looked at one another, a little dazed and disrupted by the events of the last minute. Clark moved slowly to the radio to take up the order of business again.

'We're all right,' Clark reassured him wearily.

Normally we would be anxious to get out to take a look at what had happened, but today we would not be so venturesome. We waited fifteen minutes. Headquarters reported no evidence of a water wave from the sampling aircraft, giving us permission to open the watertight door. The air-conditioner man, custodian of the door, deserved the honor of the first look through the small porthole: no water. After a nod from Clark, I followed him and the air-conditioner man out the door.

The scene outside was a mess. I looked up. By now the sun should be quite high. On other mornings, the sky would be sparkling at this time. Birds should be flying, looking for their daylight meal, there should be the hustle and bustle of a construction camp, which came to life with the rising of the sun. Today there was no such things. The cloud stretched heavy and ominous, completely obliterating the puffy white fair-weather clouds that normally dotted the tropical sky. The water, robbed of the play

of sunlight on the waves, looked dull and lifeless. Birds normally active and raucous, were nowhere to be seen.

'Any radiation?' I asked Grier.
"Yeah," the answer came. "Too low for fallout; must be shine from the cloud."

There should be little likelihood of the cloud bothering us. It would take hours for normal particles in the cloud to fall from the twenty-five-mile height to which they had risen, sucked by the tornadolike funnel of the hot fireball as it rushed skyward. With the trade winds, the cloud should be hundreds of miles away and dispersed to a safe level before it settled onto the sea.

'When are we going to eat?' the fat sergeant asked.
'Let's stick around just in case there's any fallout,' Clark replied. 'We'll have plenty of time to eat after the cloud dissipates.'

'That's a good idea, Jack. The level's gone up to five MR,' Grier cut in.

'No kidding.' I picked up a meter, carefully checked the calibration, and switched to a sensitive scale. 'Right you are, it's rising too.'

Still nothing to be concerned about. Five MR (milliroentgens) was five thousandths of a roentgen per hour, well within tolerance levels.

I watched the needle climb until it went off the sale at ten MR an hour.

'Ten MR Jack,' said Grier. 'We'd better stick fairly close to the building.'

'Let's round everyone up,' Clark directed.

Twenty MR now and rising rapidly. The level had increased four times in as many minutes. Time to seek shelter.

Suddenly the sky became filled with a whitish chaff. I stuck out my hand, which was soon covered with a substance like talcum power.

It all happened in a few seconds, but the reaction was instantaneous. "Let's get inside." It was unanimous as everyone broke for the doorway.

'Hey it's one hundred MR,' someone shouted.

No question about it, the stuff was falling on top of us. The particles were bigger now; it began to feel like a hail-storm as larger and larger particles fell from the sky. At first, they were finely divided like dust, but quickly small pebbles, then rocks began raining from the sky.

The nine of us ran quickly into the corridor of the block-house; the air-conditioner man slammed and bolted the big steel door. The fallout drummed on it like hail as everyone retreated to the safety of the control room.

'Let's all stay in one place. Keep away from the door,' ordered Clark.

I looked at my meter: one MR per hour. I walked to the doorway that led to a twenty-foot corridor to the outside door. The level jumped to twenty MR. Cochrane took out his meter and walked slowly down the corridor. Fifty MR, a hundred, two hundred, five hundred. He stopped five feet from the door, turned, and hurried back to the protection of the control room.

'It's one thousand MR five feet from the door. It must be a good five R per hour outside,'

Five R per hour meant five thousand milliroentgens per hour. At that rate a man could receive the maximum allowable yearly dose in less than one hour. There go the steaks and martinis.

Clark put on the headphones of the special radio circuit to headquarters.

No one else in the task force was experiencing any fallout. I began to munch on an apple but quickly lost my appetite when the needle of the meter at my feet began to climb, first go five MR, then to ten MR per hour. I looked around, startled.

This was serious. Clark reported the levels to headquarters.

'It can't be,' came back Ogle's reply. 'You guys have a factor of ten thousand shielding in there.'

'Can't be, hell,' Clark said angrily. 'If we have ten thousand shielding, it must be awfully hot outside.'

Suddenly someone shouted, 'The air conditioner, it's still running.'

'For God sake, shut it off.'

The air-conditioner man, looking hurt and puzzled that anyone should berate his beloved air conditioner, turned for instructions.

'Shut it off,' said Clark. 'It's probably circulating dust particles from around the door.'

It took only a second to cut the switch, within thirty seconds the level began to drop – eight MR, seven, six, five, four. It hung there for a minute, then settled to three and then one MR. I felt so good I kissed the meter.

What a bunch of sharp characters, I thought, circulating air past that doorway. If we hadn't all been out on our feet, we'd have thought of it right away.

One more crisis over, but there was still a big one left.

We checked the outside monitors.

'What's it like outside?' I asked Grier.'

'Twenty-five R and rising.'

Twenty-five R. The impact of the statement struck me. At this rate, only eight minutes outside were allowable. We were safe behind the massive concrete walls and ten feet of protective sand, but there would be no other living thing left on the island. The fallout had started an hour ago, which meant that any bird or animal that had survived the tremendous blast would already be sick from radiation. Two hours of such exposure would begin to kill humans. How high would it go? Anything up to one hundred R we could live with. We would be trapped for hours or days until the level decayed enough for a rescue. If it crept up over a hundred, we would begin to be in serious trouble. The higher it went, the longer it would be before we were rescued. If it went to one thousand, it would be impossible to rescue the party for many days, perhaps a week; in that time the accumulated exposure, even if we huddled in the farthest corner of the building, would be enough to make sick people out of most of us. If it went higher . . .

Still no design of radiation elsewhere. 'Forty R per hour outside now,' Clark was reporting to an incredulous headquarters.

'Are you sure, are you sure?' queried Ogle. 'We have practically nothing here.'

'Damned right, I'm sure.' Clark 'snorted into the microphone. 'If you don't think so, come on in.'

'O.K., Jack, it looks like you might have caught quite a bit. I'll be in as soon as we can get a helicopter to make a survey."

Thirty minutes went by. We dragged cots into the corner of the building where the level was lowest, moving away only to answer the radio or check the levels outside. They kept rising: thirty, forty, fifty,

fifty-five, but the increases were at a slower rate. We took turns reading the levels. It was my turn now.

Sixty R, but almost steady.

Grier had also noticed the slackening of the radiation rise.

'I'll feel better when it starts going down.'

'Me too.'

'Sixty-five now and steady. Hasn't changed in almost five minutes,' Clark reported. I listened to the radio. There was little traffic. The word had gotten around about the men trapped in the blockhouse; all the normal chitchat had ceased.

Fifty-nine. It was falling. I felt the same butterfly sensation as I had when the bomb went off. The final danger hazard had passed; I could relax.

We were still stuck here, still couldn't leave the building without serious danger, but hope was in sight. The radiation would decay rapidly at first but more slowly as time went on. There was a possibility that we could be rescued today; if not, certainly tomorrow. I'll settle for that, I thought.

I began to peel an orange. The food tasted good. I hadn't been able to eat for the last hour, but my appetite was coming back with a vengeance.

The radios in the control room began to pick up traffic.

The fallout was hitting the ships now, a note of concern crept into the voices on the radiation monitoring network.

'D.J., D.J., this is Hardtack. Over.'

'Ten MR this station, ten MR this station.'

