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Lunar Receiving Laboratory Project History

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June 2004

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Acronyms

CDC	Centers for Disease Control
GSFC	Goddard Space Flight Center
ICBC	Interagency Committee on Back Contamination
JSC	Johnson Space Center
LCF	Lunar Curatorial Facility
LRL	Lunar Receiving Laboratory
LSAPT	Lunar Sample Analysis Planning Team
LSI	Lunar Science Institute
LSRL	Lunar Sample Receiving Laboratory
MSC	Manned Spaceflight Center
NAS	National Academy of Sciences
OSSA	Office of Space Science and Applications
PET	Lunar Sample Preliminary Examination Team
PHS	Public Health Service
PI	Principal Investigator
UHCL	University of Houston-Clear Lake
USGS	United States Geological Survey

Introduction

In his "Urgent National Needs" speech to Congress in 1961, President John F. Kennedy committed the United States to putting Americans on the Moon by the end of the decade.[1] At that point, the lunar program was still in its infancy. As a result of this speech, Congress devoted more resources to making Kennedy's goal a reality. Space exploration was then taking place in the context of the Cold War. The United States was competing with the Soviet Union in achieving major space feats. It often seemed like the Soviets had the advantage in space exploration in the early years, as they first orbited a satellite, *Sputnik*, in 1957 and sent the first human, Yuri Gagarin, into space on April 12, 1961. Kennedy chose a major space feat, putting the first humans on the Moon, as a way of proving to the world that the United States was the leader in space. The Apollo Program's original purpose was to take Americans to the Moon and back to Earth, and in the early days planners did not give attention to any additional objectives.

It was not long until some scientists began to see the larger potential of the Apollo Program. Very little was known about the Moon in the 1960s. Most astronomers had focused their studies on objects farther away—the Sun, other stars, and distant planets, but there was still a significant amount of curiosity about the Moon and what it might tell scholars about the early history of the Earth. If the United States was going to send astronauts to the Moon, according to these scientists, attention should be given to the scientific benefits of such a journey. Pressure from outside NASA began to build for the development of more specific scientific objectives for the Apollo Program. Geologists believed that samples from the lunar surface should be returned to Earth for further study, adding another benefit to the Apollo Program beyond the prestige offered to the first country to land humans on the Moon. A number of scientists also raised concerns about the risk of back contamination from lunar samples.

In the early years of the Apollo program, however, the main focus was on solving the technological challenges of sending astronauts to the Moon and returning them safely to Earth. NASA paid little attention to scientific goals or to concerns of the larger scientific community about possible back contamination from the Moon. It was not until 1964 that NASA officials recognized the need for a facility to process lunar samples along with procedures to reduce any associated risks of contamination.

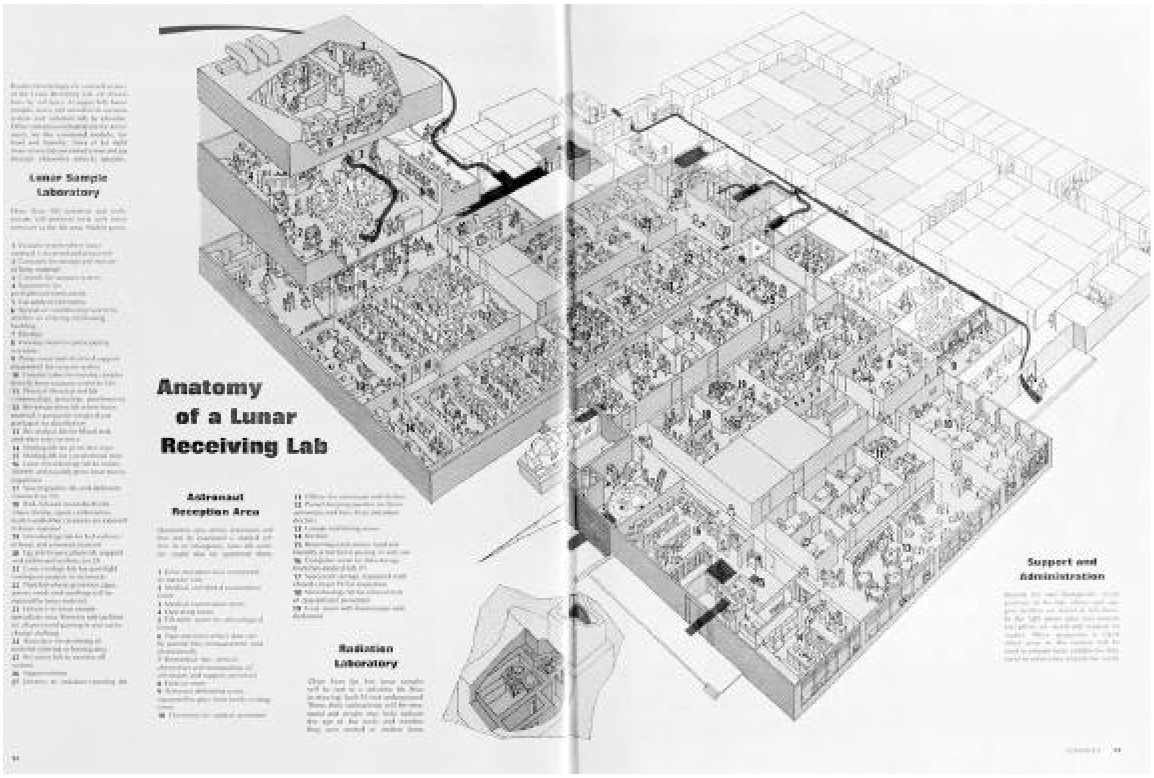
Beginning in early 1964, NASA scientists and administrators at the Manned Spaceflight Center (MSC, later known as Johnson Space Center or JSC) began to formulate a simple vision for a Lunar Sample Receiving Laboratory. Illustrating a lack of concern with back contamination issues, the earliest MSC concept for the laboratory was of a very modest facility, basically a small clean room in which material could be packaged in a vacuum. Complex experiments would be left to the Principle Investigators (PIs), who would apply to NASA for the loan of small lunar samples for their research projects.

MSC's proposal was the first articulation of a specific plan for dealing with lunar samples, but within a short period of time it was shown to be too limited to meet the demands of the various groups who felt that they had a stake in the outcome of the Apollo Program. In the next few years, there proved to be many players involved in the lunar sample issue, and from these various constituencies grew the concept of the Lunar Receiving Laboratory (LRL). Geologists were concerned about what could be learned from the lunar samples and wanted to be sure that the material would be processed in such a way as to preserve the pristine nature of the samples. In addition, some tests had to be done in the first few days and weeks after the end of a mission to ensure that data would not be lost, but the lab needed to leave the most important scientific work for PIs to do once samples were released for research purposes.

Other scientists became more concerned about the potential for back contamination. Since no one had ever been to the Moon, it was impossible to be absolutely sure that there were no biological threats to life on Earth. The Space Science Board of the National Academy of Sciences (NASA) first raised the issue of back contamination as early as 1960, but in 1964 other government agencies also became involved, including the Department of Agriculture, the U.S. Army, the Public Health Service (PHS), and the Department of the Interior. Many space experts argued that conditions on the Moon made it impossible for any life form to survive, but these agencies felt that even the smallest risk of back contamination must be prevented. As a result, a quarantine program was incorporated into the LRL, significantly complicating the original plans for the laboratory. In time, the people concerned about the potential for lunar organisms, through the Interagency Committee on Back Contamination (ICBC), came to have the strongest voice in the LRL's design and how it functioned.

Construction of the laboratory began during the summer of 1966, as Congress debated its final approval as part of NASA's budget. It was completed by late September 1967. The timing of the LRL's construction was a significant concern. In addition to the completion of the exterior building (Building 37), significant time had to be devoted to designing and constructing the laboratory space within the LRL. The LRL had to serve several purposes: geology laboratory, biological laboratory, and astronaut quarantine facility. NASA had to develop protocols for each component of the facility. Technicians had to test equipment to ensure that it functioned appropriately, and they had to be trained not only in the use of their labs but also in the safety and quarantine issues that were necessary to satisfy the ICBC. All of this had to be completed in time for the first Moon landing, which took place with Apollo 11 in July 1969. It was a time of significant stress as everyone worked hard to complete what needed to be done in time for the mission. If the LRL was not certified in time, NASA would not be able to complete the Moon landing due to the Agency's inability to satisfy the concerns of the ICBC and the agencies that it represented.

Previous studies of the LRL have focused on providing a chronological framework for the development and implementation of the facility. These works address the laboratory's multiple challenges of budget constraints, personalities, and time limits in making sure that the LRL was prepared to take on its role in time for the first crewed lunar landing. This research study further explores the competition and conflict between various factions associated with the LRL, defining not only what conflicts existed but why certain relationships became more contentious than others. In addition, this work investigates how conflict within this one particular component of the Apollo Program related to larger-scale interactions within NASA as well as between the Agency and other groups who felt that they had a stake in the space program during this era. This study not only contributes to a greater understanding of how the LRL attempted to meet its goals in the 1960s but also to the relationship between these same groups within NASA today.[2]



This drawing illustrates the complex design of the LRL, with its several different components including Lunar Sample Laboratory, Astronaut Reception Area, Radiation Laboratory, and Support and Administration

Origins of the Lunar Receiving Laboratory Concept

As early as 1959, the Working Group on Lunar Exploration within NASA advocated that "one of the prime objectives of the first lunar landing mission should be the collection of samples for return to Earth, where they could be subjected to detailed study and analysis."[3] Within NASA, neither this group nor any other scientists were concerned about back contamination issues. At this stage, NASA scientists did not recommend a specific type of facility to handle lunar samples either, as they were focused on more general goals, namely with making sure that the space program contained significant and explicit scientific goals. In this case, the objective was to collect Moon rocks, not how NASA scientists would process these samples once they arrived on Earth.

Outside of NASA, back contamination concerns had been raised as early as February 1960, when the Space Science Board of the NAS advised NASA to consider the issue. Although NASA did not seem to pay any attention to the Board's concerns at this time, the scientific community continued to be interested in the topic. In 1962, an Iowa City Summer Study focused on the issue, and in July 1963 the Space Science Board's Life Sciences Committee held a two-day conference related to back contamination. These early discussions of back contamination concerns did not make their way into NASA's administration, however, and when MSC personnel began articulating early concepts for the LRL, the back contamination issue was not even considered. Once these concerns became a major focus, the LRL's development became increasingly complex.[4]

According to Aleck Bond, then Manager of Systems Tests and Evaluation, preliminary discussions about handling lunar materials at MSC began as early as the summer of 1963, even before MSC had moved to its permanent location. John Eggleston, as the Assistant Chief for Space Environment, had approached Bond, inquiring whether or not MSC had some type of facility already available to process lunar samples. Admitting that "the prevailing attitude toward this problem was quite naïve," Bond described a potential facility that was dramatically different—and more primitive—than what the laboratory eventually came to include. It would not be long until more formal discussions developed at the Center, although the earliest of these still envisioned a fairly simple processing facility. In the early days, people at MSC thought that the laboratory would be run by the people associated with Engineering and Development at the Center, not recognizing that many scientists and other government agencies would eventually become involved as the purpose of the site was more clearly defined.[5]

Elbert A. King, Jr., another MSC employee, also recognized that the environment within NASA, at least at MSC, seemed to favor engineering much more than science. He observed that "most of the lower- to middle-level managers and administrators were extremely insecure and spent most of their time trying to understand or affect internal politics." This was a frustrating environment for King, who recognized that "it was clear that I would be fighting an uphill battle to include much consideration of scientific matters in my organization's work."[6]

King also observed the competition that existed between MSC and NASA Headquarters, as well as tension between the United States Geological Survey (USGS) and NASA. Although some people within NASA agreed that the USGS should handle all geological science for the lunar program, that view only really existed at the top level. At MSC, administrators believed that NASA should handle the science and acted accordingly. They hired their own scientists to handle the lunar program without fully communicating with Headquarters. Eventually, NASA and the USGS compromised, with both sides supplying approximately the same number of geoscientists. Although the scientists working on the LRL were pleased to have additional help, the facility's managers were the ones who continued to deal with the tensions.[7]

The early planning for the LRL was handicapped by the planners' limited knowledge of lunar material. King described their concerns: "Would the samples react with the Earth's atmosphere? What were the major and trace element compositions?" Not knowing the answers to these questions meant that planners had to be conservative in their preparation. They determined that the "initial handling and examination of the lunar samples would have to be performed in sophisticated, hard vacuum chambers at very low total gas pressure." Such a facility would be very expensive to build and maintain.[8]

King and coworker Donald Flory were involved in the earliest MSC discussions about the need for some type of processing facility. King remembered that when he first arrived at MSC, he "assumed that everyone knew why we were going to the Moon; we were going there to collect rocks, that was obvious, because this was where the information really lay." He was surprised to discover that lunar samples had not been the dominant aspect of the program within NASA, and he decided to bring his concerns to his branch chief, John Dornbach of the Lunar Surface Technology Branch. King and Flory were given permission to pursue their ideas further, culminating in a suggestion of a modest sample processing facility. As John Eggleston admitted, “We were not aware of quarantine requirements at that time, and we were proposing it purely on a scientific basis.”[9]

When this early plan was first presented to MSC’s Director Robert Gilruth, he did not perceive that the facility was necessary. After some additional effort, however, Gilruth came to recognize the validity of the proposal and eventually authorized more research on the topic. Once the issue of a quarantine became important to people both inside and outside of the Agency, MSC’s Director was more concerned with the project.[10]

With Gilruth’s backing, in early 1964 the administration at MSC began to think about the possibility of building some type of laboratory. As Assistant Chief for Space Environment, John Eggleston sent a memorandum to the Director of Engineering and Development, Maxime Faget, stating that the Agency needed to build a small laboratory that would receive lunar samples and prepare them for distribution to the wider scientific community. The memorandum did not include specific details about what the facility would look like. In the next several months, MSC management authorized an in-house study of what should be included in planning the laboratory, culminating in an engineering study that was completed in May and June 1964.[11]

In some ways the potential conflicts related to the laboratory were already beginning. The MSC administrators recognized that a laboratory would be necessary, but rather than incorporating the Agency’s Headquarters and members of the scientific community outside of NASA from the outset, MSC personnel chose to create their own independent plan from the beginning. At this point, MSC’s vision of the LRL was of a facility that was solely focused on the scientific aspects of the lunar materials—no one at MSC yet incorporated quarantine concerns within his or her concept of the facility. This shortcoming would concern many scientists and those government agencies concerned with public health issues. The MSC plan also assumed that the laboratory would be located in Houston at MSC. This encouraged conflict with other NASA facilities and government agencies. Although people at MSC were beginning to recognize the need for some kind of scientific facility to deal with lunar materials, they did not yet recognize the larger ramifications and concerns that the scientific and medical communities would associate with such a plan.

Bond presented an important glimpse into MSC’s early vision for the LRL, which he referred to as the Sample Transfer Facility, on April 14, 1964. In a memo to the Chief of the Office of Technical Information and Engineering Services, Bond presented a functional description of the facility. He claimed that there was no current facility in the nation capable of accomplishing these goals. As a result, Bond argued that “MSC should build a facility that … initially receives the samples collected by the astronauts on the Apollo missions; opens the containers under precisely controlled, uncontaminated, sterile conditions; checks the samples for presence of viable organisms; performs some control testing of the samples; carefully divides the samples into appropriate amounts for distribution to the various investigators; prepares and repackages the portion of each sample in accordance with the analytical technique to be used by each investigator; and delivers the portion of the sample to the individual investigator.”[12]

Bond was the first MSC official to recognize the back contamination issue, admitting that "it will also be necessary to check each sample for the presence of viable organisms to ensure that our nation's foremost scientists are not subjected to any dangers that may arise from exposure to such organisms," but the main focus of his concern was for the scientific aspects of the lab. He did not seem to recognize outside worries that lunar material could be harmful to humans, animals, and plant life aside from those eminent scientists who would actually be handling samples.[13]

By July 1964, MSC personnel had established a number of important criteria for the LRL. After several meetings of the Planning Teams for Mineralogy and Petrology, Geochemistry, and Biology, personnel had determined that "the primary purpose of such a facility at MSC is to provide a central laboratory for the preliminary biological, geological and chemical examinations and analyses of lunar samples." In addition, these people had concluded that the proposed laboratory should be located at MSC to make the exchange of information for future missions easier. The subsequent listing of requirements, such as a vacuum chamber and mineral separation laboratory, contributed to the stated goal of accomplishing these preliminary examinations. Despite the fact that, outside of the Agency, increased discussion of back contamination existed, these Planning Teams had not addressed the back contamination issue at all in their proposed LRL plans. King and Flory recognized that "many other requirements will develop at later dates," but they seemed to be thinking of further requirements for sample analysis, not back contamination or quarantine issues. MSC was proceeding with its plans for the LRL, but not everyone outside of the Center would approve of its direction.[14]

Growing Interest in the Lunar Receiving Laboratory Design and Concerns about Back Contamination

As concerns began to mount about possible back contamination from the lunar surface, more and more government agencies began to join the picture. The Department of Agriculture and the Department of the Interior were concerned about the potential negative effect of lunar organisms on the Earth's plant and animal resources. The U.S. Army, with its experience in building facilities to research biological agents, entered the discussions. The Institutes of Public Health and the Center for Disease Control represented scientific concerns about biohazards to human life. The NAS and the USGS weighed in with their opinions as well. Numerous scientists from research facilities and universities expressed their opinions about the importance of a lunar quarantine facility or sample processing laboratory, depending on their individual interests. Soon, what had originally begun as a simple, one-room laboratory had evolved into a very complex, expensive facility.