I couldn't worry too much about the ships. Although their thin steel plates offered little protection against radiation, they did have wash-down systems with which they could use uncontaminated sea water to keep their decks clean. Most important, they could move, which we couldn't do. On the other hand, with our troubles behind us, we were probably the safest people in the Marshall Islands – provided we didn't leave the building.

There was little to do but wait. Gradually we were able to piece out from the radio reports what had happened. Although accurate measurements of the yield would not be available for days, remote measurements indicated that the yield was at least double that predicted, at least fifteen megatons. The upper winds had shifted in the last few hours before dawn so that the cloud was traveling slightly south of east rather than north as had been predicted. It was traveling in the direction of the inhabited islands of Rongelap and Rongerik, but no readings of radioactivity were reported as yet. The ships retreated to a point fifty miles out to sea and were activating their wash-down systems. We were barely able to continue radio communication at that distance when another disaster struck.

We were preparing a fresh pot of coffee on the hot plate when the light started to flicker and the coffee stopped boiling. Gradually the lights turned yellow, then into a dull glow.

'Oh, God, there goes the power,' yelled Clark.

The generators and main power plant were in a separate building half a mile up the road; placing them at that distance was a standard procedure to cut down noise and radio interference. The two buildings were connected by half a mile of cable; it had been gratifying at shot time to realize that the shock wave had not disrupted the cable lines between the two buildings equipment.

The present trouble might be in the lines or the generators might be stopping. We knew that they had been refueled just before evaluation and had enough fuel for several days. Fortunately we were well equipped with diagnostic equipment.

We checked the frequency of the generators; it was right on the nose – sixty cycles. We checked the voltage on each of the generator's three phases and found them to be sixty-five volts. One of the phases inside the generator had failed.

'Let's put the one-ten-volt lines on the two-twenty-volt circuit,' Cochrane suggested.

'Good idea,' I replied. 'If the generator repairs itself, we'll blow out all the equipment, but it's worth the chance.'

In the meantime we had lost all contact with the fleet. We could hear them frantically calling on our battery-operated emergency radio, but we didn't have enough power to reach them fifty miles away.

We compromised by putting half our radios on the 220-volt circuit and half on the ll0-volt circuit. That way we would have some communication either way. We were out of communication about thirty minutes while we diagnosed the problem and reconnected the lines.

We flipped the switch on the reconnected radio. It warmed up beautifully, we made contact with the fleet right away. Soon the worried voice of Al Graves was heard, relieved that nothing more had happened to us. There was a pause at the other end as our new situation was discussed. Finally, Al's voice came out of the speaker, calm, crisp, and decisive.

'Look, Jack, the feeling here is that if you lose one phase of that power, the whole thing may go at any minute, so we are starting to steam in closer to you. The cloud has passed us, and we can get in quite a bit closer. Come up on your battery-operated circuit; we'll come in close enough to establish good communication by walkie-talkie in case you lose all your power. We want to keep communications open with you. Bill Ogle is now out in a helicopter taking a survey of the atoll. He should be back in half an hour. We'll know then what the radioactivity problem is on the island. What do your meters say now?'

'About thirty R per hour outside,' Clark reported.

'At that rate you could stand five or ten minutes' exposure, but we don't know how localized it is so we'd better not make plans until Bill gets back.'

Cochrane went to the walkie-talkie and started calling. Nothing to do but wait some more. The inside of the building looked eerie. The bulbs were too dim to read by; they lent an additional air of dinginess to our stuffy surroundings, warming up rapidly as the noonday sun beat down on the unairconditioned building. A feeling of what-can-happen next? pervaded the building as we sat around waiting word from headquarters.

The fleet apparently hadn't been far out of walkie-talkie range, as Cochrane raised them on the battery circuit within twenty minutes. The ships, after making contact, continued to approach us until good communication was assured. After satisfying himself that all was well, Cochrane shut off the battery switch. No telling how long we'd be here; we needed batteries. Clark and Graves set up a schedule of contact times in case we lost our power. We were to call for five minutes on the hour and half-hour only until contact was reestablished. This would conserve precious battery power.

After ten more minutes of silence, Graves called us back.

'Bill's back and says the atoll's still there,' he joked.

'I thought for a while that it wouldn't be, Al,' I answered seriously.

'He sees no reason why we can't get you guys out tonight. What do you think?'

'Stand by, Al, until we talk this over, please.'

Everyone was anxious to get out, but Clark pointed out that we were safe here; the longer we stayed the easier it would be. On the other hand, even he was not anxious to be left here another night it we could help it.

'We're for it, Al, but we're safe here and would rather stay all night than be rescued if we can't do it right.' I reported the sentiments of the others.

Graves explained the plan. The thirty-R-per-hour level read by our meter was representative of the general level of radiation in the atoll, and the admiral was not anxious to re-enter the lagoon that night. Conditions were too hazardous to attempt re-entry or recovery operations for another twenty-four hours. The Task Force Command preferred to retire to their uncontaminated home base at Eniwetok Atoll, but could not go away and leave us stranded at Bikini. Our opinion was unanimous. If the ships were leaving, we wanted to leave.

It was now two o'clock. The rescue would be set up for five o'clock to allow another three hours for the radioactivity to decay, but still giving plenty of time before dark to effect an unhurried rescue. We were to establish radio contact every thirty minutes until 4:30, when the helicopters would leave the aircraft carrier. The helicopters would buzz the building at exactly 4:45 and circle it twice, then hover offshore until we appeared. At 4:55 we were to leave the building and drive to the airstrip half a mile from control building. If our vehicles were still operative, the hovering helicopters would time their landing with our arrival. There would be two helicopters. We were to divide into two parties, each in a separate vehicle if we could get two running. The vehicles were to go to opposite sides of the airstrip to prevent confusion. In the event that we could not start any Jeeps or trucks, or the radiation levels were too high, we were to return to the building to await instructions. The reason for driving to the airstrip was that the antennas and poles around the control building would make the rescue more hazardous. Also, the airstrip was tarred and partially paved; the helicopters would stir up less dangerous radioactive dust.

Graves stropped reading his plan to ask us if we knew the condition of our vehicles. We went into a huddle before replying. There were six vehicles outside, three Jeeps and three trucks. Several had been used the night before by the firing party, and others had been left behind the building as blast protection. So far as we knew they were in good condition. We had seen them when we were out that morning after the blast, before the fallout drove us indoors. We were all willing to take the chance that at least one would be operable and decide not to set up an alternate plan.

Clark asked us for any other comments. The plan sounded good to all of us. 'What ship are we going to?' Felt asked. Clark repeated the question over the radio. 'I don't know. The aircraft carrier, I assume,' said Graves in a puzzled tone. 'What difference does it make?' That ship's so crowded they're sleeping on the decks. We'd rather stay here,' Clark joked. 'We have good mattresses and plenty of food.' The ship was filled with helicopter crews, radiation safety personnel, and members of recovery parties. An aircraft carrier, a fighting ship, is not designed for comfort under the best conditions; now it was badly overcrowded, and the ship's company fought a game but losing battle to accommodate the influx of visitors. No one would spend a night there if he could help it, and the word had gotten around. Graves knew what we were talking about and laughed. 'Don't worry. We'll find someplace for you to sleep, and chow will be waiting. Anything else?' 'No. Sounds good to us, Al'

'O.K., we'll call you again at two-thirty.' Everyone beamed as Clark put down the microphone. Rescue in three more hours; the thought of it was wonderful. Everyone's spirits hopped up. The day's experience, the stuffy air, the dim lights were forgotten as plans were made to get out. Clark divided us into two parties- one headed by him and one by Grier. Stewart and Cochrane were designated monitors to check the level s as we went along. The two sergeants were designated as drivers since we had decided to use their vehicles, which were personnel carriers and rode higher off the ground than did the Jeeps.