Most people at MSC were very skeptical about the potential hazard from lunar materials. They argued that numerous conditions made back contamination unlikely, including the "bombardment of solar radiation, the intense ultraviolet content of sunlight, the proton bombardment, the meteoritic bombardment …, the hard vacuum, and extremes of hot and cold." Some were willing to recognize that, even if the chance of back contamination was remote, something had to be done to protect the Earth from that potential. Others dismissed the need for concern altogether.[15]

In the summer of 1964, discussions of the potential biological hazards of lunar materials became a more significant focus of many eminent scientists and government agencies, with the meeting of the Conference on Potential Hazards of Back Contamination from the Planets held July 29 and 30. Conference participants included members of the Life Sciences Committee of the Space Science Board, the Department of Agriculture, the U.S. Army, the National Institutes of Health, the PHS, NASA, the NAS, Dr. Gaylord Anderson of the School of Public Health at the University of Minnesota, Dr. C. Robert Austrian of the Department of Medicine of the University of Pennsylvania Hospital, Dr. H. Keffer Hartline of the Rockefeller Institute, and Dr. Lawrence B. Slobodkin of the Department of Zoology at the University of Michigan. The widespread representation of the conference attendees reflected the increasing complexity of the back contamination issue. Because it was impossible to know for sure if extraterrestrial life existed, participants argued that NASA must be prepared to deal with the potential hazard. As a result, conference participants advocated a strict quarantine of astronauts, spacecraft, and samples behind some type of biological barrier.[16]

Once the potential for back contamination was taken into account, the LRL's development became much more complex. Rather than just protecting lunar samples from Earthbound pollutants, the facility also must protect the Earth from potential lunar contaminants. In addition, quarantine facilities must house the crew and the spacecraft. With no previous experience in dealing with biological containment, NASA had to ask for more support from other government agencies. NASA looked to the Army's facility at Fort Dietrich, Maryland, and the PHS laboratories in Atlanta, Georgia, for ideas about how to approach the problem, but the LRL would still be more complex than these facilities because of the need to address scientific needs as well as back contamination issues. Very quickly an additional concern emerged among geologists and other scientists who wanted to study lunar samples: the biological testing could seriously limit the amount of material available for other experiments. Soon there would be competition emerging within the planning of the LRL between the biologists and other scientists concerned with back contamination and those scientists, such as geologists and geochemists, who wanted to use samples to learn more about the Moon's and solar system's history. As many of the second group did not believe that back contamination was a serious threat, they argued that "obtaining scientifically priceless samples from the Moon and then using a significant portion of them for injections into mice or soil or wheat seedlings seemed absurd."[17]

Discussions between MSC and NASA Headquarters about the LRL increased during the month of August 1964. Willis B. Foster, Director of Manned Space Sciences, expressed Headquarters' official view of the LRL. According to Foster, the LRL's function was to be very limited, with only "receiving, unpacking, and preliminary examination by authorized scientists of returned lunar samples" taking place. More extensive scientific experiments would be reserved for outside laboratories and scientists. As a result of that distinction in laboratory functions, Foster declared that "the proposed facility at MSC is therefore referred to as the receiving laboratory." Foster's correspondence seems to suggest that Headquarters was unaware of the extent of MSC's planning for the facility to that point.[18]

In response to Foster's memo, Maxime Faget stated that MSC had been working on a concept for the laboratory for several months already. He believed that the requirements set by Foster in his memo of August 17 pretty much coincided with what MSC had already established but that certainly more detailed discussions between Foster and MSC personnel should take place.

Although MSC was trying to maintain control over the LRL's planning, people at NASA Headquarters were beginning to get more and more involved.[19]

When MSC requested additional funds in September 1964 for an LRL study that the Center was in process of completing, Headquarters refused the request because of budget restrictions. The Chief of Lunar Exploration, Edward M. Davin, along with Dr. Ed Chao, a USGS scientist, believed that "the planned allocation figure should be adequate for the needed work." In the early days of planning, Chao had a vision of an extremely limited LRL facility. MSC personnel met personally with Chao and Davin the following month on October 9. Once again, MSC personnel reflected their belief that Chao had already made up his mind. Even before the meeting took place, John Dornbach said that "he felt we shouldn't expose our hand to Chao, as he (Chao) had already made up his mind (yesterday) to give us no more than $150,000 for this item, maybe less." Feeling that an adversarial relationship already existed, MSC representatives did not provide all of the information when they met with Davin and Chao on October 9. J. G. Griffith observed that "Chao was shown none of our cost estimates, sketches, etc." By the end of the meeting, however, Griffith felt that the MSC personnel had made their case to Chao and Davin and that there was a possibility that more funding for the laboratory's engineering study would be forthcoming.[20]

John Eggleston perceived that Chao had his own reasons for his actions. Chao was a geochemist from the USGS. The USGS had loaned him temporarily to NASA. Eggleston believed that Chao wanted the USGS facility in Flagstaff, Arizona, to host the LRL facility and, as a result, was working against MSC personnel efforts. James McLane, like Eggleston, perceived that Chao had his own agenda, which mirrored that of geologist Gene Shoemaker of the USGS. He believed that these scientists set themselves up in competition with NASA in some respects, because they believed that the entire purpose of going to the Moon was for scientific reasons rather than for the reason originally stated by President Kennedy. Eventually he believed that Chao was able to have more of a voice in the decision-making process through the Office of Space Sciences and Applications (OSSA) ad hoc committee.[21]

In addition, other NASA facilities also competed against MSC for the LRL site. At first, Goddard Space Flight Center (GSFC) argued that it should be considered because they wanted other "data bank" facilities located there as well. University laboratories also wanted to host the facility, although NASA did not believe that locating the LRL at one university would be in the program's best interests. Eventually, quarantine issues helped to make MSC's case easier. The need to access information and astronauts during quarantine for future mission planning meant that having the LRL located on site at MSC made the most sense. In the meantime, debates over both the location and the scope of the LRL continued.[22]

Designing the Lunar Receiving Laboratory

To develop more detailed expectations for the LRL, NASA's Office of Space Sciences created the Ad Hoc Committee on the Lunar Sample Receiving Laboratory in November 1964. This committee was chaired by Dr. Ed Chao. John Eggleston had a fairly simple perspective of both the LRL's function and the Ad Hoc Committee's role in the early days following the establishment of the committee. He observed two main functions for the LRL. The laboratory would "perform the initial handling and subsequent distribution of all returned lunar samples throughout the scientific community for detailed analyses by authorized investigators." In addition, the facility would also have to make preliminary scientific investigations of lunar material to aid in planning future missions. Eggleston made no mention of any quarantine requirements at this point and seemed to assume that the LRL would be built at MSC. In the context of what he believed the laboratory's function to be, the ad hoc committee would have fairly simple concerns: "to compile performance requirements for the laboratory and its associated equipment from this functional definition." In contrast to Eggleston's views, the committee's work became much more complex as the quarantine requirements entered into the picture. And certainly many committee members, Chao included, did not envision such a limited role for the committee and did not necessarily assume that MSC was the best location for such a facility.[23]

MSC personnel disputed the need for an ad hoc committee altogether. At a meeting between MSC personnel James McLane, Elbert King, and Donald Flory and Director of Manned Space Science Programs Willis B. Foster that took place in November 1964, the MSC representatives raised their concerns about the committee. MSC believed that the ad hoc committee should function more in an advisory capacity, not having the final say in determining facility design criteria. That power should be reserved for MSC, "in accordance with conventional procedures." MSC's personnel also adamantly stated that they did not believe that the committee should have power over where the LRL would be built.[24]

According to McLane, who attended as an MSC representative, the first meeting of the ad hoc committee was a disaster. He observed that "the discussion of facility requirements was characterized by lack of definition, widespread disagreement, and vacillation." Committee members failed to consider what their ideas might cost to implement, disregarding practical implications. Just as McLane, Flory, and King had predicted in the earlier meeting with Foster, the committee did not limit itself to design requirements. Some committee members immediately brought up the issue of MSC being the site of the LRL, believing that a new laboratory might eventually compete with other established facilities. In addition, McLane raised concerns that "the committee was also agreed that they should not stop at defining requirements, but should, in fact, continue on to produce detailed design criteria, and subsequently manage the design and construction efforts." McLane believed that committee members did not have the time to devote to the detailed plans for the laboratory, but his concerns were ignored by the rest of the committee.[25]

As MSC personnel met again with Foster and Chao after the committee meeting had ended, additional tensions emerged. McLane "obtained the impression that Dr. Chao is lukewarm to the idea of siting the facility in Houston, and also is very much in favor of a "minimal' type facility." McLane was frustrated that Chao and Foster did not take his concerns about time constraints and the committee overstepping its bounds into account. In fact, Foster "seemed to think that this was no problem which could not be overcome." McLane's concerns only echoed John Eggleston's earlier concerns about the time constraints for facility development. In October 1964, he had raised his concerns to Foster as well, pointing out that the committee should have a limited role and that time was of the essence.[26]

McLane continued to have mixed feelings after the ad hoc committee's December 1964 meeting. In some ways, he believed that the committee's work was progressing. McLane observed that "it appears that the relationship of this committee to the proposed MSC program for this facility has been established in the proper perspective, and that the committee is responsive to the task of establishing requirements." He did raise one significant concern about the December meeting, however. He recognized that committee members would probably not produce a complete list of all of the experiments and operations for the laboratory and, therefore as construction took place, there might be a need to add additional requirements for the facility. He pointed out that later modifications could lead to construction delays or additional costs. The committee members' areas of expertise also did not encompass all of the laboratory's necessary operations. At one point, Foster requested that GSFC send a vacuum expert to the committee to provide some technical support.[27]

Disparate visions of the LRL emerged from the ad hoc committee's early meetings, and these differences indicated the challenges of developing and building the lab. Initial meetings also reflected the growing involvement of other interested groups. Chao kept the Space Science Board of the NAS informed about the LRL development, illustrating that other government agencies held NASA accountable at this stage. Chao also stated that the requirements that the committee was in the process of implementing were coming from the Apollo Science Program office in early 1965. As of January 1965, much of the planning for the LRL was still in its early stages. Chao discussed his assumption that thousands of plants would have to be tested to determine whether the lunar material would be safe on Earth. The committee's discussion of plant testing reflected the fact that almost no scientific work had ever been done in this area before, so it would require some new ways of doing things. Chao requested that Dr. Allen Brown of the NAS recommend some plant pathologists to help in designing these tests, incorporating even more people into the process over time. In addition to concerns raised by the NAS, which believed that, although the threat was minimal, "we would be seriously remiss morally and every other way if we did not take at least minimum precautions because there could be awesomely disasterous [sic] results," the Surgeon General and the PHS showed an increased concern for the back contamination issue. The LRL's development was becoming more and more complicated as additional groups became interested in the handling of lunar samples.[28]

Committee members not only debated the requirements amongst themselves but also made presentations about the LRL to other government agencies. In addition to a presentation for the Surgeon General, Dr. Lawrence Hall reported that he had scheduled a briefing at the Department of Agriculture. Hall showed concern that NASA had "been reluctant to put any great amount of resources behind this [project] so far." He believed that the committee would have to rely upon other agencies for support instead. In its disinclination to deal with the issue of back contamination from the beginning, NASA seemed to have abdicated some of its responsibilities. This perception created opportunities for other government agencies to intervene and do more to define the scope of the space program through the development of the LRL facility.[29]

The ad hoc committee and MSC seemed to be working at cross purposes, competing with each other by coming up with their own versions of the LRL. Chao made reference to this competition at one point during a meeting on January 15, 1965, mentioning an MSC memorandum that presented some details about the LRL. "This general concept study just threw me for a loop," Chao states. “I thought we were doing this.” Rivalry between MSC and the plans created by NASA Headquarters at times led to bad feelings and a less efficient process. The committee minutes also illustrate that the ad hoc committee’s main focus was on the biological containment issues, not the scientific issues of interest to geologists and other scientists who wanted to protect and distribute samples for experiments. As Dr. Briggs Phillips of the Centers for Disease Control (CDC) observed, “To my mind the main purpose of this laboratory in the initial discussion was that this was a laboratory whose main purpose was to get the quarantine requirements satisfied.” Less attention was given to the geological aspects, because biology was viewed as more important. Almost as an afterthought, Phillips observed that the same type of requirements to keep biohazards contained could also serve to protect samples from contamination.[30]

The ad hoc committee meeting in January 1965 also reflected more of MSC’s concerns about the development of the laboratory. McLane, continuing to serve as an MSC representative on the committee, raised some concerns about the direction of the group’s findings. He reminded other members that ultimately MSC’s budget would pay for the LRL and that, as a result, the Center “would probably have to examine any proposed plans for proceeding with the program in some detail at MSC with all the appropriate people involved.” MSC was unwilling to yield total control for the LRL’s planning to people outside of the Center. McLane reminded the rest of the committee that he could not just sign off on any plans that the group might develop, because the issue was so important to MSC.[31]

Another issue that the ad hoc committee had to address was that members of the group who were not NASA employees did not understand the federal government’s process for contracting studies. Significant confusion developed over terminology and the actual process. This lack of understanding led to some disagreement within the meeting. At one point, the committee had to stop the discussion to explain the entire process so that further confusion could be avoided. This problem illustrated the fact that personnel from government agencies were inclined to approach the LRL’s planning differently than those people who were not employed by the government, occasionally causing misunderstandings that inhibited the program’s success.[32]

At least some MSC personnel felt there was an adversarial relationship with the OSSA ad hoc committee. McLane sent a memorandum to the Chief of the Facilities Division upon returning to Houston from the meeting on January 1965. He recommended that the Center come up with a formal plan of action immediately, because the “committee leans toward recommending plans for proceeding which deviate considerably from our normal (and preferred) way of doing things.” McLane was not pleased with the direction that Chao and other members of the committee were taking with the LRL planning, and he believed that, if MSC was to achieve its vision, personnel needed to come up with a unified plan of action “to combat [the committee’s] tendency in an effective manner.”[33]

McLane also believed that he did not entirely fit within the ad hoc committee. While most of the other members were scientists, as he described them, “one level below Nobel Prize winners,” he “was a little out of [his] element.” As McLane put it, “I’m just an ordinary poor old B.S. engineer.” He often felt frustrated at meetings because the scientists approached problem solving differently than he did. Once a decision was made on one particular aspect of the laboratory’s planning, McLane wanted to move forward to the next problem. The scientists, in contrast, often revisited the same issue at subsequent meetings. The other problem he experienced within these meetings was that the scientists were extremely busy people who did not really have the time to get LRL work done within the time constraints of the program.[34]

By February 1965, personnel at NASA Headquarters were taking the approach that the PHS should be responsible for establishing and enforcing quarantine regulations. In a memorandum to Charles A. Berry, MSC's medical director of manned spaceflight, and J. Billingham at MSC, Eggleston laid out the recommendation that the PHS be in charge, stating that "NASA [should] acknowledge by letter that the Public Health Service has the responsibility for decision and approval on the sterilization precautions and quarantine following the Apollo mission." MSC personnel would create a list of procedures to satisfy the PHS's requirements on the issue, which NASA Headquarters and the PHS would approve before implementation.[35]

Although NASA had not originally envisioned the idea of an LRL within the Apollo Program, Agency officials came to realize that its implementation was essential to the Program's success. By the time that Apollo 11 took place, a failure to have the laboratory and quarantine facilities ready would mean a postponement of the entire Program. Quarantine issues had become so important by that point that other government agencies, especially those associated with the ICBC, would interfere with the Program if the facilities were not prepared. In a memo dated January 20, 1965, McLane observed that "there are no known practical alternatives to providing this facility; therefore, failure to approve the facility will result in serious loss of scientific data to be obtained in the Apollo Science Program." Not only did the laboratory have to be built before the first lunar mission, but it also had to go through many months of practice testing to make sure that it was prepared to handle lunar samples.[36]

In order to have the facility ready for the first lunar samples, MSC administrators recognized that there must be a systematic plan. This strategy was laid out in the "Plan of Organization to Implement the Lunar Receiving Laboratory." The goal was to "assure that top level management attention is given to this problem, that decisions are made in a timely fashion, and that a strong management organization exists to carry out the design and construction of the facility and its associated equipment." This task would not be easy, considering how complex the needs of the laboratory had become as more and more requirements for biological containment were added.[37] The plan called for the establishment of several important groups. The LRL Policy Board "would consist of a top level MSC Board which would be responsible for overseeing the entire Lunar Receiving Laboratory Program." The plan suggested that Dr. Maxime Faget, now Assistant Director for Engineering and Development, be appointed as the chairman of the Policy Board. In addition, there would also be an LRL Program Office, which "would be directly responsible for the management of all aspects of the design and construction of the Lunar Receiving Laboratory[, including] responsibility for schedules, costs, and technical aspects of the LRL." The plan suggested Joseph V. Piland, Manager of Technical and Engineering Services, to be the Manager of the LRL Program Office. There would also be a Facilities Requirement Office, which "would be headed by Mr. James McLane … and which represents the 'user' interests in the Lunar Receiving Laboratory." Finally, there would be a Project Engineering Office, managed by J.G. Griffith, which would "continue to be responsible for the project engineering work required to carry out design and construction of the facilities and equipment required for the LRL."[38]

MSC's vision of the organization necessary to build the laboratory illustrates the complex issues involved in the project. It also illustrates the type of thinking that would cause conflict between MSC personnel and those outside of the Center as the project continued. Everyone associated with MSC's plan already belonged within the Center organization—there was just some shifting around of personnel to fit the LRL program's needs. Piland's position as Manager of the LRL program office illustrates this point, as he would still hold his current position as Manager of Technical and Engineering Services. MSC did not envision bringing in experts from other parts of the Agency or from outside of the Agency to contribute to the planning and implementation of the laboratory construction. This approach certainly caused concern within other agencies and committees who felt that they had a stake in what was taking place. In addition, not one of the figures involved in MSC's proposal was a major scientist. Scientists from outside of NASA raised serious concerns about the laboratory's development and operation because they felt left out of the process. Many scientists also believed that personnel with engineering backgrounds were not able to consider the issues that would be of greatest concerns to the scientific community. This situation contributed to misunderstandings and a lack of communication between scientists and engineers on the project.

Faget submitted a memorandum to Foster on January 11, 1965. Acknowledging that the ad hoc committee would soon be releasing its report on the LRL requirements, he informed Foster that MSC was establishing a new committee "to review progress at critical junctures and assure that facility requirements are being properly implemented." Faget stated that members of the committee should include the chairmen of the Geochemistry, Mineralogy and Petrology, and Biosciences Apollo Science Teams, members of Foster's staff, and several MSC personnel. Faget was trying to reestablish control over the implementation of the LRL plans, and it is interesting to note that he did not invite any of the ad hoc committee members to join the new group. Nor did he express any concern over back contamination issues or the need to include any specific experts on that subject.[39]

Foster responded to Faget in a memorandum dated February 24, 1965. In this memorandum, Foster limited what MSC was able to do with LRL planning without the input of the OSSA ad hoc committee and the Apollo Science Planning Teams. In fact, money for an engineering study would not be released to MSC until the ad hoc committee's work was finished. Foster rejected the need for a new committee to be formed, as Faget had suggested, instead stating that "the Ad Hoc Working Committee should be renamed a standing committee with a reduced membership to continue its work until the laboratory is built." Only a single MSC employee would serve on the revamped committee, as Foster envisioned it. This approach dramatically differed from the committee that Faget had envisioned, which would include a number of MSC employees. Foster also implied criticism of MSC's current approach to the LRL, stating that "a greater understanding by MSC of the scientific objectives of the laboratory will facilitate the work of the Ad Hoc Committee and favor its location in Houston." He reminded Faget that MSC's assumption that the LRL would be located there was still somewhat presumptuous, stating that "other NASA centers are submitting 'bids' for the laboratory." Foster's response suggested that, if MSC wanted to obtain the LRL, the Center must cooperate with both Headquarters and the ad hoc committee. Otherwise, there were alternatives waiting in the wings.[40]

Although some might have taken Foster's memo as a warning, Faget did not back down. In a memo also dated February 24, Faget once again stressed to Foster the urgency of the matter at hand. He reminded Foster that when the ad hoc committee was originally instituted, it was to have completed its work within a three-month window. Now it was over a month beyond that time, and "according to MSC representatives on the group no definite date has yet been established for issuance of a final report." Time constraints made the issue urgent at this point, and since nothing else had been determined, Faget informed Foster that MSC had put the laboratory's funding into the Center's budget request for fiscal year 1967. Time was becoming a major issue for LRL construction, and MSC personnel did not believe that NASA Headquarters or the ad hoc committee were paying attention to the seriousness of this constraint. With these concerns in mind, Faget once again implored Foster to consider the creation of the new committee that he had recommended in the memo of January 11 and also to urge the ad hoc committee to release the findings from its work "as soon as possible so as not to delay further work." In the meantime, the ad hoc committee was still receiving new reports from various subcommittees, including the Vacuum Technology Group and the Biological Subcommittee.[41]

A month later, the ad hoc committee still had not released its final report, and MSC personnel were becoming more impatient. McLane called Chao on March 22, 1965, about the report. Chao explained to McLane that the report had not yet been released for a number of reasons. Most important were the new discussions emerging between NASA and other government agencies, especially the PHS, about back contamination issues and the need for quarantine. These requirements would greatly complicate the design of the laboratory and possibly make some of the ad hoc committee's findings irrelevant. In addition, although the ad hoc committee had finally advised that MSC be chosen as the site for the LRL, George E. Mueller, the NASA Associate Administrator for Manned Space Flight, had not agreed to that recommendation yet.[42]

Although NASA Headquarters had not formally approved the report, McLane still urged Chao to send MSC a draft copy as soon as possible. He pointed out that any further delay in the engineering study could mean that NASA might not complete the laboratory in time for the first mission. Although Chao finally agreed to send McLane a draft version, McLane had still not received it by March 30 and was becoming even more impatient as he continued to wait.[43]

The engineering study grew in importance to the MSC staff over time. By June 1965, MSC personnel stressed the need for it to be completed as soon as possible. In a presentation to the MSC Deputy Director George Low on June 28, 1965, J.G. Griffith argued that the study was absolutely necessary to define the design requirements for the LRL. He warned that, since the engineering study would direct NASA to "make decisions and commitments that will affect the whole course of the project," poor choices would have a negative effect on the "effectiveness of the facility or its completion date will be adversely affected."[44]

As Headquarters significantly reduced MSC's funding from the OSSA budget in September 1965 from $18 million to $14 million, even more concerns about the engineering study arose. MSC personnel did not know if the money for the study was included within the $14 million. The reduction meant that MSC would have to take serious measures to reduce many components of its budget for the following year, and the Center had not even included the engineering study in its original budget request.[45]

At a meeting on July 7, 1965, a number of MSC employees had the opportunity to update Low about the LRL's progress. MSC personnel presented a description of the history of the LRL to that point, and McLane offered a rather careful review of MSC's past relationship with the OSSA and the various committees that had worked on LRL qualifications. Although he was not openly critical of those other groups, McLane suggested some of the problems of working with OSSA and the ad hoc committee. Overall, McLane felt that the new Standing Committee's relationship with MSC was better, as the committee served in an advisory capacity rather than attempting to establish policy.[46]

At the same time, the Space Science Board of the NAS was completing its study and suggesting its recommendations for the LRL. In a letter written to Dr. Homer E. Newell, Associate Administrator for Space Science and Applications, dated February 2, 1965, board chairman H.H. Hess stated that members had determined that a quarantine was necessary and that a few basic measurements of the lunar material were necessary prior to the quarantine's end. Hess envisioned a very limited facility, however. In addition, he did not mention MSC as the LRL's location, instead referring to a quarantine "somewhere for some period yet to be determined." The board was concerned about the LRL potentially overstepping its bounds and developing competing research programs with outside scientists. As a result, Hess advocated a "relatively restricted-mission sample receiving laboratory for quarantine and biological measurement…, coupled with the best low-level counting facility." The Space Science Board had also created an Ad Hoc Committee on the Lunar Sample Handling Facility, whose members included Hess, Allen H. Brown, Michael Fleischer, Clifford Frondel, and Gordon J. F. MacDonald. This committee determined that MSC might be a good location for the facility, although they did not see any "inherently compelling reason why it should be." Warning that the laboratory could not be run periodically after each mission by outside scientists, the committee advocated that the facility "must be operated continuously by a resident staff …[and] cannot be turned on and off at will if it is to operate effectively."[47]

Creation of the Interagency Committee on Back Contamination

By November 1965, NASA had determined that the PHS should be responsible for the back contamination aspects of the LRL. On November 15, 1965, NASA Deputy Administrator Hugh Dryden wrote a letter to Surgeon General William H. Stewart, "expressing the agreement of the National Aeronautics and Space Administration that the PHS should occupy a leadership role in certain health problems that may accompany the return of man and materials from space." Stewart informed NASA Administrator James Webb that the PHS had already provided input into MSC's preliminary plans for the facility and that "our recommendations have been incorporated into the Preliminary Engineering Report and budget materials." Although inviting the PHS to have such a major role in LRL planning meant that tensions could develop over who was actually in charge and what goals were most important, there could also be some benefits to including other government agencies in the decision-making process. Stewart assured Webb that "we shall be pleased to assist in justifying to the Bureau of the Budget the urgency and necessity of this program," adding weight to NASA's arguments about LRL funding. In fact, Dr. John Bagby of the PHS prepared a statement to support NASA's funding requests for the congressional budget hearings. Stewart also recommended the formation of an interagency board to oversee the back contamination requirements, an organization which soon became known as the ICBC.[48]

Webb and Dryden appreciated Stewart's offer to support the budget needs of the LRL, and they also responded positively to the suggestion of the creation of the ICBC. Webb believed that the committee should include a number of scientific experts knowledgeable in the types of issues that would need to be addressed by the LRL, and he recommended that a number of government agencies be represented within the committee. He informed Stewart that NASA officials should "solicit from you recommendations concerning the design of the facility and equipment, and the number and types of staff persons required to provide the competence needed." Considering that the sample processing aspects of the laboratory had been in the design process for several months at this point, it seemed that concern about the back contamination issues was coming rather late. Certainly adding additional requirements contributed significantly to the complexity of the facility's design and implementation. This new arrangement also had the potential of putting the ad hoc committee in competition with the ICBC, as the ad hoc committee had recently expressed concern about design issues associated with back contamination.[49]

By March 1966, the ICBC included members from numerous government agencies. Dr. David Sencer of the CDC was chairman of the ICBC. Dr. John Bagby served as a second representative from the CDC. Professor Wolf Vishniac of the University of Rochester represented the NAS. Dr. Saulman, Director of Science and Education, represented the Department of Agriculture, while Dr. John Buckley served as the representative from the Department of the Interior. Aleck C. Bond and Dr. Charles A. Berry attended from MSC, while Dr. Harry Kline represented Ames Research Center and Dr. Leonard Reiffel and Colonel John E. Pickering attended from NASA Headquarters. Dr. Briggs Phillips of the CDC served as the committee on-site liaison representative at MSC, reporting back to the committee about the facility's progress.[50]

The ICBC's role was to handle back contamination concerns. Its members were responsible for insuring that the LRL was capable of protecting the Earth from potential biological threats. In addition to establishing the specific criteria for the quarantine, they also took responsibility for determining what tests would be necessary to determine that lunar material was not dangerous and for designing the contingency plans in case of breaks within the biological barrier system. On the agenda for the meeting of April 13-14 was also the issue of how to define MSC's interaction with the committee. This item exemplifies the delicate balance that had to be maintained in the relationship between MSC administrators and the ICBC.[51]

Because the LRL had not been part of the original Apollo planning, it was several years behind the rest of the Program in implementation. If the facility was going to be ready by the time of the first lunar mission, a crash program was necessary. In order to achieve the ambitious goal of completing the laboratory by 1969, MSC Director Robert Gilruth created a policy board in May 1966 that was given the "authority to make policy decisions in minimum time." In addition to the MSC representatives on the board, additional input came from scientists and the PHS.[52]

One of the MSC representatives on the ICBC was Dr. Charles A. Berry, Director of Medical Research and Operations. He and other medical personnel at MSC were often placed in a difficult position when it came to debates about the need and implementation of a quarantine facility.

On the one hand, Berry had to represent NASA on the committee. As Berry put it, "I had been charged by NASA to say that we were indeed not going to bring back lunar plague." NASA believed that the chance of back contamination was negligible but still had to institute a quarantine program because of the concerns of other agencies. On the other hand, because the medical personnel were the ones who had to enforce the quarantine once the LRL was in operation, scientists who were involved with sample processing sometimes viewed them as a hindrance to their goals. Elbert King's memories of the debate over the LRL's purpose illustrates the tensions that existed even within the MSC organization. Not only did he believe that a disagreement existed between Wilmot Hess and Charles Berry over the purpose of the lab, but he thought that there was also a split between MSC's original personnel who had come from the Langley Research Center and those who had arrived later. King felt that Gilruth and others at MSC almost always took the side of the Langley people, unless it was obvious that they were entirely wrong.[53]

NASA Justifies the Lunar Receiving Laboratory to Congress

The LRL received significant attention during congressional hearings about NASA's fiscal year 1967 budget authorization. Even as congressional committees debated the need for funding for the LRL in 1966, further concerns about the proposed location of the laboratory surfaced. These congressional committees raised the issue, questioning, "What is the justification for locating the Lunar Sample Receiving Laboratory (LSRL) at Manned Spacecraft Center?" In a position paper detailing MSC's rationale for the site location, numerous reasons were provided. These explanations included such arguments as "the sample receiving and distribution function is an operational part of the Apollo position for which MSC is responsible," and "Quarantine isolation of the astronauts and spacecraft at MSC makes them readily accessible to the entire Apollo engineering and medical team for essential post-flight activity." In addition, the justifications admitted that MSC had devoted a significant number of scientists and engineers to LRL planning over the past two years, and if a change of location was to be made at this late date, "this experience and project momentum will be lost." Since no other site was already available, MSC was centrally located to all potential recovery areas, and a change at that point would mean a significant delay in getting the entire Apollo Program completed, MSC officials argued that the current site had to remain in place.[54]

Some congressional representatives believed that dividing the facility's operations and creating several separate sites would be appropriate. Political issues made some politicians inclined to divide the site so as to provide the economic benefits to a larger number of constituents, but NASA officials argued against such an approach. In addition to making the same arguments as those about locating the facility at MSC in the first place, officials claimed that because of the back contamination requirements, "it is simpler and cheaper to combine operation of these three units [Sample Processing Area, Quarantine Clearance Test Area, and Crew Reception building] under one staff at a central location, than to diversify." Too many redundant components of the facility would have to be built if the LRL was divided into separate parts.[55]

MSC officials had already developed this list of justifications for the MSC siting of the LRL, but Deputy Director George Low had felt that NASA personnel at Headquarters had not paid adequate attention to the issue. Low raised his concerns as early as February 25, 1966, before this issue had become so important within the congressional budget hearings. At that time, Captain Robert F. Freitag, Director of Manned Space Flight Field Center Development at Headquarters, had assured Low that his office was preparing a "detailed report on possible existing facilities that were considered and to justify the requirements on the basis primarily of astronaut quarantine requirements." Although MSC's original vision of the LRL had only been of a sample processing facility, the back contamination requirements proved useful in justifying the laboratory's construction at MSC.[56]

NASA worked hard to defend the LRL's funding during hearings before the Subcommittee on Manned Space Flight of the House Committee on Science and Astronautics in February and March 1966. Early in the hearings, NASA officials explained why the laboratory was needed, what it would involve, and what the proposed costs of the facility were. In spite of that presentation, Representative Robert R. Casey (D-TX) wanted a more detailed description of the purpose of the laboratory. Casey pointed out that "the ordinary layman is uninformed as to the necessity of this lab and what its purpose is going to be." If the committee was going to approve LRL money as part of NASA's budget, committee members needed to be able to justify the expense to their constituents. Up until this point, the discussion of the LRL had remained primarily within NASA, the scientific community, and interagency discussions. No one had considered the fact that the facility had to be "sold" to the public as well. An educational campaign of some type was necessary to explain the importance of the LRL to the Apollo Program's success.[57]

Representatives Donald Rumsfeld (R-IL) and James G. Fulton (R-PA) criticized the proposed location of the facility at MSC, as well as the need for any facility at all. Rumsfeld demanded that NASA officials justify "what it is about the Houston facility that makes it necessary to put this particular facility there." Fulton went a step further, arguing that it would make more sense to locate the LRL at the University of Hawaii, since it would be close to the astronaut recovery site. Or, better yet, Fulton thought that NASA should "put this facility in a place that certainly is not getting its full share of space contracts such as the Midwest section of the country," illustrating representatives' desires to obtain more opportunities for their own states. Fulton was quick to point out that he did not represent either of the two locations that he suggested, trying to avoid accusations of partiality. Fulton also challenged the concept of the laboratory, arguing that there was no need to combine all of the facility roles into one site and that surely there had to be other locations around the country that could satisfy the LRL requirements with only minor modifications. If that was the case, why spend the money building another laboratory that would be redundant?[58]

After these hearings, NASA was certainly concerned about funding approval for the LRL. Some representatives at the hearings seemed to be hostile to the Agency's plans for the facility, and they certainly seemed to be concerned about their own self-interest. The Houston *Chronicle* soon reported on the hearings, focusing on Rumsfeld's criticisms of the facility. An article on March 7, 1966, quoted Rumsfeld as saying, "'I have yet to hear any good scientific reasons why this facility—which ultimately will grow into a multimillion-dollar operation—has to be erected at the Houston space center.'" Only a few days later, the heading of another *Chronicle* article cautioned, "Lab Delay May Slow Mission to the Moon." The reporter quoted MSC's Deputy Director George M. Low, who warned that "without the laboratory … 'we could not bring back samples from the lunar surface. In fact, we could not complete the Apollo mission.'" Although this claim was accurate in light of the concerns about back contamination, many people accused the Agency of using scare tactics to force Congress to approve the LRL's requested budget.[59]

In the aftermath of the budget hearings, NASA Headquarters developed a more extensive report that discussed prospective sites for the LRL and why the MSC site was the one that the Agency had chosen. In some respects, this report justified the decision after the fact. Because the laboratory concept had originated at MSC and MSC personnel had always assumed that the facility would be located in Houston, many critics felt that there had been a focus on explaining why other facilities should not be used rather than carefully determining what the best location would actually be. Headquarters determined that a new site study should be completed, looking at the strengths and weaknesses of prospective sites. NASA personnel recognized that "it is apparent that the proposed study will be essentially politically oriented." As a result, the study would focus specifically on the concerns of the House committee, making sure that it addressed different geographical regions and facilities that already existed.[60]

Over the next several weeks, a number of NASA personnel remained focused on the issue of convincing Congress of the need for laboratory funding. At a meeting of center directors in late March 1966, one of the main topics of conversation was the LRL justification. MSC personnel admitted that "the report that we have given Congress and the testimony to date apparently does not satisfy the Committee that no other place exists in which we could make such a lab with minor modifications to present buildings." One of those potential sites was the Oak Ridge National Laboratory, which was operated by Union Carbon and Carbide. That facility's administrators were evidently lobbying their Tennessee congressmen to have Oak Ridge chosen as the LRL's location, and NASA had to counter their arguments about the suitability of their site and personnel to do the job.[61]

Representatives also criticized NASA for introducing the need for the LRL so late in the process. Paul E. Purser, Special Assistant to MSC Director Gilruth, explained the Center's response to this concern in a memorandum dated March 30, 1966, to Captain Robert F. Freitag at NASA Headquarters. He explained that it was impossible for NASA to have notified Congress any sooner about the need for the LRL, because official discussions about back contamination had not begun until a meeting between Dryden and the PHS's representatives on July 31, 1965. It was only after this date that NASA began to develop back contamination policies. Prior to that point, "the requirements were so ill-defined that no proposal worthy of congressional notification existed." Less than a month later, as soon as NASA was capable of being more specific about the laboratory requirements, Gilruth had sent a letter to Representative Olin E. Teague (D-TX) that mentioned that the laboratory might be necessary.[62]

NASA authorization hearings continued on March 31, 1966, focusing significantly on the LRL issue. The stated purpose of the hearing was to "give NASA an additional opportunity to present other information in a complete way," illustrating the subcommittee's dissatisfaction with NASA's explanations of the LRL to that point. Once again, Dr. George Mueller explained the main issues associated with the LRL: "To protect the public's health, agriculture and other living resources. To provide lunar sample distribution to approved scientific investigators. To preserve the scientific integrity of the samples at all times." Back contamination had become the focus of the justifications and, as a result, were listed first.[63]

When Representative Fulton again raised the issue of separating the various components of the facility and locating those components in different places, Mueller was prepared with an answer. Stating that NASA had spent a significant amount of time thinking about this issue since the last hearing, Mueller listed the additional costs that would be involved and the fact that the degree of danger would increase with the more facilities involved. Rather than making it seem like NASA had made this decision, Mueller pointed out that "there was a unanimous opinion on the part of the Public Health Service that whatever you did, you wanted them in a single location." When Mueller tried to explain how all of the various committees that had been associated with the planning for the LRL had all come to the same conclusion that the LRL should be built at MSC, Fulton argued that MSC personnel had been essential in that decision-making process and, as a result, NASA's conclusion that Houston should be the location was biased.[64]

Although the House Science and Astronautics Committee voted to approve funding for the lab, Fulton voted against the LRL and entered his dissenting opinion into the record. He stated that he believed "that this proposal, with an initial construction cost of $9.1 million, is poorly conceived and has not been given an adequate amount of study and analysis." He still opposed locating all of the facility at one site as well as the proposed location of MSC. Even though the Science and Astronautics Committee had voted to approve the NASA budget, the Committee on Appropriations cut NASA's budget authorization significantly. This was particularly true of the facilities budget, which included money earmarked for the LRL's construction. The Houston *Chronicle* suggested that the cut in NASA's budget could mean that the LRL would not be built, which would be detrimental to the entire space program. Eventually, funding for the laboratory was restored, although not in the original amount requested. The Senate version of the authorization included only $8.1 million for LRL construction and cautioned NASA "to construct the facility in the most economical manner consistent with efficient accomplishment of the function to be performed."[65]

Further Complications in the Design of the Lunar Receiving Laboratory: Scientists vs. Engineers

Even before the budget hearings in 1966, the LRL's design process was becoming more and more complicated as additional groups of people became involved. Scientists and engineers approached the LRL differently and prioritized different issues in the laboratory design and implementation. These differences had appeared during early debates about the facility's purpose but became even more pronounced as the construction phase neared.