We decided to eat before leaving. It was an odd meal. The voltage was still low and the lights dim. We managed to coax some lukewarm water out of the hot plate and to take the chill off some cans of meatballs and beans. It wasn't very appetizing, but the prospect of action lent zest to the meal. Graves checked in with us at 2:30 and again at 3:00 P.M. At 3:30 Ogle came on the air, chiding us for not

waving to him as he flew over our island. 'It looked pretty peaceful to me down there. The least you could do would be to stick out your head and wave.'

'Why didn't you stop in and see us, Bill,' Clark chided. 'We'd have served you coffee.' We hadn't heard any helicopters all day, so I assumed that they had hovered over water as much as possible on the survey, as a dunk in the lagoon would be safer than a land-based landing in case of trouble. By 4:00 P.M. we were chomping at the bit, ready to go. Clothes were the big problem. Grier and Clark had long-sleeved shirts and long pants, but the rest of us had only shorts and T-shirts and no caps. 'Let's use bed sheets,' someone suggested. We ripped up bed sheets and pillowcases to make leggings, sleeves, booties, and caps. We covered up what clothes we had as much as possible because they would have to be discarded if they picked up contamination, and they were the only clothes we had. Our belongings had been left in our tents, which, if they were still standing, would be unapproachable for days.

What a run on the PX there will be tomorrow morning, I thought. We ran into a problem – no safety pins. Steward found two rolls of paper masking tape. It broke easily, but we wound ourselves in tape like mummies. We made a truly comic sight as we inspected one another for uncovered spots, like monkeys inspecting one another for bugs. The fat sergeant, I thought, would get the prize for best costume. His feet and ankles were wrapped in one pillowcase each and secured by black electrician's tape. He had made puttees with pieces of rags and paper tape. He had tried to do the same for his arms, but the impromptu sleeves wouldn't stay put and kept sliding down. His body looked like a mummy that had forgotten to reduce. His headpiece, another pillowcase, enveloped his head and draped down his neck, his face peeping out like a cherubic nun's from habit. We were all a little nervous as we waited, but the outlandish costumes lent a masqueradish air to the dimly lit room.

Grier and I had been on many recovery programs. He cautioned the first-timers: 'The important thing is not to rush. If we move carefully, we should be out in the open only eight minutes or so before we get to the helicopters. It should take no more than thirty seconds to get to the automobiles. Keep your feet off the floor as much as possible. You'll be several feet off the ground, which will help considerably. Don't get out of the automobiles until you are ready to go for the helicopter. Trot, but don't run. A fall in this dust can do more harm than the few seconds you will gain by rushing. Do you have any further instructions, Jack?'

Clark instructed the air-conditioner man. "When I give the word, you open the outside door so that we can hear helicopters. Leave it open and come back to the control room. When I say go, the drivers will leave to go to the personnel carriers. If they do not start immediately, come back in and Grier and O'Keefe will go out to try the Keeps. If none of the vehicles start, we'll contact headquarters and set up a different plan. Does everyone have film badges?' All nodded.

'Doug and Harold, do you have meters?' 'All set, Jack.' 'O.K., that's it until the choppers come.' Clark went back to check with headquarters. 'We're ready,' he reported. 'O.K., Jack.' It was Ogle's voice. 'The copters are airborne. You should be able to hear them in about ten minutes. We've just raised them on King net.' Although we had most radio circuits in the communications center, there was no provision to talk directly to helicopters, which had their own radio network. Graves and Ogle, however, could talk to both of us.

'What does your level read now, Jack?' Bill asked. 'About twenty-two R per hour,' Clark replied. 'You shouldn't have any problem at that level,' said Ogle encouragingly. Clark and Ogle chatted aimlessly to pass the time until we were ready to leave. All other networks had radio silence imposed until we cleared the island. At 4:35 Clark gave instructions to open the outer door. The afternoon tropical sunshine poured in; we blinked and rubbed our eyes. I had forgotten how dim the lights were in the windowless building. The sunlight almost blinded us, although we were twenty-five feet or more from the door. 'We're like a bloody bunch of moles,' muttered the air conditioner man in his Scottish burr, but there was no reply.

We strained to hear the sound of the helicopters. At 4:40, on schedule, the faint *flop, flop, flop* of the helicopter blades was heard, softly at first but soon distinct and unmistakable. Cochrane and I grinned at each other out of our shroudlike garments. 'Here they come,' someone said softly to himself, unable to be quiet in his elation. 'O.K., Bill we hear them,' Jack reported. 'Right, Jack. Give them time to buzz the building twice before you come out,' Ogle warned. 'Roger, out,' said Clark, ready to cut the conversation and be gone. 'Good luck and out here' came the final message from the ship.

The noise grew louder, deafening in the small corridor, as the first helicopter passed low in front of the building its shadow visible for an instant before the sound subsided to a steady *flop, flop, flop*. Again the noise as the second helicopter passed in front of us, just high enough to be out of sight. There was a thirty-second pause, then both helicopters repeated the maneuver. The sounds grew quiet, barely audible after the second pass, as the copters backed off and hovered over the lagoon. Thank God for helicopters, I thought as I took a last look at the building. The dinginess and dimness of the lights and the building were more obvious now that we had been staring at the sunlit corridor. The other shrouded figures looked ghostly as they prepared to quit their tomb. 'O.K., start the cars,' said Clark.

The two drivers went out, trotting softly and trying not to hurry. I heard the engines whirr and catch almost immediately. 'Let's go' We moved in unison, needing no instructions. It was only a few steps to the personnel carrier. I had wrapped my hands and shoes in rags just before leaving and was careful not to touch the vehicle with my hands as I climbed into the back. Only seconds had passed before we were driving slowly down the road in first gear, stirring up as little dust as possible for the group that followed. We had all made breathing masks with which we covered our mouths and noses before leaving and were virtually unidentifiable, with only our eyes showing.

I looked out the side window for the choppers. There they were, motionless in space, but with wings whirring like dragonflies poised over a sunlit pool. I looked at Cochrane to check the radiation level. He nodded his head in reassurance and held the meter where I could see it. It was wavering a little as we drove along but seemed fairly steady at about ten R per hour. The three-foot separation from the ground did help some, I thought. The truck lurched as the driver detoured around a fallen tree. The road was a mess, with palm branches, leaves, stickers, and rocks scattered around by the blast; most of the debris was small though, and we had little trouble along the half-mile stretch to the airstrip.

The copters settled closer to the ground as we approached the edge of the strip. We went to the far side and the others came up on the near side, the two vehicles coming up on the paved strip almost simultaneously. The copters were directly overhead now; it was impossible to talk or hear. The driver cut the engine precisely as our copter settled on the strip. We jumped from our vehicle and trotted gingerly about the helicopter to the side door, carefully avoiding the spinning rear propeller and running with our heads down from force of habit. Helicopter blades are set to clear the heads of a basketball team, but I have been never able to resist the temptation to duck. As I made my way the twenty yards to the helicopter door, I could see the pilot in the cockpit, grinning broadly and waving. It was Jerry, the squadron commander who had left us some seventeen hours earlier.

The side door opened as we approached, and a familiar figure reached down to help us into the copter. It was Major John Servis, the commander of the Rad-Safe detachment, looking relaxed and calm, as though he did this every day. He was dressed in conventional radiation protective clothing – loose coveralls taped tight at the ankle, snap-on booties over his shoes, a cloth cap, and cotton disposable gloves. He had a respirator-type face mask on a strap around his neck but apparently preferred not to use it. He looked like home and safety to me. I smiled at him, completely forgetting that only my eyes were visible through the bed sheets. A big grin on his face showed his amusement at our clothing, and he threw up his hands in mock despair as we clambered aboard. The noise of the engine was too strong for him to be heard, but he pointed to our feet like a housewife whose children had dirtied up her nice clean living room.

I understood immediately and removed the rags from my hands and shoes. The others followed and we tossed them overboard before fastening our seat belts. Major Servis reached up behind the pilot and nudged his legs – the signal to take off. We were airborne immediately, as Jerry wasted no time getting off the island. The major passed his survey meter expertly over all of us. He shook his head negatively and shrugged his shoulders as if to say, "What's all the excitement about. You guys are as cool as a cucumber.' Missouri-like, I grabbed Cochrane's meter and checked my clothes – not more than ten MR per hour. Apparently we had picked up no contamination to speak of in our journey along the island and could relax. The back of the plane looked like a ragpile as we removed makeshift caps, facemasks, and leg and arm shields. I felt cooler and more comfortable as I sat back in my shorts and T-shirt. We spent the twenty minutes back to the ship grinning at one another like canary-eating cats.

There were handshakes and backslapping as we debarked from the helicopter, but the efficient Rad-Safe crew was not to be deprived of its only customers of the day. We were monitored carefully, head

to foot, as we disrobed and showered. Our clothes were passed as safe. We dressed, turned in our film badges and were given new ones. Considered clean, we went off to a drink, a meal, and a debriefing. We were safe. We were lucky. But others were not so lucky. Our film badges showed that we had accumulated only a few hundred milliroentgen, less than half a roentgen – an excessive does for a single day - but well within tolerance limits if we were careful for the rest of the operation. Similarly, aboard the fleet total accumulations were not outside limits. The wash-down systems, the evasive actions, patrol aircraft to tell the task force commander which way to go, all kept the radiation accumulation within reasonable limits. But we were the experts. We had meters, film badges, we understood what we were doing and for the most part what was happening; we knew how and what precautions to take. We had all the tools and techniques of modern science to protect us.

Remembering EG&G, Part VI
A New World

When Barney O'Keefe returned from the Pacific in 1954 following Operation Castle, he found the company at a turning point. By then Grier was living full time in Las Vegas and would from that point on devote most of his attention to the work being contracted with the laboratories and the Test Site. Back in Boston, O'Keefe and Germeshausen wanted to focus more time to non-defense related activities. They seemed to sense that nuclear testing may be entering a period of unpredictability in terms of world events. It was a new world these men were facing as the arms race began to intensify while simultaneously public controversy developed over nuclear testing.

Their first major work outside testing in 1954 was with improved ceramic designs of hydrogen thyratrons for radars. EG&G would also soon receive a contract to set up a radar site near the Test Site. Germeshausen had made significant advances in radar design since he worked in that field at MIT's Radiation Lab during World War Two. O'Keefe then got the growing company involved in a second project. This was the development and production of instrumentation for the Air Force which O'Keefe had played a key part in. It involved a defense related contract and the details appear classified, so I was not able to research this area further.

In 1954 EG&G sales grew to $2.3 million with a $40,000 profit. The number of employees had grown from six to two hundred in just seven years. By 1955 sales exceeded $3.5 million with 390 employees. In 1956 that figure grew to $5.7 million with 480 employees while earnings reached $111,000.

This rapid growth and move to convert the organization from pure scientific research into a market place business seems largely due to O'Keefe and Germeshausen. O'Keefe has an amazing reflection on this key period in the history of EG&G in his book, "Nuclear Hostages:"

"In the flush of the initial formation of the corporation, when we plunged full time into preparation for the Sandstone test series in 1948, we didn't even have an accountant. We packed up our bills in a large envelope and sent them to the New York office of the Manhattan District for payment. We didn't have facilities of our own, operating out of MIT as we did when working for the university. We did our budgeting on the blackboard and then erased it. Later in the year, government auditors pointed out to us that this was not quite acceptable financial practice. After Sandstone, we acquired our own facilities in a converted garage on Brookline Avenue in Boston. We hired accountants, clerks, secretaries, and telephone operators. At one point, as our numbers approached one hundred people, we seriously debated whether we should stop there and not get any larger because we would begin to lose quality. . . Our budgeting technique [by 1952] took a quantum jump. Instead of budgeting on the blackboard and erasing it, we budgeted on the blackboard and took a Polaroid picture before erasing it. We thought certainly that would satisfy the auditors, but for some reason it didn't. We set up an accounting system to pay our own bills and send invoices. We hired a personnel man to set salary grades and monitor performance against wages. We set up our own machine shop and chemical laboratories. We developed our own networks of suppliers and converted some of our aging electronic technicians into buyers and purchasing agents.

Everything did not go smoothly or without protest. After we had grown to the size of several hundred employees, the business needed more and more accountability. It is the practice in small laboratories to have an open stockroom where engineers and technicians can go in and take the supplies they need. When a box gets empty, somebody orders more. There comes a point in growth when a stock clerk is needed to maintain continuity of supply and to account for distribution to various tasks and product

lines. Dr. Edgerton objected to this. He maintained his own laboratory at MIT, where he was now a full professor. He felt that accounting for supplies was a nuisance and hindered his research. But progress marches on. I finally had to hire a stock clerk and lock up the stockroom, but I forgot to tell Dr. Edgerton. I arrived one Monday morning to hear the stock clerk reporting a burglary over the weekend. I soon found the culprit. It was Dr. Edgerton. He had come in to do some work on a Sunday, a normal workday for him, found the stockroom locked, went to his car for a pair of wire cutters, and calmly cut the screen out of the stockroom wall. A free spirit!"

By 1955 with O'Keefe's commercial diversification in Boston, the continental test work rested primarily with Grier in Las Vegas. However, the testing program still remained EG&G's chief responsibility. At the Test Site Grier supervised a contract for fifteen detonations where the timing and firing and high speed photography work expanded to include the diagnostic measurement of the rate of the multiplication of the neutrons in a nuclear detonation. Meanwhile, Barney O'Keefe took over the responsibility for further weapons tests in the Pacific. It is hard to imagine how these men were able to take on so much work at one time and still lead a growing and diversifying company.

On October 1st, 1956, EG&G published its first newsletter called "*EGG ink*". Our Museum is proud to have an original copy of this early edition thanks to a donation by Nevada Test Site Historical Foundation Board Trustee and former EG&G General Manager Peter Zavattaro. Also in our collection is the original handmade printing block used on those first newsletters to emboss the early EG&G logo. This is a truly remarkable, one of a kind, artifact.

EGG ink

BOSTON LAS VEGAS

FIRST EDITION

AN INTRODUCTION

DON McCLELLAN IN NINTH YEAR WITH EG&G

DISLOCATION PAY

Contained in that very first circular is a short history of how EG&G became involved in nuclear weapons testing. Earlier parts of this article have already covered that story; however very interestingly, the newsletter points out that the founders of EG&G had debated as far back as 1949 about whether or not to continue to expand in the direction of defense work.