By January 1966, Oran W. Nicks, Director of Lunar and Planetary Programs at NASA's Headquarters, determined that he should find out more about the LRL planning. Realizing that his directorate would most likely be responsible for some aspects of the LRL, Nicks called the MSC Deputy Director George Low to find out more about the LRL's progress. Low explained to Nicks the main role of the laboratory, focusing mostly on the scientific purposes of the LRL in receiving and processing lunar samples. The back contamination issue was mentioned as well, but only after the other scientific purposes. At the same time, Low directed Nicks to speak about the facility's details with Aleck Bond, who was more directly linked to the day-to-day planning. Nicks already had concerns about scientists feeling left out of the LRL design process, and he suggested to Low "the desirability of soliciting appropriate scientific inputs during the design phase, and of making sure the scientific community was aware of NASA's plans before the building became a matter of fact." Although Low agreed it was important to keep the scientific community informed of the LRL's progress, his response to Nicks's suggestions reflects the tensions that still remained from MSC's experiences with the OSSA ad hoc committee. Nicks described Low's concerns, stating that he "told me of some difficulties experienced recently with such a committee became involved in too much detail with the firm engaged in the pre-design studies without proper NASA participation and supervision." After Nicks reassured Low about what scientific input he envisioned, Low "recommended that I make an early visit to Houston to discuss the several aspects of this matter."[66]

In addition to the OSSA ad hoc committee and the ICBC, another NASA Headquarters committee followed the LRL's progress. Believing that its members also had an interest in the laboratory's operations, the Planetary Subcommittee of the OSSA's Space Science Steering Committee recommended the creation of another ad hoc committee in February 1966, whose role would be "to follow the progress of this Laboratory and make periodic reports to the Planetary Subcommittee." After all, Urner Liddell, the Planetary Subcommittee's chairman, argued, "the design and construction of the Lunar Sample Receiving Laboratory … cannot be separated from the scientific task of sample distribution and analysis."[67]

By 1967, as the facility was under construction, most NASA officials had become resigned to many of the constraints placed on the LRL by quarantine considerations. McLane presented MSC's position on the laboratory's quarantine requirements in a May 1967 article in *Astronautics & Aeronautics*. In an article titled "Collecting and Processing Samples of the Moon," McLane commented that "it is outside the scope of this article to consider the arguments for and against the possibility that life in any form exists on the Moon." He explained that NASA and the United States government had the responsibility of providing protection from potential hazards, in part because of the International Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space of 1967. Nonetheless, by bringing up the fact that debates did exist about whether or not there could actually be life on the Moon, McLane introduced some skepticism about the necessity of a quarantine. In spite of that potential skepticism, he went on to provide details about the laboratory and how the quarantine would operate to provide assurances about the readiness of the LRL.[68]

Some NASA personnel at MSC felt that their interactions with the larger scientific community was frustrating at times. Paul E. Purser felt that scientists sometimes viewed NASA employees as inferior. He observed that "the scientific community places a very heavy degree of importance on the possession of a Ph.D.—and preferably a Ph.D. from the same major professor that I got mine from." This type of attitude—or at least the perception that it existed—contributed to the friction that developed between NASA personnel and the scientific community as work on the LRL continued.[69]

As USGS geologist Eugene M. Shoemaker observed, tensions existed on numerous levels as the LRL developed. He recognized that "it's not just a problem of the engineer and the scientist coming to understand one another; … the problem is equally severe of having one kind of scientist understand another kind of scientist." Engineers and scientists tended to approach problem-solving and management issues from different perspectives and used different techniques. But even scientists of different fields did not always communicate well or agree upon priorities, as biologists and geologists had different goals that they were trying to accomplish through the laboratory.[70]

As the Apollo Program had developed in the early-to-mid 1960s, MSC administrators recognized a need to pay more attention to scientific issues. As a result, they created a new science directorate and invited Wilmot N. Hess to be the first director. In spite of Administrator's recognition of the need for science, the attitude of most managers and engineers was not entirely welcoming. When asked "What was the reaction from everyone on site to this new directorate and to this new focus for Apollo for gearing up on the science side?", Hess stated that the basic attitude at MSC was "Stay out of my way and don't bother me." This attitude remained in place throughout the 1960s, often frustrating NASA scientists. Although most recognized that astronaut safety should be the most important concern, they were often frustrated that science was not more of a priority. At times, Hess was bitter about the relationship between scientists and the rest of the Center. He believed that "It's clear that the rest of the Center doesn't really think that science is an important element in the present space program." Eggleston admitted that in the 1960s, "Science in the Manned Spacecraft Center … was almost a dirty word."[71]

As a whole, communications between scientists and engineers at MSC during the Apollo Program was fairly limited. The fact that there was an informal hierarchy at MSC in its early years that was based upon seniority, and that most of those people with seniority were engineers who had come originally from Langley, did not help the relationship between scientists and engineers. Many senior scientists, who would have had more leverage, were skeptical of the space program in its early years. This meant that most of the scientists who worked at MSC were recent college graduates who did not have as much authority within the profession.[72]

The scientific and engineering conflicts existed not only within the Center, but also within the larger NASA administration. At the Headquarters level, there was often rivalry between the Office of Manned Space Flight (OMSF) and the Office of Space Science. The OMSF was most concerned with the engineering activities needed to safely put humans on the Moon and return them safely to Earth, while the Office of Space Science advocated more scientific applications for the space program and were more representative of the desires of the larger scientific community in this regard. The "turf war" at Headquarters trickled down to MSC as well. Shoemaker observed that the directors at the Center "were all battling one another," but that they also "resented any interference from Headquarters as well." In that atmosphere, "to make things go you had to go in and fight for everything." Scientists such as Shoemaker found that type of environment frustrating.[73]

Although some scientists did not recognize that engineering concerns were paramount for Apollo 11, Shoemaker did. Not only did he observe that engineering concerns would override scientific considerations for the first Moon landing, Shoemaker admitted that "if I'd been sitting in the saddle with that same responsibility I would have made exactly those same choices as far as what's the priority." Although most scientists, according to Shoemaker, recognized that astronaut safety was the most important consideration for Apollo 11, after the first voyage had been made safely they expected to receive more consideration for scientific endeavors on future expeditions. Because scientists had arrived relatively late in the Apollo Program's planning though, Shoemaker believed that some NASA engineers viewed "science as just an extra burden that complicated their task." As a result, "there was an uphill struggle on the part of the scientists to get some science patched on, and there was a considerable resistance among the engineers to letting the scientists get in the way." Although this atmosphere seemed most common in discussions about what scientific packages could be included on lunar missions, it made its way into the debate over the LRL as well.[74]

This significant difference between scientists and engineers helps to explain the late addition of LRL planning to the larger Apollo Program. Shoemaker recognized that, at the administrative level, "it had never really occurred to [NASA officials] that the Moon would be an interesting place to go to, in its own right." After all, President Kennedy's original statement about the lunar program had only set a goal for getting to the Moon and returning to Earth, not creating a scientific program along the way. In this context, the lack of attention to processing lunar samples in the early months and years of the Apollo Program may have seemed more understandable. This inattention to lunar science in the early development of the Apollo Program also contributed to scientists' complaints that NASA did not prioritize science very highly in the later years. Shoemaker admits that "there was nothing in the design of the system that was really set up to do science," which limited the types of experiments that could be done. These scientific concerns spilled over into the design and implementation of the LRL facility, as many scientists desired to make sure that the best quality of science could be done and that samples would be handled in such a way as to not contaminate them or impair the ability of the scientific community to use them as much as possible. At times, this atmosphere put scientists in an adversarial position with regard to MSC personnel.[75]

Christopher Kraft, who became MSC Director after Gilruth, also recognized this inherent conflict from the perspective of the engineers and administration at the Center. Kraft believed that the main objective of the Apollo Program was to get Americans to the Moon and back safely, but he was not opposed to focusing more on science once the initial mission was completed. He felt that an adversarial relationship existed between the scientific community and NASA, because the scientists did not believe that the engineers were willing to incorporate scientific objectives. Kraft admits that part of the distrust resulted from the fact that he "just didn't have the time to listen to them." Regardless of intent, there were constraints upon scientific objectives because they were added after the engineering parameters had already been established.[76]

As more and more scientists became a part of the planning process, new concerns developed in the relationship between NASA personnel and the scientific community. Apollo Flight Director Eugene Kranz observed that, over time, the scientists and NASA personnel communicated less and less directly with each other. Instead, middle men emerged as brokers to represent the scientists' interests. Although Kranz recognized that, in many respects, a middle man was necessary to keep each individual scientist from making too many demands that would only benefit his or her own field, at the same time he admitted that NASA officials often fought against the use of middle men. At times, NASA was not hearing exactly what the scientists really wanted or needed, and this system contributed to further tensions developing between the two sides. Throughout the construction and operation of the LRL, the tensions between scientists and engineers continued to be a factor.[77]

Creating an Organizational Structure for the Lunar Receiving Laboratory

As John O. Annexstad stated in his management study of the LRL facility, "the most important issue [to be solved in building the LRL] turned out to be how to handle unknown extraterrestrial material in its original state and to perform scientific investigations without contaminating the material or the researcher." Rather than working with a set of standards and requirements that was firmly established before design and construction began, the LRL staff had to remain flexible as requirements changed on a regular basis. Annexstad believes that the constantly changing requirements contributed significantly to the challenges that LRL management faced during the construction and implementation phase of LRL development.[78]

The LRL program office managed the laboratory construction phase. Once construction was completed in June 1967, the LRL was to be turned over to a new manager. Until Dr. Persa R. Bell became the Chief of Lunar and Earth Sciences in August 1967 and took over management of the laboratory, Joseph V. Piland acted as the temporary manager of the facility. Throughout most of the period prior to Bell's assumption of the facility's management, Piland's duties were to construct the building in which the LRL would be housed. This role was not as simple as it might seem on the surface. In addition to ordinary construction concerns, Piland had to deal with the demands placed on the LRL design by back contamination concerns and scientists' desires to have their needs addressed within the facility.[79]

A number of important groups were instrumental during the construction and implementation phase of the lab. One of these groups was the Biological Advisory Committee. This particular group advised Dr. Charles Berry, who was the Director of Medical Research and Operations at MSC. Biological Advisory Committee members were specialists who could provide specific advice as Berry and his staff developed protocols for quarantine and back contamination testing.[80]

A second group was known as the LRL Working Group. The Planetary Subcommittee of OSSA established this group in early 1966. The LRL Working Group was to process the many proposals for lunar sample analysis that were submitted by potential principal investigators. Once the group had determined whether an experiment was appropriate, it advised the LRL about design issues related to these experiments. In addition, LRL Working Group members provided advice to make sure that the laboratory met stringent scientific guidelines, although this role was more informal than the group's other duties. Once the final certification process for the LRL began in 1968, however, the Working Group ceased to be as important to the laboratory's management.[81]

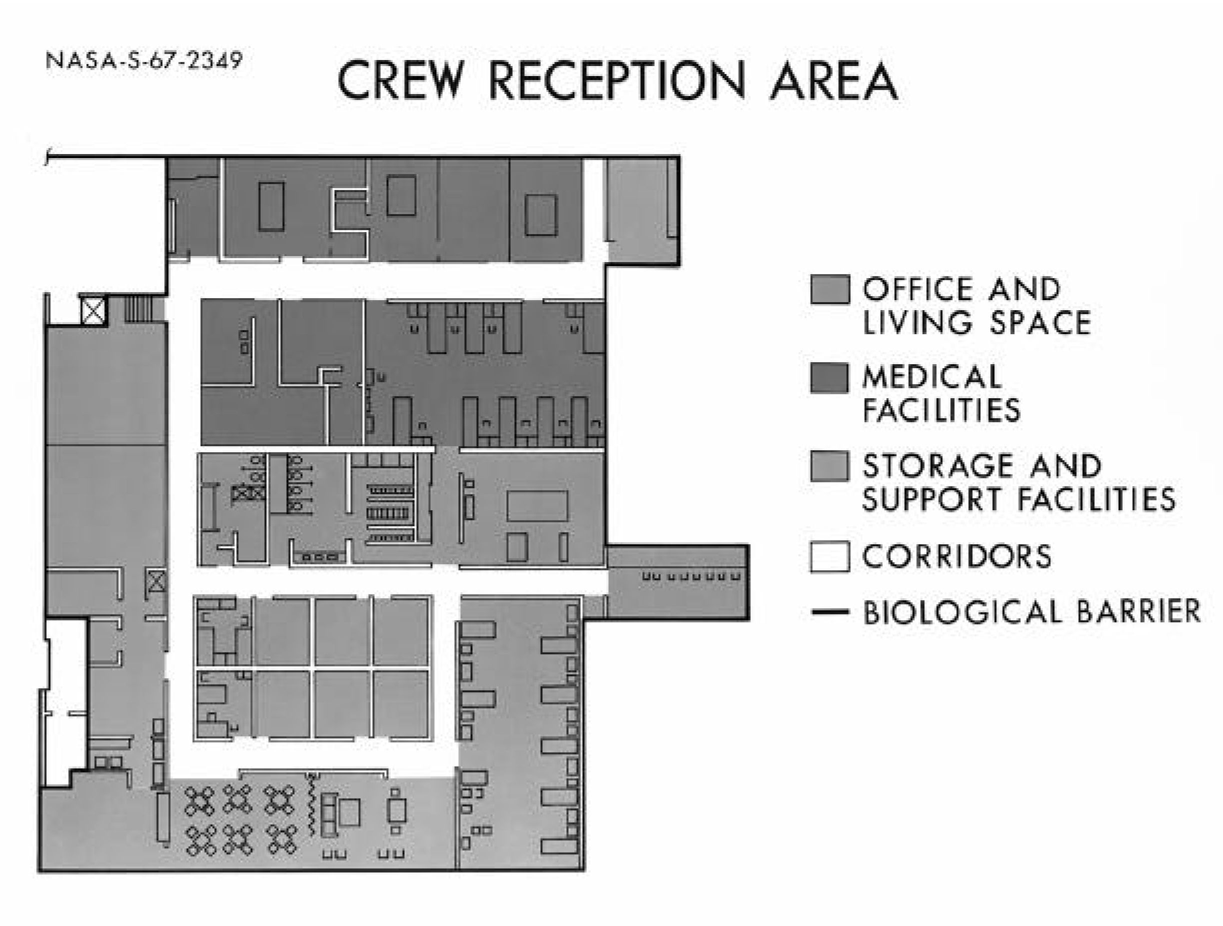
A third group was known as the Lunar Sample Analysis Planning Team (LSAPT). LSAPT's role was to determine which lunar samples would be most appropriate for each PI's proposed experiments. The LSAPT committee was made up of scientists from government agencies and universities. Because LSAPT's membership included prominent, articulate scientists who were willing to voice their opinions and put pressure on officials to implement their advice, this group had power that was far greater than their basic description detailed. LSAPT expected that NASA officials would execute its recommendations. This group's influence led to conflict during the operation of the facility during the Apollo missions, and at times its relationship with the LRL management was better than at other points. Often LSAPT's relationship with LRL managers illustrated the common tensions between engineers and scientists, as most of the LRL managers came from an engineering background at MSC. Specifically, LSAPT had three basic roles: (1) To help with LRL operational planning by advising the Science and Applications Directorate on procedures, equipment, and operations in the laboratory. (2) To recommend to NASA sample allocations, methods of sample handling, priorities of experiments, sequence of experiments, etc., and to advise on plans for contingency sample analysis (small sample return, degraded sample return). (3) To work during the initial sample quarantine period at MSC to advise NASA on precise sample allocations and distribution in light of the information gained about the samples in the course of the preliminary examination.

The team was officially established in December 1967 and operated throughout the certification process and the Apollo missions.[82]

At the same time that LSAPT was created, NASA also organized the Lunar Sample Preliminary Examination Team, known as PET. Members of the PET were scientists who either came from NASA's organization or from academic laboratories. These scientists would oversee scientific testing within the LRL during the quarantine period. PET members would operate behind the biological barriers during the early quarantined missions, while LSAPT operated outside of the barriers. The two groups were to work together in completing the important early scientific work related to sample return operations. At times, the relationship between LSAPT and PET was strained as various members of each group seemed to be in competition with the other. This conflict would not become apparent until the Apollo missions commenced.[83]

The LRL was going to be a complex facility, and its very complexity contributed to the difficulties of equipping, certifying, and maintaining it. It had to fulfill several very different, yet interconnected, functions. First, the facility had to act as a quarantine facility for the returned space crew. The Crew Reception Area operated behind the biological barrier. Designing this part of the facility to fulfill back containment requirements while still operating as a comfortable residence provided numerous engineering challenges, although ultimately it proved to be one of the easier aspects of dealing with the laboratory. This part of the LRL also held the Mobile Quarantine Facility and the Apollo Command Module during the quarantine period.[84]

In addition, the LRL contained the Sample Operations Area. This is the area that would immediately receive the lunar samples, process them, complete time-sensitive experiments, and carry out biological testing necessary for the release of astronauts and lunar materials from quarantine. There were a number of significant components to the Sample Operations area, which had to operate behind a biological barrier. This part of the facility included "vacuum, magnetics, gas analysis, biological test, and radiation laboratories, as well as the physical-chemical test area." If for some reason the biological barrier was ever broken, laboratory personnel would have to reside with the astronaut crew in the Crew Reception Area until the end of the quarantine.[85]



A concept drawing of how the Crew Reception Area of the LRL would be organized.

Finally, there was also a Support and Administrative Area. Unlike the Crew Reception Area and the Sample Operations Area, administrative offices were not located behind the biological barrier. Many support services for the facility did not have to be concerned with back contamination issues, including laboratories that prepared specimens in advance of missions for biological testing, offices and conference facilities for visiting scientists during the missions, a viewing area for visitors to observe operations form outside of the barrier, and a data storage and retrieval system. Although some of these support services were housed within the LRL, most were located in nearby buildings. Visiting scientists, for example, did not usually have office space within the LRL.[86]

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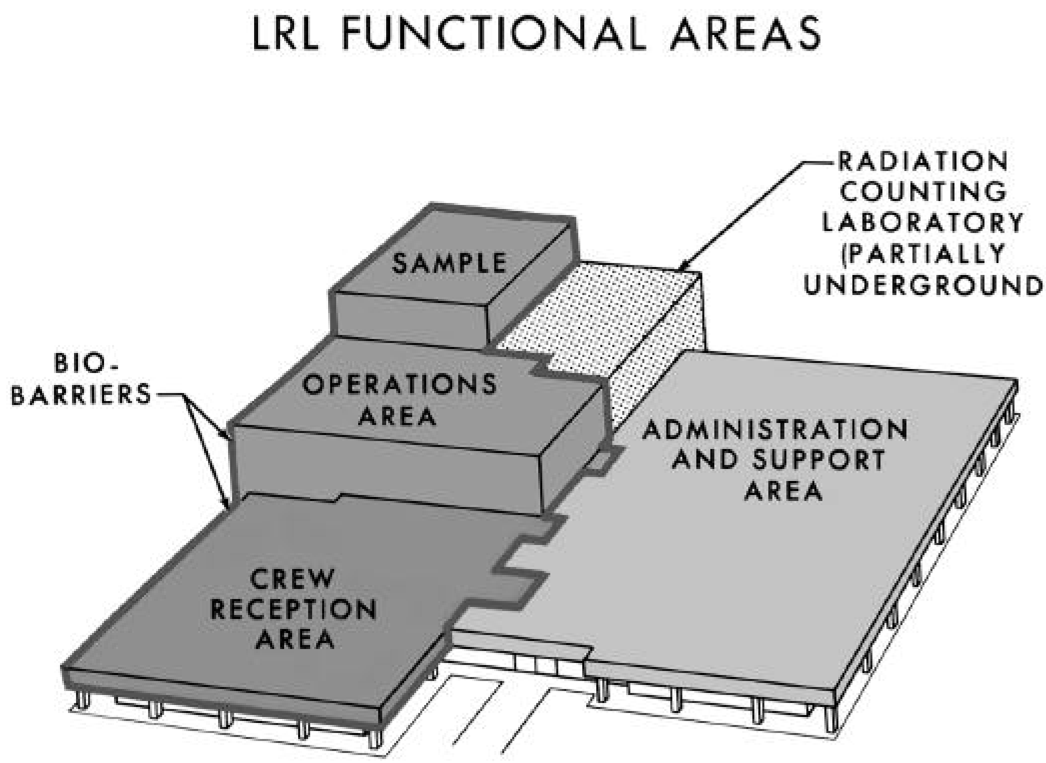


A concept drawing of the various components of the LRL.