Nevertheless, O'Keefe and Germeshausen continued to try to expand the company into commercial instrumentation. The EG&G newsletter article does stresse that Dr. Edgerton, Germeshausen and Grier all felt obligated first and foremost to serve the interest of their country. O'Keefe also stressed that fact in his writings.

The stunning news in 1949 that the Soviets had tested an atomic weapon and a few short years later mastered a thermonuclear device in 1953 impressed upon the EG&G founders the gravity of their own expertise in classified nuclear weaponry. Plainly, they had a responsibility no one else could provide. Thus by 1956 when this story appeared in the first EG&G newsletter, it is clear that the trio, along with O'Keefe, wanted to continue nuclear testing work. In their eyes they saw that to maintain the peace meant gaining nuclear security. By that point it is evident, at least in Grier's mind, that the growing nuclear arms race would be about

deterrence. Later interviews reinforce that although the possibility of a nuclear war was never out of anyone's mind. Grier, and O'Keefe, seemed to sense that nuclear weapons were becoming so powerful and numerous that they may never actually be able to be used. However, their very existence necessitated a strategy of deterrence.

Grier exhibited a profound sense of patriotism as well as community as he established his home in Las Vegas. He became not only an integral part of the Test Site but Las Vegas as well. He served on the local draft board during those years, and he always insisted eligible EG&G employees do their service. He, however, promised all of his employees who went into service that they would be guaranteed their jobs back as well as be given credit for their years of military service in terms of company seniority and retirement benefits.


EG&G EQUIPMENT SHOWN AT WESTERN ELECTRONIC SHOW AND CONVENTION

This is the display booth nearing completion shortly before the Wescon Show opened in Los Angeles.

Those first newsletters also provide a fascinating insight into the early days of EG&G as a company. They truly demonstrate a business in service to a community. These valuable research sources also give an interesting look into everyday life in Las Vegas in the 1950s. Dr. Edgerton, Germeshausen and Grier certainly contributed to a cultural life for EG&G employees and the local community. (This was also true at their Boston office.) From the first newsletter issues in 1956, the company is seen as being active in supporting scholarships in Clark County and providing frequent demonstrations of the unclassified portions of its work. They produced what look to be some very attractive exhibit panels documenting their work. These were put on display at numerous public gatherings and at school science fairs and educational activities.

A real desire is evident to promote science and education. The company staged many service events both for employees and local citizens. The Boston and Las Vegas EG&G offices had active bowling and softball teams. In 1958 EG&G supported the Las Vegas High School Junior Achievement Club. The Las Vegas office also hosted an impressive art exhibition in July of 1957 with over 500 local people in attendance. The show took place at Las Vegas High School where EG&G employees and their families were key contributors to many of the works on display.


OCTOBER, 1957

EG&G ART EXHIBIT

Pictured above are first, second, and third place winners at the EG&G Art Exhibit. From left to right: Mrs. Margaret Fraizer, with her oil, "Arizona Landscape"; Mrs. Alice Peck, with oil, "Woman With Rice"; and Mrs. Ruth Shrock and her oil, "Grand Tetons." The awards, which were ceramic plaques, were designed by Mrs. Peck.

EG&G sent a special exhibit trailer to the Clark County Fair and among many exhibits actually displayed examples of their early firing and timing systems which were by then a part of history. Also at that exhibit were examples of some, then, very cutting-edge analog business computers. A talk at the Fair

sponsored by EG&G explored the outlandish concept that computers may one day actually be able to talk to one another on a global scale.

At the end of each year the three men would host a party for company personnel. It was said there were never any no-shows. Many former EG&G executives recall how the partners would circulate among every table and speak to each employee in person. Accounts all agree that these fine men would go to great lengths to make each individual feel recognized and appreciated.

By 1957 the Nevada Test Site and contractors like EG&G were a major part of the growth of Las Vegas. Nuclear testing created a metaphorical boom that by then supplied millions of dollars in resources and jobs. Nearly seven thousand civilians were working at or for the Test Site that year. The Atomic Energy Commission had another fifteen thousand workers supporting nuclear testing. Each test was estimated to pump over a million dollars into the local economy although it is impossible to equate test for test the benefits in jobs and spending at any precise movement. Overall, the Test Site and its workers were making Las Vegas grow day by day because almost every worker had a wife and children. Those families needed housing and schools. Houses and schools called for more roads and power lines and water works, and this created a chain reaction as real as the chain reactions going on during the nuclear tests.

In 1958 the government asked Barney O'Keefe to become the scientific commander for the Bikini operations in Operation Hardtack. Grier stayed in Las Vegas to oversee EG&G contracts at the Test Site. As O'Keefe took a brief leave of absence from the company for his return to the Pacific, fifty-four tests took place between Nevada, Eniwetok, Bikini and Johnston Island. Eleven weapons development tests of high yields were carried out at Bikini. O'Keefe described the pace as overwhelming, and he described this period as one of great stress. He recounted:

"As I sat evening after evening in the senior officers' mess, I was struck by the siege mentality of the senior military and of the civilian scientists. I had been away from direct involvement in the field operations for almost two years; I understood the worldwide concern about fallout, the sincere desire of the President [Eisenhower] to do something tangible about stopping the headlong race to oblivion. To me a test ban treaty, or at least a temporary moratorium, was inevitable. Not so to the people at Bikini. They were inculcated with a spirit of the importance of nuclear superiority to the national security. They were strongly anti-Communist, deeply suspicious of the Soviets, convinced that the Russians would find some way to cheat. They dismissed the fallout question as media-inspired; they felt betrayed by the politicians and duped by the Soviets. Having no one to talk to but one another, they became more and more convinced of the validity of their position, more and more eager to complete as many tests as possible before they were put out of business."

A moratorium on nuclear weapons testing began in late October of 1958 and would last for almost three years. Just before the ban came into effect, eighteen full-scale tests were hurriedly detonated at the Test Site in just a few weeks with four on October 22nd alone. They also conducted last-minute experiments in deep wells dug in the Yucca Basin. Articles in the EG&G newsletters debated if nuclear testing might be over for good. Following that last rush of tests, company newsletters detail their work in Project Rover, an effort to develop a nuclear thermal rocket. The stories detail how in the spring of 1958 EG&G established a Reactor Engineering Department in Las Vegas to support the work going on at the Test Site in nuclear rocket propulsion. That work kept many employees busy through the years of the moratorium.

The lull in nuclear weapons testing only put new and ever-increasing demands on EG&G. During the moratorium, the company mastered the use of conventional but very high grade explosives to simulate atomic blasts. Much of that work was done at the Test Site. Even before the test ban, an EG&G newsletter from 1957 talks about a rather severe recession which had hit the country. History tells us it was comparatively brief, but defense spending did decrease as a result. The newsletter in fact talks about significant decreases in defense spending; however, the company's work had become so critical and specialized that EG&G continued to expand.

In 1958 they signed six government Research and Development contracts. Five of these were with the United States Army and one with the Atomic Energy Commission.

Dr. Edgerton proved to be quite a talented guitarist as he led a group song fest during the annual EG&G family outing last August at Camp Tabor in Needham, Mass. The two little girls in the foreground are Doc's Grandchildren. Somewhat cloudy skies failed to dampen anyone's enthusiasm as swimming, tennis, pony rides, baseball and vollyball were enjoyed on the vast recreational grounds. The fresh air and sports sharpened enough appetites to demand 60 pounds of hot dogs, 100 pounds of hamburgers, and another 60 pounds of Italian sausages served up with relish by members of the Employees Activities Committee.