Construction of the Lunar Receiving Laboratory

MSC personnel faced numerous challenges during the construction of the LRL. MSC established a specific program office to oversee facility construction. Joseph V. Piland became head of that office, and also served as Acting Manager of the LRL during the early period of the construction. Piland observed there were many concerns associated with the lab's construction. The time constraints meant that "criteria development, design, construction, shakedown testing, operational planning—all were done concurrently." Every time that there was a design change, construction had immediately to be modified to address the change. In addition, NASA used a cost-plus contract system because of the urgency of the facility's construction. This allowed the facility to proceed at about twice the speed of similar projects at MSC. Piland believed that the organization of the LRL Program Office worked very well, making the process much more efficient because "some of the people involved in establishing design criteria and monitoring equipment development were also the people who would be involved in the operation of the lab when it was complete."[87]

Piland and the LRL Program Office had faced some significant problems from the outset. When congressional approval for the LRL was delayed in the spring of 1966, plans to begin construction of the facility had to be postponed. As a result, Frank A. Bogart, Deputy Administrator for Manned Space Flight, sent a datafax to MSC in July 1966. The memorandum instructed the MSC administration to delay opening the bid for the first phase of the LRL construction project from July 6 to July 20, in hopes that Congress would vote in favor of the appropriations by that point. Of course, if the bids were delayed, actual construction would also be delayed. In a presentation to the LRL Working Group on July 11, 1966, Piland expressed concern about the construction delays. In his talk, Piland stressed "the necessity for the highly compressed LRL facility schedule and the reasons for the planned operational date of the laboratory." It was yet another warning of the dire consequences for the Apollo Program if the LRL was not completed in time. Delays in congressional approval would ultimately not be an acceptable excuse for a delay in the timeline for the first Moon landing. It would be up to the LRL Program Office to get facility construction back on schedule, a daunting and stressful task.[88]

Congressional funding would not be the only challenge to the LRL construction schedule. Piland repeated his warning in a memorandum to the Chief of the Facility Requirements Office later in the month, reminding him that "The LRL is required to be operational by November 15, 1967." If construction was to be completed on time, the process would have to go smoothly. Piland recognized that any changes to facility design while construction was in progress would lead to both time delays and additional expenses that the timetable and budget could not tolerate. As a result, Piland set September 1, 1966, as the final deadline for any design requirements.[89]

By July 1966, the OSSA LRL Working Group, also known as the Goodman Committee, had made a number of recommendations about the facility. The group suggested that NASA write an article justifying the LRL to be published in *Science* as soon as possible. In addition, the group's members believed that the LRL needed a permanent manager appointed as soon as possible and that MSC should begin recruiting some key scientists to ensure that the laboratory would have a strong science base and be prepared for the first sample return. Colonel John E. Pickering agreed with Working Group recommendations about recruiting personnel as soon as possible, as "it will in large measure shape the scientific scope and success of the LRL for the present and follow-on programs."[90]

In some cases, the LRL Working Group helped MSC personnel in expressing the urgency of their needs. On August 24, 1966, Homer E. Newell, Associate Administrator for Space Science and Applications, sent a memorandum to the Associate Administrator for Manned Space Flight. In this memo, Newell reminded his audience of the Working Group's earlier recommendation that additional civil service billets be made available for the hiring of scientists for the LRL. Newell echoed this recommendation, agreeing that "unless scientists were acquired on the staff in the immediate future, they would not be sufficiently trained to be ready for the activities of the Laboratory at the time the lunar material was returned by the astronauts."[91] Sufficient scientific staffing was also necessary to legitimize LRL operations to the larger scientific community.

Not all scientists were satisfied with the progress that was being made on the LRL's design in 1966. On February 4, 1966, Professor A. L. Burlingame of the University of California, Berkeley, wrote a scathing letter to Dr. Orr Reynolds, who was Director of Manned Space Flight Field Center Development at NASA Headquarters. In this letter, Burlingame criticized NASA for moving too slowly in implementing scientific recommendations. Specifically, he claimed that the “critical final design stage of the Lunar Sample Receiving Laboratory is suffering … from the lack of clear, concise guidelines and directions from NASA hadquarters [sic].” In addition, he felt that the role of the ICBC in back contamination issues needed to be fully defined.[92]

By October 1966, the LRL Working Group was raising serious concerns about whether outside scientific advice was being taken into account in the planning for the laboratory. This concern reflected the criticisms of scientists such as Burlingame. Clark Goodman, the chairman of the Working Group, expressed the committee’s grievances in a letter to Dr. Urner Liddell, chairman of the OSSA Planetology Subcommittee, on October 11, 1966. In that letter, Goodman stated that “The LRL Working Group is deeply concerned that lunar sample containers, tools, and procedures are presently being developed without proper attention to scientific recommendations.” In addition, NASA personnel were not involved in “adequate consultation with scientific advisors and prospective investigators.” These concerns were repeatedly expressed by outside scientists in the years preceding the first lunar mission. Neither NASA personnel, especially those at MSC, nor outside scientists seemed to always trust that the other side valued their input.[93]

As LRL construction continued, at least some MSC personnel had come to the conclusion that the LRL staffing problem had to be approached in a different way than the LRL Working Group had originally recommended. Difficulties in recruitment and the enormous costs meant that hiring a significant number of scientists to work within the laboratory for NASA would be extremely difficult. Instead, MSC Director Robert Gilruth recommended to Lieutenant General Frank A. Bogart, Deputy Associate Administrator of the OMSF, that “the special nature of the laboratory and the special skills involved in laboratory operation in the various scientific disciplines strongly suggest the need for contract laboratory operation.” As academic scientists were already interested in the LRL operations because of their place as PIs, Gilruth argued that they could be recruited to handle some of the specialized laboratory operations. Ultimately, this plan was used, at least in part, by recruiting academic scientists to work within the PET and LSAPT. At the same time, NASA was cautious not to allow universities to have too much power within the LRL management, as “There is always a danger in the fact that the university Board of Governors and the university Administrations can become involved in the day-to-day operation of the facility in an undesirable way.” NASA administrators wanted to make sure that it was NASA, and not the universities, that had managerial control over the LRL.[94]

When MSC employees did reach out to the scientific community with regard to the LRL, NASA Headquarters expressed concern as well. Robert R. Piland, Manager of the Experiments Program Office at MSC, described this concern to the Center deputy director in a memorandum on November 8, 1966. Piland stated that “Mr. Webb made it quite clear that he was dissatisfied with MSC procedures.” First, MSC personnel had discussed issues related to the LRL with scientists at nearby universities without first obtaining approval for those forays from NASA Headquarters. Second, MSC had chosen to explore these issues with the local universities before exploring whether or not Headquarters had any responses first. NASA Administrator James Webb’s concerns in this area reflected the fact that NASA Headquarters was trying to maintain control over the direction of the LRL. Despite this desire, MSC personnel sometimes made decisions without working with Headquarters.[95]

A number of other groups also wanted to have their say in how the LRL developed. One such group was the Biosciences Working Group of the Planetary Biology Subcommittee at the Department of Chemistry, University of California, Berkeley, which Melvin Calvin chaired. This group normally made recommendations to NASA through the Space Sciences Steering Committee, but when members felt that their voices were not being heard through the normal channels, they applied directly to Dr. Homer E. Newell, the Associate Administrator for Space Science and Applications at NASA Headquarters. In a letter on December 29, 1966, Calvin articulated committee concerns about how the construction of the LRL was proceeding. He specifically referred to the laboratory's purpose as a quarantine facility and believed that his committee's recommendations were not being considered. Calvin warned Newell that the facility's development "will fail to fulfill the original function for which the laboratory was built but will, at the same time, have a detrimental effect on the participation of the biological and biochemical scientific community, not only in the lunar science and exploration but in the broader scientific activities of the space agency." In particular, Calvin seemed worried that the direction that the LRL was taking might lead it to compete with other laboratories, either private or academic. He recommended that the Agency not only appoint a director for the facility that would keep it on track but also that NASA "place the lunar receiving laboratory in its proper function and encourage the collaboration of the national community of biological and biochemical science before it is irretreviably [sic] lost to the agency." Biological scientists, like other scientists, were beginning to be concerned that the LRL might develop into a competing force with its own research interests, rather than simply serving as a quarantine and processing facility for samples.[96]

In the meantime, LRL construction continued. One of the problems that MSC faced as construction neared a critical phase was that many people were interested in the laboratory and wanted to tour the site. Although in and of itself that interest was not necessarily a bad thing, the number of visitors to the construction site had become difficult to handle. As a result, MSC developed a formal visitation policy for the facility in March 1967. Because construction needed to be completed in a very short time if the facility was to be entirely ready for the first lunar mission in 1969, it was "necessary to control visitors to the construction site." Anyone who wanted to visit the site, including NASA personnel who might eventually work in the facility, had to make an official request to the Lunar Receiving Laboratory Construction Office before gaining access.[97]

As construction of the LRL neared completion, NASA was developing other aspects of the lunar science program as well. NASA Headquarters' OSSA was responsible for choosing the scientists, known as PIs, who would actually do experiments with the lunar material. An OSSA committee selected more than one hundred scientists from around the world to participate in the first lunar mission. Some of the PIs would conduct their investigations within the LRL facility, but most would receive lunar samples for research back at their home institutions. The PIs' selection was proof that the first lunar mission was moving ever closer, but it also signaled additional challenges for the LRL's completion. Since a number of PIs would be completing experiments within the facility, they had their own requirements for the design and equipping of their respective parts of the laboratory. Because most of the PIs had not been part of the original design process, their recommended modifications could potentially mean increased costs and delays in the facility becoming operational.[98]

In addition, NASA began to organize its back contamination efforts. Center Director Robert Gilruth gave Dr. Charles A. Berry, MSC's Director of Medical Research and Operations, total responsibility for biological containment, quarantine, and testing of lunar material in the LRL. This placed Berry in a significant position of power within the facility. Berry assigned Dr. Walter W. Kemmerer, Chief of the Biomedical Specialties Branch, to head MSC's biological operations. Kemmerer was directly responsible to Berry and managed the day-to-day aspects of the LRL related to back contamination. He and his workers had to direct the crew quarantine phase at the end of each mission as well as manage the biological testing required to prove that lunar samples were not a threat. This was certainly a complicated process. Berry and his staff found that other areas of the laboratory operations and also outside scientists continually criticized their efforts. Since many scientists did not believe that lunar samples posed a real health risk, they felt that Kemmerer and his staff created unnecessary difficulties for their research efforts. They sometimes resented the restrictions that back contamination protocols placed upon their work. Astronauts were also concerned about the restrictions that Kemmerer's staff were imposing. Berry and his staff often found themselves in a difficult position. In addition to his interactions with scientists and MSC personnel, Kemmerer worked on a close basis with Dr. G. Briggs Phillips, who was the PHS's liaison to the LRL. Ultimately, it was the PHS and the ICBC that had to approve Kemmerer's efforts. To a certain extent, this issue meant that Dr. Berry's staff was divorced from the traditional management structure within MSC and NASA as a whole—the medical personnel were ultimately responsible to an outside agency, not just to the higher levels of the NASA hierarchy.[99]

Even as the laboratory was nearing completion, additional requirements necessitated more construction. In October 1968, Berry sent a memo to MSC's Director of Administration, requesting approval for a separate facility to be built next to the LRL. As biologists began working on setting up their component of the laboratory, it became apparent that an outside facility was necessary to grow and prepare sample material, such as plants and invertebrate animals, prior to each mission. Berry felt that this issue must be acted on as soon as possible, as it was "an emergency project critical for the Apollo lunar mission."[100]

As construction on the LRL continued, concerns about certification of the facility became paramount. Associate Administrator for Manned Space Flight George E. Mueller voiced concerns about the certification process to MSC Director Robert Gilruth in June 1967. He pointed out that "since a prime function of the LRL, in its initial phase, is one of quarantine, practical provisions must be made for early certification testing of the containment and operational capability prior to final facility acceptance." Although NASA personnel recognized that some certification process was necessary, no formal process had been created at this point. Outside scientists, as well as many people within NASA, began to question what that process would entail and whether certification could be completed in time for the first lunar landing. Mueller advocated that MSC organize a demonstration of the facility's capability to be held by July 1968, encompassing all of the components from splashdown until the end of quarantine. Mueller's timeline proved to be optimistic, as the laboratory was not prepared for a full-scale dress rehearsal by this deadline. He assumed that protocols would be fully in place by that point, but in reality those protocols were still under development.[101]

The construction process for the LRL had reinforced a number of trends that had begun during the early planning phase. Different visions of the laboratory's purpose and design contributed to delays in completing construction. There were continued differences of opinion between NASA Headquarters and MSC personnel about the approach to the facility, as well as between academic scientists and the Agency. Completion of the building that would house the LRL did not mean that these challenges would end. Equipping the laboratory and completing the protocols for quarantine and testing led to additional conflict and stress as the first mission neared.

The Interagency Committee on Back Contamination and LRL Construction

Although a number of committees and institutions had been involved in the design of the LRL, as of April 1966 there had been no formal government approval of the back contamination program. The ICBC, representing the relevant government agencies concerned with the back contamination issue, formally approved the design of the facility in April 1966, although members recognized that "additional reviews will be conducted as construction proceeds." Until the ICBC began to meet, all of the concerns about back contamination focused specifically on the lab itself, but the ICBC enlarged its scope by addressing the landing and recovery operations of spacecraft, lunar materials, and astronauts as well. This topic became the key area of debate between the ICBC and NASA personnel in the months and years to follow, as the ICBC's back contamination concerns sometimes seemed to be in conflict with engineers' desires to protect astronaut safety. Eventually a compromise had to be reached if the ICBC was going to certify the entire operation. Very quickly after the ICBC came up with its recommendations for the back contamination effort, George E. Mueller directed Robert Gilruth to work on meeting the new standards set by the ICBC on April 13, 1966. Gilruth assured Mueller that MSC personnel were already at work on meeting the committee's standards and had begun studies to determine the feasibility of the recommendations specifically related to splashdown and recovery plans.[102]

Ames Research Center had always expressed an interest in the LRL, at one point arguing that the facility should be built at Ames because of the center's interest in the search for life in space. Although NASA ultimately chose MSC as the site for the facility, many people recognized the need to reach out to Ames as well. ICBC member Colonel John Pickering addressed this issue at one point, reminding MSC personnel to "give thought to this problem and the political overtones attendant to geographic locations." It seems that MSC heeded these warnings about including Ames in the project. In June 1966, MSC Director Robert Gilruth sent a letter to Dr. H. J. Allen, Ames Director, requesting that Ames provide some personnel to support the LRL, "in consideration of the competence at Ames in the Biological Sciences." MSC thus invited Ames to participate in the project, but MSC personnel controlled the construction process.[103]

Although the PHS had not been involved in early planning of the LRL, that agency's leadership had determined that it would have an important role in all lunar quarantine proceedings by the time that construction was under way. Having explored the legal issues related to the quarantine, the PHS had concluded that the Surgeon General had legal authority over all quarantine issues. Dr. G. Briggs Phillips had determined that "The Surgeon General of the U.S. Public Health Service is empowered by law to make and enforce such regulations as may be needed to prevent the introduction and spread of communicable disease into the United States, its Territories or possessions." As a result of this power, "returned lunar material, until shown to be free of possible pathogenic or infectious materials and otherwise not harmful to man's biosphere, should be controlled, quarantined and tested in accordance with procedures approved by the Surgeon General or his representative." Ultimately, this determination meant that, unless the PHS's representatives were convinced of the efficacy of the LRL and its related quarantine procedures, the Apollo Program would not reach its conclusion. In addition, Phillips also pointed out that the Department of Agriculture had authority to be involved with the quarantine planning. Just as the PHS was concerned with potential threats to human health and lives, the Department of Agriculture would be concerned with lunar pathogenic threats to plant and animal life.[104]

The ICBC took a significant interest in the construction and certification of the LRL, sending representatives to Houston on several occasions to observe its progress firsthand. Not all of the committee members felt that MSC personnel took the back contamination issue as seriously as they should, and the ICBC wanted to make sure that MSC addressed the stringent requirements that the committee had established for the facility. After one meeting, Colonel John E. Pickering reported back to the committee that MSC "recognize[d] the severe environment of the operation and the implications [and were] proceeding with these concepts to satisfy with practicality the total requirements." In contrast, MSC employees were concerned that the ICBC might slow the completion of the LRL and, hence, the timeline for the Apollo Program in general. MSC personnel believed that the role of the ICBC should be "broad policy guidance, with occasional detail review by the committee." Otherwise, smaller details should be left to the "experts" already at the Center. NASA therefore advocated that someone be designated on site to make the day-to-day decisions so that minimal time was lost. MSC recommended Dr. Briggs Phillips for this role, and the ICBC followed that recommendation.[105]

Even though the LRL was still under construction during the fall of 1966, the ICBC was concerned that NASA had not yet appointed a director for the facility. While paying lip service to the fact that NASA was fully in charge of making personnel decisions, the committee still made several recommendations about hiring a director in a letter to Dr. Robert C. Seamans, Jr., NASA Deputy Administrator, on November 14, 1966. ICBC Chairman David J. Sencer pointed out that "the rationale for the Laboratory is biological containment. Therefore, the director of the Laboratory should be well versed in the biological systems involved." At no point did Sencer's letter acknowledge the other scientific purposes of the facility, such as processing lunar samples for scientific research. Sencer went even further in this letter to provide his recommendations for whom the LRL director should be responsible to—"a policy making echelon in the National Aeronautics and Space Administration"—and suggested that NASA should appoint the PHS's representative to MSC, Dr. G. Briggs Phillips, as director. This recommendation reflected the common concern among both biological and geological scientists that the management issue was paramount. At the same time, these two groups had different goals and made different recommendations about who that manager should be. Once again, MSC personnel would be placed in the middle, as neither side was happy with the other's recommendation.[106]

In a status report of the LRL dated December 12, 1966, Phillips echoed the ICBC's concerns about the facility management. Phillips observed that "The LRL has no management structure, no director and very little staff." He also criticized the lack of a clearly defined chain of command, stating that "It is not clear where it appears in the MSC Table of Organization or to whom and at what level it is responsible." Restating Sencer's assumption that the LRL's purpose was biological containment, Phillips also argued that whoever was appointed as the laboratory director had to be an expert in that area. He made a number of recommendations for how the facility should be organized and what budget and personnel issues needed to be addressed quickly if the LRL was to be operational. Phillips also recognized that his own position at MSC was somewhat precarious, as he stated that "the role of the PHS consultant to NASA needs to be defined in more precise terms."[107]

In contrast to both Sencer's and Phillip's perspectives of the laboratory's progress, Dr. Charles A. Berry, MSC's Director of Medical Research and Operations and the MSC administrator in charge of the LRL's containment program, presented a much more optimistic view in a letter to Sencer in late December 1966. Berry claimed that "In general, the management plan, staffing, budget, protocol development and construction all appear favorable to an effective operation within the schedule dates." He recognized that "provision of competent biological safety personnel present a problem at this time," but "a series of alternatives [is] being aggressively pursued to alleviate this problem, and resolution is anticipated by mid March."[108] As on a number of other occasions, MSC's perspective of LRL progress differed significantly from that of the ICBC.