Moratorium or no moratorium, the company continued to specialize in nuclear-related technologies. In 1959 Dr. Edgerton represented EG&G at the Peaceful Uses of Atomic Energy Conference in Geneva, Switzerland, where he exhibited examples of the company's numerous patents in the nuclear energy field. In 1958 EG&G formed a nucleonics group in Las Vegas to design diagnostic nuclear instrumentation. The group later relocated to a newly established operation in Santa Barbara, California.

The company's numerous patents in Hydrogen Thyratron Tubes made it indispensable to the work in advanced radar systems then being developed by the military. At a time when technology depended on vacuum tubes, EG&G led developments to extend the life of this fragile form of technology by finding ways to more evenly distribute the high levels of heat produced by tubes. In 1961 EG&G sales were $19 million and that doubled to $38 million in 1962. When MIT became the first to shine a laser beam to the Moon in 1962, it was thanks to EG&G Xenon flash tubes.

On August 30th, 1961, the Soviet Union announced at a disarmament conference in Geneva that it would resume testing. The Soviets tested a 150-kiloton device one day later. Clearly they were already preparing to resume testing. In the next sixty days, the Soviets conducted fifty atmospheric tests. This became the most intense sustained-test series in history. Barney O'Keefe and Grier agreed in their assessment that since it takes years to prepare for such a large series of tests, that it had become obvious that the Soviets never stopped preparations as the United States had naively done during the three-year moratorium. O'Keefe reflected:

"The United States was caught unprepared. . . The weapons laboratories, without the deadlines of a scheduled test program, had delayed settling on the final designs of most of their new devices. The military, with restricted budgets and limited technical personnel, had allowed their forces to atrophy.

Politically it was embarrassing not to be able to resume testing immediately as the Soviets had done. . . . Again there were two full-scale test programs, one in Nevada and one in the Pacific. Because of the three-year moratorium, there was a severe lack of trained testing personnel, particularly in the military and in the nonweapons government laboratories. . . Contrary to what had happened in other organizations, we at EG&G had not lost any experienced people. In accordance with our fundamental diversification strategy they had been transferred to other, nonweapons programs. . . When asked to take on a heavy test load, we were reluctant to do so since it would delay many of the commercial developments into which we had put so much time, effort, and money; furthermore, the President had ordered that the atmospheric tests be completed in six months, after which there would be an atmospheric test moratorium. <u>But the appeals to patriotism on the importance of the tests could not be ignored</u>."

Around that time, Grier and O'Keefe were in Samoa making some measurements of the aurora effect from a new series of high altitude tests near Christmas Island. O'Keefe tells an amusing story from those last few months of the atmospheric testing period.

"Grier and I were driving through jungle roads twenty-five miles to the western tip of the island, [of Pago in American Samoa] where our photographic installation was located. We had found a promontory about fifty feet high, which was ideal for our cameras; to help us with the installation we hired two chiefs from the village to the east at a going rate of $28 per week each. There we found the sources of friction [that they soon learned from a call from the Assistant Secretary of Interior and had caused concern all the way back in Washington DC]. None of the natives had ever paid attention to ownership of the high ground because it was useless to them. Their main livelihood was fishing, so everyone lived by the beach. When the chiefs of the village to the west of the promontory heard that the chiefs to the east were making $56 per week, they claimed ownership of the promontory, [and] starting a dispute that filtered all the way back to Washington. We solved the problem in typical American style, by hiring the other two chiefs for $28 per week each; since there was now nothing to do but wait for the test, we had four [chieftain] employees watching two plywood shacks. The natives were delighted. They decided to have a big feast for the two chiefs from Boston who had brought peace to their villages."

By 1963, and the move to underground testing, the world changed dramatically for the EG&G founders. Peter Zavattaro's book on EG&G provides a very detailed account of that period as well as the whole EG&G story. A new chapter of increased diagnostic analysis became possible with the underground era which EG&G played a significant role in. However, the heydays were over and along with them, at least some of, the best stories. O'Keefe went on to write an outstanding book called *Nuclear Hostages* from which many passages have been quoted here. His book concludes with the thesis that the great powers like Russia and America finally made themselves hostages to one another. The nuclear weapons they had created posed a threat that they could not undo. O'Keefe and the three founding fathers of EG&G never regretted the work they did in nuclear testing. They all supported the United States' adoption of nuclear deterrence, which is the credible threat of retaliation to forestall enemy attack. They rightly pointed out that the natural laws of the universe were always there and if America had not unlocked the secrets of the atom first, someone else would have. And once one super power has such a weapon it will always follow that an arms race begins. Nuclear bombs are in one respect just the latest great weapon of the day. A hundred years ago, engineers and great powers feverishly struggled to see who could build the most battleships or greatest "dreadnoughts" of the day. A hundred years before that it was the invention of high explosives or Dynamite. You go back further and it was the cannon and then the crossbow, all the way back to swords and spears. A hundred years from now we will likely have another new innovative weapon. The men of EG&G played a remarkable part in the history of nuclear testing in the Twentieth Century. However, their story as human beings and great engineers is even more amazing and varied.

The more one reads about the history of EG&G and thus the works of the Dr. Edgerton, Germeshausen and Grier, one fact stands out. It becomes apparent that in those early days the physicists were the ones who conceived elaborate concepts such as atomic weaponry. Yet, it took practical scientists and engineers to actually make the devices work. Many varied skills were required to put any type of complex system into production. In my mind the remarkable feature about these founding scientists of EG&G concerned just that. All three men had a great scope of work and many varied interests. Today such figures would be relegated to history as "renaissance men." Modern science and engineering today is so highly specialized and compartmentalized that the like of such figures may never be known again.

Yet, it was their great diversity and teamwork which made them so successful. Just look at the life these men led. As stated in an earlier section, photos by Dr. Edgerton grace the halls of the New York Museum of Modern Art. In later years, he became deeply involved with deep-sea photography helping Jacques Cousteau in undersea research. Working in collaboration, Edgerton and Cousteau sought out and discovered numerous historic undersea shipwrecks and examined perplexing marine mysteries. It was said he had an amazingly optimistic outlook. On one failed marine expedition while looking for the Civil War era ironclad *Monitor*, one colleague said "what a waste." Dr. Edgerton, who had helped develop sonar for that search, popped back in a cheery voice and said totally unaffected "we discovered where it is not." Mrs. Grier recounted the very unique and charming personality of Dr. Edgerton:

"He was one of the most delightful persons I have ever met. Just interested in everybody and everything—one of those people who make you feel worthwhile no matter who you were. And a great inspiration to his students; at MIT they still worship his memory. His wife, Esther, was a dear, also. She outlived him for quite a long time. Germeshausen (Herb called him 'Germs' with a hard G, his wife Polly called him Ken) was an admirable person, too. A brilliant man, very reserved and quiet."

Dr. Edgerton held forty-seven patents over a lifetime of achievement. He was even a musician while Germeshausen became an accomplished cook and lectured on the art of cooking. Germeshausen mastered the science responsible for fifty patents over his years and became an authority on patent law. He became an able businessman serving as the company's vice president and treasurer from 1947 to 1954, president from 1954 to 1965 and chairman from 1965 to 1972, when he retired. Germeshausen also amassed a notable contemporary art collection and dabbled in modern architecture, designing his own home.

There seems no end to the many varied interests of Grier. To a great degree, he was his father's son. Herbert E. Grier, Sr. worked as a die chemist who influenced his son's interest in anything mechanical. He urged him to attend MIT which is where Grier began his long career in science and engineering.

David Grierson writes about Grier's time at MIT:

"Grier earned his bachelor of science and master of science degrees in electrical engineering at MIT. His thesis paper on stroboscopic photography led him to collaborate with MIT faculty member Harold Edgerton and Kenneth Germeshausen. Together, the scientists pioneered ultra-high-speed photography and the then unique stroboscopic and flash lighting techniques, including a portable flash unit for news photographers. In a history of EG&G produced by the corporation, Grier points out that the partnership was first formed 'to achieve, as a group, more than we could as individuals.' With no written agreement, the scientists simply pooled their resources for a variety of consulting projects. As their abilities became more widely known, they prospered. 'The effort worked very well; at least we ate,' recalled Grier, 'and in those days in the early thirties, that was somewhat of problem."

In an oral history interview Dr. Edgerton told an interesting story about Grier. It involved the time when the AEC sought assistance for the upcoming Sandstone tests. Dr. Edgerton said a large gathering of engineers and physicists were seated in rows debating how best to remotely detonate the bombs. He said a lot of wild ideas flowed around and they even considered using radio signals which in those early days according to Dr. Edgerton would have surely lead to a disaster. Grier, who was sitting in the back, was said to have remained perfectly quiet till everyone had exhausted themselves. Then he stood up and began to explain how it should be done. Dr. Edgerton said indeed that is exactly what they proceeded to do and from that point on Grier was the voice of authority and so was EG&G.

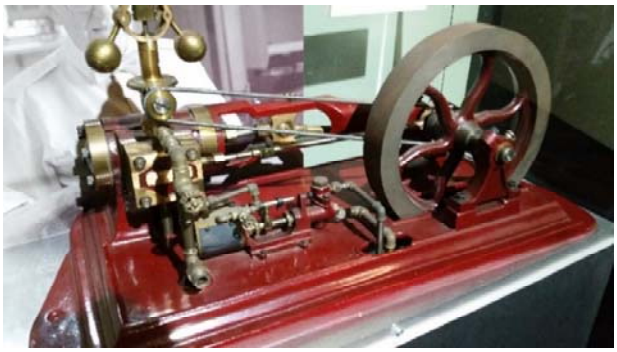
As the years went by, the company grew much larger than anyone would have imagined. In 1964 Grier became president of the consortium of a merger of the Continental Oil Company, EG&G and Reynolds Electrical. He retired from EG&G in 1976 at the age of 65 although he stayed on the Board of Directors for several years afterwards. Grier served on a number of other boards as well such as the NASA Aerospace Safety Advisory Panel. (All the three founding men made a promise to one another to retire from the company at age 65 so other junior members could move up.) In fact, in his memoirs, O'Keefe recalls that when the group began a serious debate about the company growing too large and losing quality Grier was quoted as saying:

"When we get that big, we'll have to start writing memos to each other. . . If we have to start writing memos, we should quit."

I think the comradeship those men had is hard to appreciate in our modern legal and politically correct world of today. The father of three, Grier finally left Las Vegas and retired with his wife Dolly to La Jolla, California. There, he spent most of his time with Dolly and her passion for gardening and his own mechanical hobbies with small engines and restoring clocks. Grier recounted in an interview at that time:

"Most of us in science do our best work when we're young. . . As you get older and see more of the big picture, you inevitably graduate toward management. I've been very fortunate in that I've always worked for myself in an occupation and with people I enjoyed."

Grier remained as a consultant to EG&G until his death in 1999. In 1989 Grier received the Presidential Medal of Science. Herb Grier was a scientist who could engineer and build almost anything from scratch. One of my favorite exhibits at our Museum is a working model of a steam piston engine that Grier built by hand. It is amazing to me how all three of these men accomplished so much in their lifetimes.



By early 1995, EG&G decided to end its long association with the Department of Energy and the Test Site when they did not compete for the follow-up contract after the existing one ended in December 1995. The founders were long gone from involvement with the Company. O'Keefe died the earliest, in 1989, followed by Edgerton and Germeshausen in 1990. Grier passed away in 1999. The Company's CEO, John Kucharski, began looking for a buyer of the remaining government work. When EG&G sold that division, its own name went with it. The remaining commercial work was consolidated into a recently acquired company, PerkinElmer Inc. which became its new identity and is still prospering today. The Carlisle group became the buyer of the government work and set up a privately held company called EG&G Technical Services, Inc. That company was then sold in 2002 to the United Research Services or URS Corporation in San Francisco. In 2014 the California based company AECOM acquired URS. The original essence of EG&G and the company name is now long gone. Surprisingly, few outside the circle of surviving Nevada Test Site veterans even know what the initials EG&G stand for. This is a history that needs to be documented because it has a national significance! This story also imparts a strong legacy for our Las Vegas region.

The last EG&G General Manager Peter Zavattaro made some interesting reflections in an oral history interview he gave in 2015:

"EG&G has really been a unique company. The people that worked at EG&G, almost everyone has good feelings about how they were treated, how we worked together, how management ran. It's truly been a unique experience. We used to have reunions back in Boston when I went back there. People would come from all over the country to those reunions. We'd have a thousand people. Everybody that I've talked to, I talk to people at the lab, there's a lot of people at the lab that were EG&G at one time. Like the deputy director, Don Cobb used to work for me in Los Alamos. And I invited him to the reunion and he would write a couple of nice sentences about how great, EG&G was such a great experience and a unique company to work for. So, it's unlike any other company that I'm aware of that has that kind of rapport and history. . . But the company philosophy has always been to treat everybody well, and there was no structure that was typical of a lot of companies today. It was a good place. . . With EG&G, it's always been it's can-do technical attitude, very field oriented and positive kind of thing. . . We managed to keep the bureaucracy pretty well buried. At least I did. As I say in my book, there's only four general managers in fifty years there. It was Grier, Felt, Hammon, and me for the history of our participation in the weapons program."

Remembering EG&G, Part VII
Final Word

In its day EG&G grew to over 30,000 employees and owned seventy companies while becoming a very large contractor at the Nevada Test Site. Even though the company became so immense, a strong sense of camaraderie remained. This is something I find stressed in all the numerous reminisces which I have heard from veterans of the Site. Many of our Museum visitors of course ask questions about the Area 51 connection. EG&G, just as REECo, served as key contractors to both the Test Site and Area 51. It is my intention as we upgrade exhibits and construct a new conceptual Master Plan that we will give better attention to Area 51 subjects that are truly amazing. These involve the documented history of captured and US aircraft tests at Area 51.

Permanent future exhibits must certainly give greater attention to the test flights of famed aeronautical engineer Kelly Johnson and his wondrous concepts that culminated in the U-2 and A-12 OXCART to the SR-71 and later stealth technology. EG&G contractors employed a lot of courageous men and women who devoted notable service to their country during the Cold War in Area 51 and at the Nevada Test Site. Their stories are remarkable, and many of these veterans justifiably focus on the important story of how the peace of Cold War was secured through deterrence, in part, thanks to the work conducted at the Nevada Test Site and Area 51. This would not have been possible without the help of highly skilled contractors like EG&G.