By January 1967, the ICBC and NASA had more clearly defined the managerial aspects of the LRL quarantine operations. At a meeting at the Communicable Disease Center in Atlanta, Georgia, on January 16, 1967, Dr. Charles Berry, Frank Smith (Assistant Director at Langley Research Center), and George Low met with PHS officials Dr. David Sencer and Dr. J. Bagby. As a result of this meeting, NASA agreed that the quarantine function was the most important priority of the LRL and that the laboratory's organization would reflect that point. The Chief of the Biomedical Branch in the LRL would be responsible for preparation and execution of quarantine operations. In addition, "because quarantine and containment constitute overriding requirements for all operations in the Lunar Receiving Laboratory," this person would have an active voice in all other aspects of the facility, including sample processing and geological testing. The Chief of the Biomedical Branch would have a significant amount of power within the LRL, because he would have "the authority to impose quarantine and containment requirements on every aspect of the operation and to see to it that those requirements are carried out."[109]

Although NASA and the ICBC were working out their own agreements about the extent of the quarantine, it did not mean that other groups felt that they could not weigh in on the subject as well. A meeting of the Planetary Biology Subcommittee at MSC on January 10 and 11, 1967, reflected that reality. At the meeting, scientists raised a number of concerns about the direction of quarantine planning. Many of the scientists involved "questioned the adequacy of quarantine requirements set by 'unimaginative' regulatory agencies." NASA officials were quick to reassure the group that everything possible was being done to incorporate scientific suggestions into the quarantine procedures. Baylor University scientists were developing the protocols with the help of prominent bioscientists from across the country. In addition, scientists Carl Sagan and Cyrus Levinthal disputed MSC's logic for quarantine procedures, because "in emergencies the safety of the crew transcends the quarantine requirement." Harold Morowitz, another scientist, proposed an additional step beyond the quarantine. He wanted additional sample testing completed at Ames Research Center once the quarantine was lifted. This testing would have to be completed before lunar samples would be released to PIs. Certainly, if this suggestion had been made into a requirement, geologists would have been outraged.[110]

The role of the ICBC was becoming clearer as the LRL's construction phase neared completion. Members of the committee had developed a clear vision of the laboratory's importance. They tended to define the facility solely in terms of back contamination concerns and focused on developing quarantine requirements and biological testing protocols. This focus was in contrast to that of geological scientists, who were determined to protect their interests within the LRL. NASA had made a commitment to follow the ICBC's recommendations, but MSC personnel still had to deal with the differences of opinion between these two groups.

LRL Management and the Rush for Certification: Persa R. Bell and Richard S. Johnston

Some of the concerns about the LRL's future were temporarily assuaged by NASA's appointment of Dr. Persa R. (P.R.) Bell as Chief of MSC's Lunar and Earth Sciences Division in August 1967. One of Bell's duties as Chief was to manage the LRL. Bell had the type of background that appeared on the surface to make him the perfect choice for the position. He had a strong scientific background and experience working with the government in the past in his position at Oak Ridge National Laboratories. His scientific background and experience made him acceptable to the scientific community, who had been concerned that NASA was not taking their suggestions seriously until this point. Bell's background finally gave the LRL a sense of legitimacy that it had not had within the scientific community in the past.[111]

P. R. Bell, formerly a nuclear physicist at the University of Chicago, came to the LRL after working as the Director of the Thermonuclear Division at Oak Ridge National Laboratories in Tennessee. Having served on the OSSA ad hoc committee that had helped determine the LRL's requirements in 1964 and 1965, Bell was already somewhat familiar with the facility. Bell was officially hired to manage the LRL in August 1967, before construction was entirely complete. Although the building was finished by the summer of 1967, much work had to be accomplished to equip the lab for its many roles during the lunar missions. Bell remained as Chief of the Lunar and Earth Sciences Division, of which the LRL was a part, until after the Apollo 11 sample handling was completed. Bell eventually resigned from NASA in January 1970 so he could return to Oak Ridge.[112]

One reason why Bell was hired to manage the LRL facility was because outside scientists had been unhappy with the direction of the facility prior to that point. They wanted to see a prominent scientist in charge of the laboratory who fully understood the significant scientific issues associated with getting the lab up and running and someone who would also represent the scientists' interests in power struggles with the more engineering-focused personnel at MSC. In addition, Bell's appointment reassured geological scientists that their concerns about limitations caused by quarantine requirements would be heard.

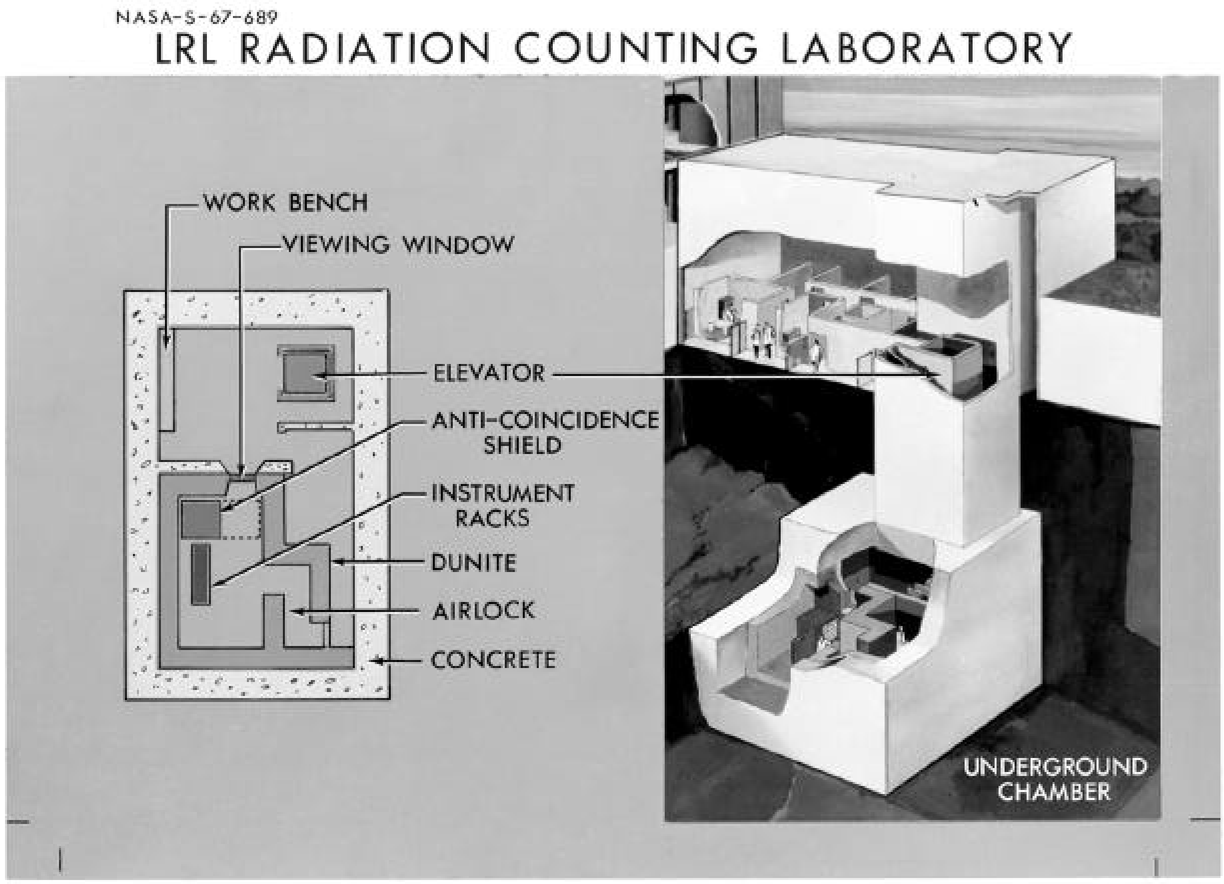
The selection of a manager for the LRL was very difficult. NASA had to choose someone who would be capable of handling the facility's diverse roles. He would have to be knowledgeable about the many scientific needs of the laboratory to satisfy scientists that he was qualified. Still, the manager was likely to be more interested in either the biological testing for back contamination or the geochemical testing, but not both. Not all scientists were going to be equally pleased with a management appointment, even if the manager was a scientist as well. Engineers involved in the LRL's operation would also find it difficult to work with a scientist-manager. Probably most important, however, choosing a highly qualified, well-respected scientist to run the facility did not necessarily mean that that person had the personality or managerial capabilities for the position. It would take more than brilliant scientific abilities to manage such a complex facility, employing diverse groups of people, and making sure that the LRL was operational in time for the first lunar mission.

Immediately upon becoming manager, Bell faced enormous pressures. The time constraints to have the lab operational in time for Apollo 11 were very real. There was an immense amount of pressure to get the LRL equipped and certified in the shortest amount of time possible, but at the same time, some of the requirements were still in flux as the scientific experts modified their plans for testing. In addition, Bell felt that the project was already two years behind schedule. He felt that the rushed effort to get the facility ready in time "resulted in a marginal effort at best during the first Apollo mission."[113]

Bell's perception of his role within the facility illustrated that, even in the years immediately preceding the first Moon landing, many scientists and NASA personnel still did not believe that back contamination was a serious issue. When asked what the long-term mission of the LRL was, Bell stated that "the samples were to be uncontaminated and every effort should be put forth to see that the science was done." In his mind, the concern about back contamination was negligible. Bell thought that the most difficult part of his job as manager was the "practical side—sample handling, vacuum systems, gloves and lack of time to do a proper job." He focused on the "science side of the house," staffing the laboratory and setting up the equipment necessary to complete experiments. Bell's administrative assistant during this era, Richard Wright, observed that Bell did not like the doctors associated with enforcing back contamination protocols at the laboratory, and those feelings had an influence on his interaction with them.[114]

Bell observed ongoing conflict between engineers and scientists during his tenure as LRL manager. He described these clashes as resulting from a "basic difference in philosophy. Scientists are experts and opinionated—cannot manage them. Engineers are conservative. Need flexible opinions in science and not engineering." As a scientist himself, Bell sometimes contributed to the differences between these two approaches. Many of the personnel involved in preparing the laboratory for the first mission did not feel comfortable with Bell's approach to problem-solving.[115]

While manager of the LRL, Bell faced criticism from a number of quarters. Some MSC personnel believed that Bell was too caught up in establishing the radiation counting laboratory within the LRL, his pet project, and as a result they thought that he did not focus enough of his attention on the rest of the facility. Bell's area of expertise was in the area of radiation counting, making that part of the facility of great interest to him. His specialty was the reason why he had been asked to join the ad hoc committee in the first place. John O. Annexstad described Bell as always being "down in the counting laboratory, almost like King Midas down there counting his gold and working with the people down there." Other scientists felt that the other components of the facility were suffering in the meantime. Bell's personality also created distance between him and other members of his staff. He had a number of quirks that made people think that he was not listening to them. Although Bell was a brilliant scientist, Wright observed that he "had no managerial ethics" and never really adapted to work in a government agency.[116]



A concept drawing of the design of the LRL's Radiation Counting Laboratory.

As the months leading up to the first Moon landing approached, there was increased concern about whether the LRL could be certified in time for Apollo 11. This problem became increasingly urgent, and many people became critical of Bell's handling of the certification process. At that point, MSC Director Robert Gilruth assigned his assistant, Richard S. Johnston, to the laboratory. Although Bell still technically remained in charge of the LRL, Johnston had the full backing of the Center Director and acted as the operational manager of the facility through the first Moon landing. Once the initial operations were complete, Johnston's job was done and he was reassigned to another role in the Center in October 1969. Johnston's perception of his place within the LRL management illustrated the difference between him and Bell. While Bell stated in Annextad's management study that he perceived his first task to be organization of the lab, Johnston stated that his role was to instill discipline. He needed to "set up a method for identifying problems and a decision process." The fact that Gilruth had basically given Johnston a blank check to do whatever was necessary to get the lab operational "gave him great confidence and security during his tenure." To Johnston, the most difficult part of his job in managing the lab was "to establish support with the ICBC and to identify the problems in the LRL. System was so complex it was a problem of where to start." Unlike Bell, who focused on the scientific aspects of the laboratory and viewed scientific testing of lunar samples to be of supreme importance, Johnston prioritized back contamination issues as most important. He organized the LRL's work towards certification in light of the need to convince the ICBC of the facility's preparedness.[117]

Johnston's temporary assignment to manage the laboratory was an essential aspect of getting the laboratory ready in time for the first Moon landing. Although his scientific background was not nearly as strong as Bell's, Johnston had many years of management experience. John Annexstad described Johnston's coming on board in the following way: "he just called in everybody and just plain said, 'This is what you're going to do. I want paper. I want paper. I want exact operational scenarios. I want everything on my desk, and this is the way I want this thing to work, and this is the way you're going to do it.'" This was a very different approach from Bell's, who did not appear to understand the importance of management techniques or the pressure of the timeline that NASA was operating under by this time. Although ultimately Johnston was successful in getting the LRL certified in time for Apollo 11, when he first arrived in the LRL he met some resistance. Within a couple of days after Johnston took over, several LRL personnel had gone to Gilruth to complain about Johnston's methods, albeit unsuccessfully. By the time that certification was completed, however, those same people had come to support Johnston.[118]

Johnston also represented the differences that existed between scientists and engineers at NASA and how those differences related to the success of the LRL—although he defined it more as a difference between scientists and managers. Scientists sometimes accused NASA managers of being anti-science, but Johnston believed that the real problem was that "science does not understand management problems." Johnston was harshly critical of scientists' problem-solving skills, declaring that "Science was too personal. … Science polarizes opinions too quickly. Science is not willing to have things viewed in open forum." As a result, according to Johnston, managers had to "understand science ego and individualism."[119]

NASA Headquarters recognized that significant progress was made in preparing the LRL for the first lunar mission after Johnston was appointed to head the certification process. In a memo to MSC Director Gilruth on July 11, 1969, Apollo Program Director Sam C. Phillips congratulated Gilruth on appointing Johnston to the lab, stating, "I have noted continued improvement in the back contamination effort under the leadership of Mr. R. S. Johnston. Please express to Dick Johnston my appreciation for his fine work." In an understated way, this praise of Johnston was also a criticism of Bell's management approach.[120]

Management issues proved to be a significant aspect of certifying the LRL in time for the first mission. Managerial approaches could have a major effect on the success of the facility. Regardless of the expertise of managers, not everyone was going to be satisfied with the process. Bell, as an eminent scientist, was able to gain the respect of many parts of the scientific community. His expertise was certainly a factor in the success of the vacuum chamber and the radiation counting laboratory. At the same time, however, despite his previous experience at the Oak Ridge National Laboratory, he did not have a managerial approach or a personality that was conducive to the timeline that the LRL had to follow. Johnston, in contrast, was a capable manager whose organizational skills contributed to the LRL achieving its final certification. At the same time, Johnston did not have the scientific training that Bell had. Johnston's success was built in part on the earlier scientific and technical work that Bell and his staff had accomplished.

Continued Competition Within the LRL

In the years preceding the first lunar missions, tensions existed within the LRL on a number of levels. Laboratory management and personnel remained concerned about the amount of influence that outside advisory groups had on the facility's development. Engineers and scientists continued to struggle with communicating their goals and needs to each other. The competition between back contamination issues and other scientific goals remained strong. All of these issues created even more challenges for laboratory management as the certification deadline approached.