Of course some of our visitors are attracted to the more sensational stories surrounding that time, and as part of our service as educators we can appreciate all interests. So I will add a story for the diehard UFO enthusiasts. These patrons bring us significant visitation to the National Atomic Testing Museum. We deeply appreciate the support of their admissions because their dollars keep this Museum staffed! Thus, here is a truly well-documented "UFO" sighting for those valued customers. It, however, has absolutely nothing to do with Area 51, absolutely nothing to do with EG&G and nothing even to do with the state of Nevada for that matter.

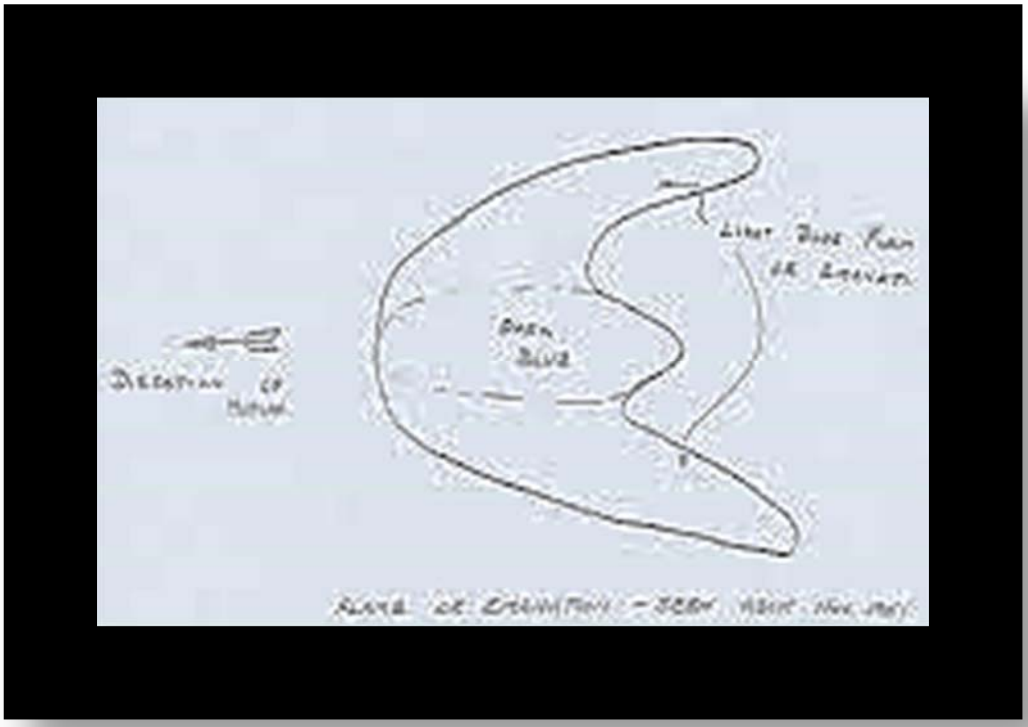
The story is notable to recount, however, because Kelly Johnson served as a first-hand witness along with some of his key technical staff. Their noted sighting occurred during daylight on December 16th, 1953, near Agoura, California. At that time, Johnson observed from his home on the coast a very large, saucer-shaped, high-flying aircraft. By sheer coincidence his top team of engineers was then aloft in a Lockheed Constellation just off shore testing avionics equipment when they observed the same unknown object.

Johnson reported this sighting to Air Force Intelligence where it was reviewed by a good friend of his, Lieutenant General Donald Putt. Putt had a long-respected history in aeronautics and intelligence work. Putt with others had helped collect and disseminate much of the exotic, advanced aircraft and rocket technology brought back from Germany

at the end of World War Two. His team also worked with American industry after the War to commercially utilize a lot of the advances made in Germany.

Declassified Pentagon memos from Putt indicate he knew every classified Air Force project then going on but did not have a clue as to what Johnson and his technicians witnessed. To date, however, Johnson's account is the only story of any credible substance even remotely connected to our history. Kelly Johnson's own reflections of these sightings are carefully documented in Record Group 341 of the National Archive holdings in College Park, Maryland, as well at the National Archives Record Administration files at Maxwell Air Force base collection ID: MAXW-PBB19-1710.

A sketch depicted below, which Johnson and his Lockheed engineers produced in an effort to document what they saw for United States Intelligence agencies, looks amazingly like a modern-day B-2 Bomber. From that time on Johnson considered himself a believer in the term "flying saucer," although there is no evidence to suggest he ever publicly postulated on the origin of the more credible sightings like his own.



It should be noted for a proper historical perspective that there was a period from approximately 1947 to 1955 that the subject we now refer to as "UFOs" was given some considerable attention and respect by various Intelligence services.

Many of the Air Force sighting reports went to a large variety of agencies including the Atomic Energy Commission. This was not because the Atomic Energy Commission had anything to do at all with UFOs, but because of a mandate from Vannevar Bush who directed the post-World War Two Research and Development Board established by Harry Truman. Dr. Bush simply thought the AEC a logical resource of scientists to keep informed and their opinions were occasionally consulted by Air Force Intelligence until about 1952. And what almost everyone fails to realize is that the urgency surrounding those UFO

reports in those early Cold War days centered not on visitors from space, but a true fear that they might represent advancements in Soviet aircraft technology. This was taken very seriously.

It should also be noted that another reason the AEC often found themselves involved in the early investigations, correspondence and meetings concerning UFOs is because a number of notable sightings occurred over or near AEC installations. According to procedures, AEC security guards filed reports when unidentified aircraft or phenomenon were sighted. These reports put the AEC in the middle of some of the early investigations. Not all sightings involved conventional UFOs. Numerous early reports involved a phenomenon known as "Green Fireballs" which did get some considerable attention by the AEC because they were spotted so often near their sites. These early UFO reports involved numerous meetings with AEC officials.

One meeting in particular is of note because archives have the transcriptions of the meeting's minutes. It occurred at Los Alamos on February 16, 1949, and involved Edward Teller and Norris Bradbury who attended with other AEC scientists and a noted astronomer of the region, Dr. Lincoln La Paz. The meeting hoped to utilize the expertise of the nuclear physicists. They had a productive discussion to review the latest reports on the phenomenon and primarily the green fireball reports of the time. This meeting's records are in the National Archives under file number: NARA-PBB88-398, and NARA-PBB90-1027 through NARA-PBB90-1050, in document code group T1206-88.

So, for our loyal patrons, that is a well-documented story which we hope you enjoyed. As stated, we are open minded and appreciative as educators, however, our intent with the more sensitive subjects such as Area 51 is to concentrate on the documented stories of aviation and technology which of course EG&G had a supportive role in as it did with the Test Site.

Our story has only been a very brief description of a notable American defense contractor and the amazing engineers who made it so unique. Maybe this story will be of service to future research inquiries. We again thank Nevada Test Site Historical Foundation Board Trustee and former EG&G General Manager Peter Zavattaro for his wonderful book on EG&G and a great collection of EG&G documents he donated to our Museum. Also, a thank you goes to Peggy Hallerberg for her helpful comments and corrections and memories of Herb Greer. My intent is to give our resources on the history of EG&G and other recently-donated items more attention and focus as well as the Museum's appreciation. As we get into our new Master Plan, we need to give more attention to documenting the contracting firms, the laboratories and the many great men and women scientists, engineers, technicians and specialists who helped win the peace of the Cold War.

Thank you,

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