Most managers felt that, while the advisory boards were necessary to provide expertise for the facility, there was often a "cordial but strained" relationship between LRL management and those groups. At times, they believed that the advisory groups had too much power in determining policies for the facility. While "advisory boards filled a necessary role since the laboratory did not have sufficient personnel to do the entire task," at the same time managers believed that they "should remain advisory and not be given the power to make decisions."[121]

Wilmot Hess, Director of Science and Applications at MSC, presented a different perspective of the LRL. He believed that the LRL was a well-planned facility. One reason for this, in his mind, was that outside scientists, not NASA personnel at MSC, had been instrumental in developing the requirements for the facility. Experts from various organizations, including the USGS and other scientific groups, meant that the LRL's design was very well done. At the same time, Hess, as a scientist at MSC, was himself often at odds with managers who had an engineering background, and he felt that the atmosphere at MSC was not really conducive to science.[122]

Anthony Calio, Director of the Science and Applications Directorate at MSC, also observed that there was a lot of tension between the scientists and the engineers at MSC, a situation that he described as "apprehensive." The two sides did not really trust each other and sometimes felt that the other's concerns and requirements were unnecessary. Ultimately, Calio believed that Gilruth supported the Science Directorate, although when Christopher Kraft became Center Director he was "on the fence." Hess, who had been put in charge of the Science Directorate, was not really willing to compromise with the engineers. Ultimately, Hess chose to leave NASA, really not on good terms with the engineers at MSC.[123]

Hess also reflected the concern about back contamination planning that many other scientists felt. He was very concerned that the LRL perform a specific research function, and he felt that the back contamination issues had the potential to undermine the scientific goals of the facility. He recognized that during the initial phase of processing samples, safety had to be the highest priority and that biological testing on the lunar materials should be the main focus. Once the quarantine was lifted, however, he wanted to see the LRL revert back to a research facility between missions.[124]

Even within MSC there were struggles over what the primary purpose of the LRL was. Different factions argued about whether the most important goal was to protect against back contamination or whether it was to focus on lunar science. This struggle was personified by Charles Berry, who was the MSC official responsible for maintaining the quarantine program, and Wilmot (Bill) Hess, who was trying to develop more of a scientific focus for the Apollo Program. Observing this situation, Elbert King believed that in almost all cases Berry was successful in maintaining his viewpoint because he was usually backed up by Center Director Gilruth. Because Berry was one of the original people to have come to MSC from Langley, that gave him an advantage, whereas Hess was more of an outsider.[125]

James Dawson, one of the engineers who had the responsibility of putting together the vacuum system for the LRL and preparing it to handle all of the various duties that it would have to deal with during the sample processing phase, recognized that there were numerous difficulties associated with the facility. He observed the lack of significance that engineers placed on the threat of back contamination: "we felt, the engineering side of it, felt like we were just kind of spinning wheels, but it was a statutory requirement, so we had to meet the law, it's just that we thought we were wasting a lot of time." In the end, Dawson believed that the biggest challenge was not the technical issues or the scientific issues, but instead was the variety of people involved. It was not always easy for these different groups of people to see eye to eye. "We had all of these different disciplines, each one of them used to working in their own little area, … and yet they had to interface and had to really concede areas, space, time, money, to these other people, and everybody thought their experiment was the most important, of course." Solving engineering difficulties was never nearly as much of a challenge as dealing with all of the different personalities and egos.[126]

NASA Administrator James Webb recognized the difficult position of the Lunar Receiving Laboratory in a memorandum to Frank B. Smith, Assistant Director at Langley Research Center, on January 7, 1967. Webb believed that NASA should work with NAS to clearly define what the LRL's purpose would be for the future. On the one hand, Webb recognized that the laboratory must be careful not to compete with research on university campuses or to draw scientists away from other institutions. On the other hand, future space program needs might require a more developed facility than had originally been envisioned for the LRL. Webb believed that "future projects may require the establishment of what some scientists have called 'a home away from home' for those scientists most actively engaged in a specific program such as astronomy or lunar sample analysis."[127] In early 1967, the solution to this issue was not entirely clear, but eventually NASA chose to address it by creating the Lunar Science Institute (LSI). The LSI would function independently from NASA yet allow scientists more direct access to MSC and the LRL.

In an attempt to create a better environment for science at MSC in conjunction with the LRL, NASA helped to establish the LSI. A number of scientists would come to MSC during and immediately after each Apollo mission to participate in various aspects of the sample processing, whether as members of PET or LSAPT, or as PIs. In reality, MSC did not have the facilities in place to provide all of these scientists with office space and other resources they might need. To compensate for this lack, the LSI was established. Originally, the LSI was located in a large old home known as the West Mansion, located next to MSC. Eventually, a new facility housed the institute. Wilmot Hess hoped that the LSI would add to the "aura of science" at MSC and help to get rid of scientists' feelings that MSC was anti-science.[128]

NASA Administrator James Webb was concerned about the perception that NASA was not concerned with the science that could be accomplished through the Apollo Program, and he and other NASA personnel perceived that the LSI could be a way of reaching out to the scientific community. LSI's role was so important that President Lyndon Johnson made the official announcement of its creation while on a visit to MSC. Joseph V. Piland described the Institute as "a place where scientists will meet to exchange ideas and information on lunar science and is expected to enable the scientific community to become involved in the NASA programs without direct government supervision." NASA would not run the facility; instead, NAS was responsible for its management. This organizational approach would help to reassure scientists of the institute's validity and reduce concern within the scientific community that NASA was trying to encroach upon their domain.[129]

Some MSC personnel felt that some of the conflict between the Center and outside scientists was caused by elitism, not having the right degree from the right institution. This fact sometimes caused difficulty for MSC personnel who were trying to get the LRL implemented. Bob Piland experienced this as he oversaw the construction of the LRL. As Paul Purser explained it, "There was nothing wrong with … Piland at all except his lack of suitable credentials—he didn't have a union card." Geologist Elbert King faced the same problem at times—although he had a Ph.D., some outside scientists viewed him as inferior to the academic scientists because he worked for NASA. Purser believed that the interaction between outside scientists and MSC improved once the LSI was established. Although scientists had previously been given access to all of NASA's research, the proximity of the LSI to the LRL meant that it was more convenient for scientists to access that information and more convenient for MSC to disseminate their work. Even if concern about having the right degree was based on perceptions rather than fact, it had an effect on how these various groups interacted with each other.[130]

NASA Headquarters was also divided. The OMSF usually focused on technical aspects of transporting the astronauts safely to the Moon and back. On the one hand, outside scientists, as well as many scientists within NASA, sometimes felt that this office was not friendly to science and that its administrators did not feel that it was necessary to incorporate scientific goals into the program. On the other hand, the Office of Space Science and Applications pushed for more science to be incorporated into Apollo, but this office's personnel were sometimes divided between those more concerned about back contamination issues and those who were more concerned with lunar science.[131]

In a perfect world, everyone associated with NASA and specifically with the LRL would have had the same vision and would have had similar philosophies about how to approach their goals. The significant differences between scientists and engineers, as well as between different types of scientists, added to the complexities involved in preparing the LRL for the first mission. Management approaches and personalities contributed further to the challenges that the laboratory faced. Despite these issues, the facility was eventually certified for the first lunar mission, but only after a lengthy and stressful process.

The Certification Process

Although the building that would house the LRL was finally complete, there was still a long way to go before the facility would be ready to handle the first lunar mission. The LRL had to pass a lengthy certification process before the ICBC would find the safety precautions acceptable. The design of the LRL had to be very complex to meet ICBC standards. The facility operated within a double barrier system. The first barrier was the vacuum system, in which laboratory personnel first processed all lunar material, and the second barrier was the actual building. Modeled in part after the laboratory at Fort Dietrich, the LRL was a very sophisticated system. Technical requirements for such a facility were a significant challenge for everyone involved, but in the end the facility passed certification. In addition to keeping any harmful organisms from getting out, the system was also supposed to protect lunar samples from being affected by Earthly contaminants. These dual, somewhat contradictory, goals provided endless work for the people associated with the laboratory's construction and operation.

As an early step towards LRL certification, Robert Gilruth established an Operational Readiness Inspection Team in October 1968. He appointed John Hodge as the head of the team. Other MSC representatives included Peter J. Armitage, Aleck C. Bond, John W. Conlon, D. Owen Goons, Joseph Kerwin, Paul H. Vavra, and Earl B. Young. The team also had three other members: E. Barton Geer, from Langley Research Center; A. G. Wedum, from Fort Dietrich; and Donald U. Wise, from NASA Headquarters. Gilruth set the formal review of the laboratory for February 3, 1969. At that point, the LRL began a six-week practice session, operating the facility just as it would be run when the first mission returned to Earth. Unfortunately, when the practice session began, it quickly became apparent to everyone involved that the facility was not prepared to handle actual samples. It was at this point that Gilruth assigned Richard Johnston the task of getting the LRL operational. Johnston quickly went to work on the facility, creating formal procedures for operations and obtaining direct input from PIs to ensure that the facility would be up and running in time for Apollo 11. Ultimately, Johnston was successful in preparing the LRL for review, but not everyone appreciated the detailed procedures that Johnston required. Geologist Elbert A. King observed that "NASA managers like to see volumes and volumes of procedures for everything," and much time was spent creating enormous quantities of paperwork. Looking back, King felt that it was "one of the worst jobs associated with the LRL."[132]

Review of the LRL was just one part of the preparation for the first mission. NASA used readiness reviews as a way of certifying each component of the Apollo Program and making sure that everything was ready in time for the first lunar landing. Although both were under the authority of the ICBC, John D. Hodge observed that the review process for the LRL was significantly different than the review of the back contamination protocols in place for splashdown and recovery. While the "design of the system was very serious," because the crew was removed from the command module while still in the water, there was no way to absolutely protect from back contamination after splashdown. As a result, Hodge felt that "it was really kind of a game after that." The back contamination issues connected the LRL to the splashdown and recovery efforts and complicated an already complex design and certification process.[133]

Gilruth also established a second committee in May 1969 to make sure that the LRL was ready in time. Known as the Apollo Back Contamination Control Panel, this body focused specifically on back contamination and quarantine issues. Richard Johnston chaired the panel; other members included Walter W. Kemmerer, Jr., Persa R. Bell, R. Bryan Erb, Bennie C. Wooley, John C. Stonesifer, James H. Chappee, and Herbert L. Tash. This panel's job was to ensure that the LRL met the stringent requirements set by the ICBC.[134]

While members of the ICBC were satisfied overall with how the LRL was developing, they wanted much more stringent requirements for the retrieval of the astronauts and spacecraft after landing. In particular, the ICBC was concerned about the venting of the spacecraft once it reached the atmosphere. In addition, members wanted astronauts to remain within the sealed spacecraft until it had been retrieved from the ocean and isolated. MSC representatives, on the other hand, were more concerned about astronaut safety and adamantly believed the ICBC's recommendations about splashdown and recovery would be too risky for the astronauts. MSC proposed that astronauts be required to wear respirators and biological isolation garments when they were retrieved from the spacecraft. Then, once on board the recovery ship, they could be placed in a specially designed quarantine vehicle. The Center completed studies of the ICBC's recommendations "to show that we had given proper attention to the problem in the past," but at the same time MSC personnel remained focused on their own plans for biological containment.[135]

Even as the LRL was undergoing inspections and preparing for certification, NASA Headquarters still remained important to the planning process. On March 27, 1969, Apollo Program Director Sam C. Phillips sent a memo to Gilruth that discussed the Apollo Program Directive titled, "Responsibilities for Protection Against Lunar Sources of Back Contamination." This document originated at Headquarters, but Phillips requested that MSC provide feedback as well. The directive illustrates the complexities involved in the LRL. Many people within NASA bore some responsibility for back contamination issues, including the Apollo Mission Director, the Director of Space Medicine, and the Director of Apollo Lunar Exploration. MSC had numerous responsibilities but also had to coordinate efforts with other centers and government agencies. One important issue that reflected the importance of the time constraints was the requirement that MSC "submit the Integrated Quarantine Operations Plan 90 days prior to a lunar mission to the Apollo Program Director for approval and concurrence." At this stage, the LRL staff was not prepared to do this—potentially putting the entire mission into jeopardy. An additional report, issued one month prior to launch, had to be made after certification of the LRL was complete.[136]

As part of the planning for the first lunar mission, NASA had to create a procedure for quarantine release. The officials at MSC did not have any control over when the quarantine would end. Instead, they had to wait for word from the OMSF, located at NASA Headquarters. OMSF would only give MSC permission to release astronauts and lunar material from quarantine once it had received official word from the other regulatory agencies involved, namely the ICBC. All of the details for the quarantine operations had to be put into place at least ninety days before the launch of the mission. This plan required not only the descriptions of the specific roles of all of the groups and individuals involved but also "nominal and contingency procedures, facilities descriptions, and other information pertinent to this matter." As with other protocols developed for the LRL, the quarantine requirements involved complex advanced planning.[137]

LSAPT began meeting in 1967 and in the months leading up to the first lunar mission held a number of important meetings. The LRL management kept lines of communication with the committee open, trying to make sure that the concerns of LSAPT scientists were included in LRL planning and implementation. At a LSAPT meeting on February 23, 1968, LRL Manager P. R. Bell made a presentation on the development of the facility to that date. Giving a detailed explanation of the actual workings of the laboratory, focusing specifically on the vacuum system and handing out charts about the system's design, Bell stressed the complexity of getting the LRL up and running. He informed the group that, if they wanted to make any further design changes, they needed to let the laboratory management know within the following three months. After that point, "no changes will be possible unless failure to do so would seriously damage the program." LSAPT members determined that they should hold at least part of the next meeting, scheduled for March, in the LRL so that they could observe it firsthand and hopefully be able to recommend any final changes to the plan at that stage.[138]

This photograph shows the complex design of the LRL's vacuum system

The original vision of the LRL design included two different legs for the vacuum system, but only one leg had been built by early 1968. Bell believed that the second leg of the system was necessary so that, if there was a failure in the first leg, a backup system would be provided.

Although Bell argued passionately for the resources for the second leg, not all scientists believed it was necessary. Within LSAPT, there was important discussion of this issue. Bell argued "that if a mechanical failure were to occur [in the first leg] the samples would be seriously jeopardized by the measures necessary to effect repairs, and that such repairs would also result in serious delay of the preliminary examination." LSAPT members did not agree with Bell, and several of them felt that the amount of money necessary to make the second line operational could be better used in other areas of the laboratory. After some debate, the group decided that the second leg should only be built if a study was done that proved that it was necessary. In effect, this postponed a final decision on the issue until after Apollo 11 was completed. The debate over the second line of the vacuum chamber illustrated the fact that advisory boards had significant influence on the LRL's development, at times overriding management.[139]

One of the important LRL debates centered around how samples would be allocated for testing within the facility. The goal of scientists was to preserve as much lunar material as possible for future experiments. People associated with the back contamination component of the facility required enough sample to complete their testing, however. There was ongoing debate between the two sides about how much sample was actually needed for biological testing, resulting in a turf war of sorts within the LRL. As early as January 1967, this issue was already developing within NASA. On January 12, 1967, Leonard Reiffel of the Apollo Program Office at NASA Headquarters sent a memo to Dr. Charles A. Berry expressing his concerns. Reiffel demanded "to be kept informed of the action planned in this regard," as "there are some potentially serious inconsistencies" in the amount of material to be reserved for biological testing.[140] Certainly, the concern about the amount of sample to be used for back contamination testing did not go away as the LRL neared completion, and in fact the issue remained important even after the laboratory began processing samples from early missions.

There was significant concern about how to maintain science efforts and yet keep valuable lunar sample material if only a contingency sample was obtained from the first lunar mission. A number of contingency plans were in place in case the first Moon landing did not go as planned. Astronauts were trained to take a quick contingency sample as soon as they stepped on the lunar soil so that, if the mission was interrupted before the planned experiments and sample activities were complete, there would at least be one small sample. The problem with the contingency sample was that it was very small. It would be impossible to allocate samples for every PI's experiments, keeping in mind that some material had to be reserved for back contamination testing. LSAPT asked each PI to determine the minimum amount of sample that they would need, in case the astronauts were only successful in collecting the contingency sample. Some scientists were more cooperative than others. At the February 1968 meeting, LSAPT members raised concern that the bioscience PIs had not reduced their requests in any significant way. LSAPT determined that they would speak to each bioscience PI to determine whether it was possible to further reduce their sample requests in case of a contingency sample. In addition, LSAPT recognized that it was possible that some PIs would not receive any lunar material at all if there was only a small amount of sample returned. The group began to discuss how material would be allocated in that case and decided that they should warn all PIs of that possibility.[141]

By the summer of 1968, LSAPT's role within the LRL had developed further. LSAPT's members became involved in discussions about the design of tools for the LRL, as there was significant concern about tools made of the wrong materials actually contaminating the samples. Ultimately, LSAPT's approval was necessary for any LRL design changes. In addition, LSAPT would function as an intermediary between PIs and the LRL during the missions. In the meeting in June 1968, LSAPT members also defined their place within the public affairs arena, deciding that the team should be responsible for issuing a daily press release during the weeks following the return of each mission. This particular aspect was not one that necessarily fit NASA's interpretation of LSAPT's mission.[142]

Another issue that had to be dealt with was the relationship between the astronauts and the LRL. Although the ICBC and other committees had determined that a quarantine was necessary, the astronauts were not necessarily in agreement. The quarantine was going to directly affect them. After spending several days in space, they would then be required to return to Houston to the LRL and spend a total of twenty-one days in quarantine. Anthony Calio observed that the astronauts were unenthusiastic about the prospect of quarantine, although they ultimately submitted to the requirements.[143]

In order for all of the back contamination concerns to be fully addressed, the astronauts had to go through a significant amount of training. Dr. Charles Berry's office had to design a program of biological training for them that would meet the requirements of the ICBC. This training included such things as specific training in how to best collect lunar samples to avoid contamination, a detailed segment on the ICBC and its requirements, and training about the LRL and the quarantine procedures. All in all, the plan called for approximately twenty-two hours of biological training, which had to be fit into the astronauts' already hectic training schedule. Ultimately, the Director of Flight Crew Operations, Deke Slayton, had to work with Berry's representatives to create a more condensed training program that would still meet ICBC requirements.[144]

As NASA developed the protocols for quarantine testing, further differences between MSC personnel and scientists who advocated a strict quarantine policy became apparent. NASA had asked Baylor University scientists to develop the LRL quarantine protocols. As the scope of the scientists' recommendations became known, MSC staff members became more and more concerned. Aleck Bond observed that even Dr. Wolf Vishniac, one of the ICBC members, felt that Baylor's specifications were much more elaborate than what was needed for a basic quarantine. According to Bond, Vishniac recommended "only 'a few minimal tests,'" a stance that was much more in keeping with MSC's goals than Baylor's proposed protocols.[145] Very soon the protocol requirements, as well as the amount of lunar material that would be required to complete them, would come under fire from both NASA personnel and geological scientists. With only a limited amount of potential lunar sample available, the needs of various scientific interests had to be weighed against each other, along with NASA's desire to preserve a portion of the lunar material for future experiments. Scientists of various disciplines began to feel they were in competition with each other to obtain samples for their own work. This concern continued not only through the final stages of preparation but also throughout the years of the laboratory's operations, especially while quarantines were still in operation through Apollo 14.

Although back contamination concerns often dominated the certification process, the LRL also had to be prepared to process and distribute lunar samples to scientists around the world. Developing procedures to handle this issue also proved to be challenging in the months preceding the first mission. The laboratory had to handle the lunar material appropriately so that it would not potentially contaminate people. Laboratory staff also had to keep technicians from contaminating the samples. In addition, missions were scheduled just months apart, and it would be necessary to process all of the samples in a timely fashion so the facility would be ready to handle the next set of samples from the subsequent mission. This challenge once again illustrated key differences between the way in which scientists and engineers approached problem-solving within the LRL. "The engineers wanted things structured and rigid and proceduralized, and the scientists wanted to just sort of free float." Bryan Erb, Assistant Chief of the Lunar Science Division, observed that these differences in approach led to some conflict between him and P. R. Bell.[146]

As development of quarantine procedures continued into 1968, the differences between those people concerned about back contamination issues and those concerned with preparing lunar samples for PIs became more and more apparent. This phenomenon had emerged within MSC personnel ranks as well. Dr. Charles A. Berry, Director of Medical Research and Operations and the key NASA link to the ICBC, illustrated this conflict in a memorandum dated January 3, 1968. Dr. Elbert King, an MSC geologist, had prepared a response to the minutes of a recent ICBC meeting. Berry felt that King did not have the right to issue any type of response to the minutes that might be interpreted as an official MSC or NASA response. He strongly stated that he believed that "if any Center comments on the minutes are necessary, they should be prepared by the people most responsible for the quarantine operations." Berry went further to state that the only person who had the right to speak for MSC on this issue was his own appointed representative, Dr. Kemmerer.[147]

Berry also provided a perspective on potential areas for agreement and conflict between MSC and the ICBC on the quarantine issue. When it came to the rigors of the actual quarantine procedures, Berry was mostly in agreement with the ICBC and its chairman, Dr. Sencer. Sencer felt that "part of the members of the total LRL staff [tended] to view the quarantine as an imposed operation to be done the easiest way possible while hoping that it will go away." Like Sencer, Berry believed that quarantine must be approached enthusiastically and with full commitment, but he also felt that not all MSC personnel had made the same determination.[148]

As certification became a more and more important issue, a number of prominent scientists provided suggestions for how the system could be proven. One potential plan was to use an actual live organism to check for leaks in the system. This proposal caused concern and, at times, even outrage among NASA personnel. Robert Gilruth challenged the validity of using pathogenic organisms to test the system, stating that "the use of high-hazard disease agents to satisfy the facility certification requirements is of major concern to me." Dr. Charles Berry was even more adamant in his rejection of the proposal, arguing that "The regulatory agencies [sic] requirement for the use of pathogenic organisms for containment certification is questioned on both scientific and ethical grounds." In the end, no live pathogens were used to certify the laboratory. The issue reflected the reality that just one person could cause debate and complicate the certification process.[149]

Differences between NASA Headquarters and MSC became more apparent as the LRL neared completion as well. Headquarters personnel expressed their desire for input into the process on numerous occasions. John E. Naugle, then Associate Administrator for Space Science and Applications, expressed his view on the subject in a memorandum to the MSC Director on January 25, 1968. Naugle stated that he believed that OSSA, as well as relevant committees and subcommittees, should have final approval of any appointments to the LSAPT or the PET. In addition, Naugle directed Gilruth to schedule a review of the LRL facility as soon as possible, suggesting that the following month would be an appropriate time.[150]

Lee R. Scherer, the Director of the Apollo Lunar Program Office, echoed Naugle's views on MSC's accountability to NASA Headquarters, informing Dr. Wilmot Hess that any additional experiments suggested by PIs, LSAPT, or PET had to be approved by the Associate Administrator for Space Science and Applications. At the same time, both Scherer and Naugle expressed their sympathy with the challenges that MSC faced. Scherer expressed that "we recognize the magnitude of the problem in preparing the LRL for the Apollo missions and are ready to work closely with you in completing these tasks." Some people associated with the LRL at MSC questioned the sincerity of such statements, believing that Headquarters wanted to take too much control of the laboratory.[151]

The Agency's budget concerns had a significant effect on MSC and the LRL in 1967 and 1968 as well. By the late 1960s, Congress had decreased NASA's appropriations significantly. NASA programs had to compete with the war in Vietnam and domestic programs for funding, and the Apollo Program did not always fare well in that competition. The result was that by October 1967 there was a hiring freeze in effect, and Agency managers ordered that expenses such as overtime and travel be drastically reduced. The urgency for completing construction and certification of the LRL was in direct contrast to NASA's need to conserve financial resources.[152]

NASA's decision to contract out much of the workforce led to its own challenges as well. The Agency hired Brown and Root-Northrup as the support contractor for the laboratory. Contracting someone else to provide basic personnel for the facility did not absolve NASA of responsibility, however. Every Brown and Root-Northrup employee who would be working in the LRL had to go through an extensive training and certification process. Until that process was complete, each technician was not allowed to work in the facility. To determine whether or not employees were prepared to work in the laboratory, NASA established that "a formally constituted certification board will conduct both task demonstration and oral (technical knowledge) examinations which must be passed according to established criteria." Technicians were required to carry proof of certification and would have to go through the certification process each year to remain in the facility.[153]

To receive permission to go behind the barrier once the quarantine period had begun for each mission, every person had to receive a medical clearance. In some cases, that provision meant that the person could only work in the LRL between missions, and once the lunar samples and astronauts returned to the laboratory, those without medical clearance were excluded from the facility until the quarantine was lifted. In a few limited cases, officials provided a waiver for someone who otherwise would have been excluded on medical grounds. In one instance, Dr. R. L. Smith, a scientist involved in preliminary sample activities, received a waiver signed by Dr.

Charles Berry. Although Smith would be allowed into the LRL during the quarantine phase, he "was to be escorted at all times behind the barrier" and was only to remain in the LRL for short periods of time. This waiver was granted only after Elbert King and Wilmot Hess insisted that Smith could not be replaced. Others were not granted waivers and had to watch the excitement of the missions from outside the barrier.[154]

This photograph shows a technician working with plants in the LRL. This part of the laboratory was home to the back contamination testing.

As the first mission loomed closer, it was becoming apparent to those involved in the preparation of the LRL that more experts were needed to help the laboratory function. Although they had some very sophisticated equipment and had contracted with Brown and Root Northrup to supply technicians for the facility, more outside help was needed. People like Ross Taylor were hired in the last few months before Apollo 11 to help get the lab operational. Taylor remembered these months as a very hectic time. Brought into the chemical laboratory in early June 1969, Taylor and other laboratory workers rushed to make sure they were prepared for the first samples. LRL personnel worked extremely long hours in the months preceding the first mission. The scientific community followed the LRL's process closely and made numerous suggestions about staffing and modifications in the months before Apollo 11. The scientists were concerned that precious lunar samples would be properly handled to preserve their scientific value.[155]

By November 1968, laboratory personnel were conducting simulations within the LRL. These simulations, while useful in working out problems associated with equipment and protocols, also illustrated the amount of work still necessary to have the facility operational in time for the first lunar mission. At a meeting of the Science and Applications Directorate staff on November 4, 1968, the topic of a Lunar Sample Preliminary Examination Team simulation was raised. In the final analysis, personnel declared that "clearly, there is a fair amount of work still required to bring the systems on line," but at the same time "this simulation was considered a major step in that direction."[156]

The LRL was scheduled to undergo the Lunar Receiving Laboratory Operational Readiness Inspection starting on November 18, 1968. Laboratory personnel were scrambling to be ready for the inspection. Each component of the facility had to describe its equipment and procedures to the investigating team. Only a few days before the inspection was scheduled to commence, personnel were still working on creating their presentations and making modifications in procedures that the Preliminary Examination Team had suggested.[157]

By November 25, 1968, there were some changes taking place within the laboratory management that reflected the new sense of urgency as well. Bryan Erb, who was Assistant Chief of the Structures and Mechanics Division in the Engineering and Development Directorate, was appointed Assistant Chief of the Lunar and Earth Sciences Division. In this position, Erb provided support for Dr. P. R. Bell. The LRL issues had become complex enough that Bell was concentrating much of his energy on getting it ready. In the meantime, his work as Chief of Lunar and Earth Sciences was sometimes neglected. Erb took some of the burden off of Bell so that Bell could concentrate on getting the laboratory operational.[158] Erb often found himself in a position where he had to provide the link between P. R. Bell and the rest of the LRL staff. Bell was an expert in the field of vacuum technology, but he did not always interact well with other people. His singular focus on the task at hand, along with extremely limited vision, meant that he paid little attention to the people around him. Erb had to serve as "the interpreter and buffer between P. R. and the rest of the world." Erb observed firsthand the challenges associated with LRL management and the interactions, sometimes stressful, among managers, scientists, and engineers.[159]

In early 1969, laboratory personnel began a full-scale simulation of laboratory operations, scheduled to last forty-five days. This simulation was the most complex test of the facility to date. Exercises in the physical chemistry and geology areas were to take thirty days, as that was where the complex vacuum system was located. All simulated lunar materials would go through the vacuum chamber before being dispersed to other parts of the laboratory. The remainder of the tests involved the biological component of the facility, where technicians were scheduled to run back contamination experiments. Although the simulation proceeded better than previous exercises had, there were still a number of significant problems. One important concern was that the glove system, which allowed technicians to access samples in the vacuum line, was still experiencing problems. The gloves kept developing holes that could lead to back contamination if the lunar samples were dangerous or potential Earthly contamination of the samples themselves. In the middle of the simulation, managers decided to take a three-day break to allow various elements of the laboratory to make modifications to their plans. After the three days were over, exercises resumed. The full-scale simulation was successful on a number of levels, but the results still raised concern that the LRL would not be ready in time for Apollo 11.[160]

By April 1969, LRL arrangements had reached a state of urgency. Everyone involved recognized the importance of getting the laboratory certified prior to the first lunar mission. As a result, the LRL went through a complete review process on April 17 and 18, 1969. Headquarters representatives participated in the review process, which thoroughly inspected all aspects of the facility, its equipment, personnel, and protocols. Although completion of the review did not certify the LRL, it provided insight into potential problem areas that needed to be dealt with before the certification process began.[161]

In June and early July 1969, preparations within the LRL were reaching their peak. The laboratory completed yet another simulation on June 16, 1969, that was overall successful. Still, there were a number of small modifications that had to be made before the first mission. In its Weekly Activity Report for June 23-30, 1969, the Science and Applications Directorate reported that "All available effort is being directed toward final preparation of the Lunar Receiving Laboratory for Apollo 11." Laboratory personnel were approaching their work with enthusiasm, with "sixty to seventy-hour work weeks [becoming] the rule rather than the exception." Despite the hard work, laboratory personnel were enthusiastic about their jobs and looked forward to the first mission. No one seemed to resent the long hours they worked. Academic scientists who would be involved in various aspects of the laboratory's operations during the first mission, such as PET or LSAPT, were also arriving in the weeks preceding Apollo 11 so that they would be prepared for sample return. The LRL was scheduled to go into readiness mode on July 14.[162]

Summary of LRL Operations During the Apollo Missions

Once certification was complete, it was time for the first lunar mission, Apollo 11. Although not everything within the LRL ran smoothly in the early missions, most of those people involved in the facility felt that it was overall a success. As Bryan Erb stated, "I believe it was a reasonable rigorous quarantine and an effective demonstration that there were no effects of the lunar material that showed up quickly." There were a few breaks within the biological barrier in the early missions that led to a few staff members going into the quarantine with the astronauts, but all in all there were no serious problems. While lab managers had thought out extreme solutions in case there had been any serious danger from the lunar material, the "doomsday" predictions proved not to be accurate and any dramatic action, such as burying the laboratory under a mountain of dirt and sacrificing the lives of those still inside, ended up not being necessary.[163]

The first lunar samples arriving at the LRL after Apollo 11

Overall, considering the complexity of the LRL and the limited amount of time in which it had to be built and implemented, it functioned extremely well. It was among the best laboratories of its type in the world during the Apollo era. In some respects, its personnel were given the impossible task of creating a perfect system for the processing of lunar materials and the enforcement of the quarantine. The LRL was not able to meet that goal of perfection. Throughout the years that the laboratory functioned, there were continual challenges to be met, including the efficacy of the vacuum system and the potential contamination of lunar samples. In the early years, there was a limited amount of time to deal with these challenges, not only as the LRL was being built and going through the certification process but also during the minimal lag time between the early missions. Laboratory personnel worked long hours, often ten to twelve hours a day, six and seven days a week, to meet deadlines and to make sure that the LRL was prepared for each mission. Once the quarantine requirements were lifted after the Apollo 14 mission, some of the difficulties were reduced, but both contractors and NASA employees worked hard to ensure that the lunar samples would be processed in the best possible environment. Until the quarantine standards were changed, however, the laboratory employees lived with the potential of being placed in quarantine if biological barriers were somehow compromised and it was determined that contamination had occurred. Because many of these workers had families, that threat was certainly a real concern, but the potential of quarantine did not stop them from doing their jobs. The vast majority of laboratory employees felt immense pride in their work.[164]

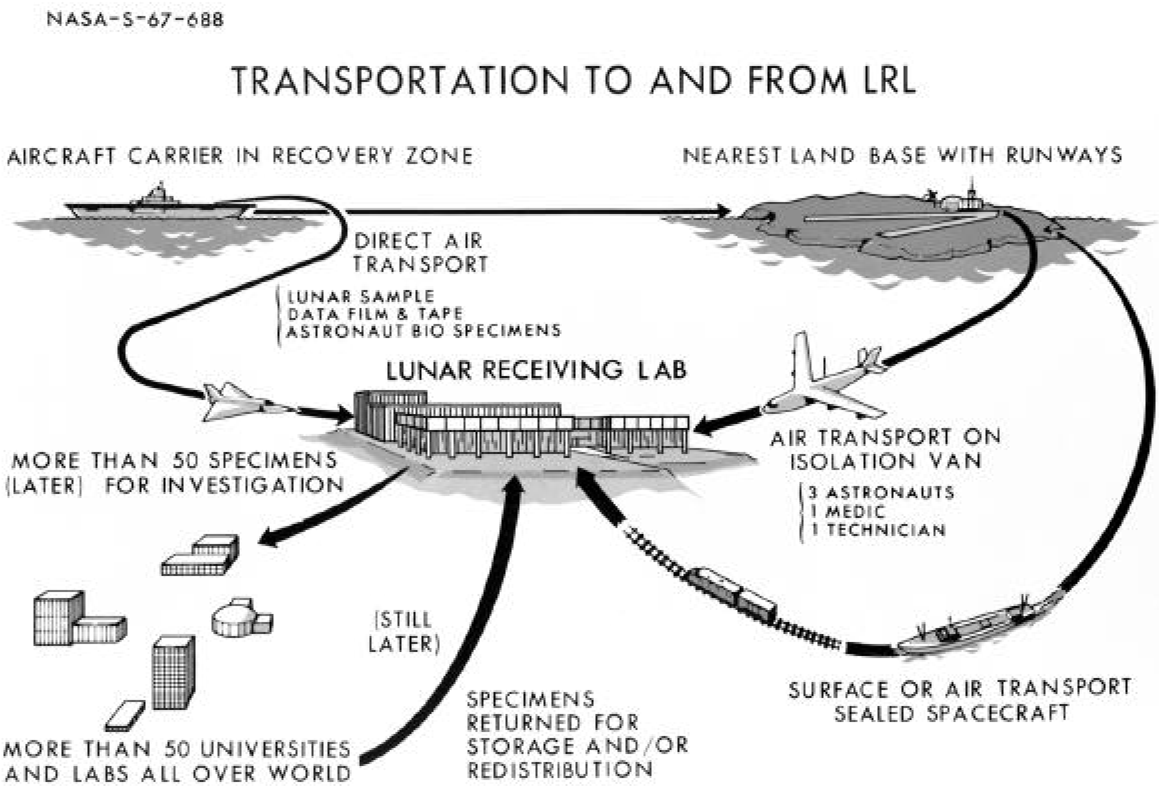
Experiences for those associated with the LRL varied significantly, depending on what part of the laboratory they worked in and what their position was. Overall, within the biological area of the LRL, technicians seemed to be somewhat isolated from potential conflict. They recognized a certain amount of competition with the geology component of the laboratory but overall focused on their own experiments. There was a little defensiveness at times about their importance. The biological component of the laboratory existed to meet the concerns of the ICBC. Technicians used lunar material in tests of plants and animals to determine that there would be no harmful effects from lunar life forms. Because many scientists, including most of the geologists, did not feel there was a real threat of back contamination from the Moon, there was some resentment that precious lunar materials were being spent on the biological testing. For the most part, the technicians were insulated from this concern by the fact that they were contractors. Their management interfaced with the rest of the laboratory and NASA, leaving the technicians to do their jobs. The most stressful time for the biology area came with the rush for certification prior to Apollo 11, and then it was possible to settle down to a routine. Even once the quarantine requirements were lifted, biological testing was still completed on the remaining Apollo missions. At no point were any potential biological threats found in the lunar samples, although lunar material did seem to stimulate positive growth in one of the plant studies.[165]

The geological component of the laboratory faced more significant challenges over time. In addition to the issues related to certification, which were certainly significant, geologists had other responsibilities throughout the duration of the Apollo Program and had to deal with a number of pressures. As with the biological area of the laboratory, the geological component also used contracted technicians. At the same time, there were also scientists both from within NASA and from the larger academic community who sought to oversee the operations of the LRL. These scientists made sure that the samples would be processed in such a way as to make possible the types of scientific undertakings that they wanted to accomplish. Both the Preliminary Examination Team and the LSAPT were influential in how the geological area of the LRL functioned. Scientists wanted to make sure that the lunar samples were treated as a precious, limited resource that would be handled with great care. They were often concerned that the strict containment requirements imposed by the ICBC might interfere with their ability to use the samples as scientific resources. At the same time, these scientists did not always agree with each other about the best way to handle the lunar samples. Some scientists tried to protect their own interests, concerned about their potential experiments that would use lunar material. Others were concerned with preserving as much of the lunar samples as possible so that future generations of scientists would also have the opportunity to study them. All of these people, however, viewed the lunar samples as a valuable resource that had to be carefully guarded and processed in such a way that the greatest knowledge would be gained by all. The relationship that developed between NASA and the academic scientific community grew over time as a result of their interactions in the LRL, but it also reflected some of the frustrations of both sides.[166]

The third component of the LRL was the quarantine facility where astronauts were housed after returning from the Moon. In many ways, the quarantine area acted independently from the other parts of the laboratory. Beyond monitoring the health of the astronauts and taking in any LRL personnel who might become contaminated during the quarantine period, many of the concerns of the other parts of the laboratory did not make their way into this area. There were no elaborate cabinet lines or vacuum chambers and protocols were much simpler. The fact that this component of the LRL was so dramatically different from the rest illustrates the difficulties involved in the management of the LRL.[167]

In many respects, the greatest challenges associated with the LRL were management issues. In the end, the management was accountable for the operation of the laboratory and would be held responsible for any problems that might develop. As soon as construction of the LRL began in 1966, managers balanced the demands of staying under budget, making sure that the laboratory would meet certification standards, and dealing with the changing requirements of scientists who were helping to design the internal aspects of the LRL. The closer that NASA came to the target date for the first Moon landing, the more stress there was within the LRL office to have it ready in time to process lunar samples. Managers also had to balance the demands of a number of very different groups—the ICBC and government agencies concerned with the threat of back contamination, geologists and other scientists eager to learn about the Moon, and engineers and others within NASA who were most concerned with completing the first Moon landing and safely returning the astronauts to Earth. Although the quarantine concerns became less of an issue over time, there was a growing realization that NASA had to come up with a long-term plan for curation of the lunar samples, and the LRL became closely associated with that effort as well.

Even after Apollo 11, the LRL continued to face significant challenges. There was friction among the various groups involved in the laboratory's operations. Biologists and geologists had competing objectives. Scientists who participated in lab activities as part of the Preliminary Examination Team were not always in full accord with the advisory body that determined which scientists received lunar samples, the LSAPT. There was also tension between the administrators of the LRL and those who worked inside the facility. Quarantine restrictions made the scientific objectives of the laboratory difficult to achieve at times.



This drawing illustrates the complex process of transporting lunar samples fromthe recovery zone to the LRL and eventually to the PIs for research

Conclusion

The history of the LRL reflects both the strengths and the weaknesses of the U.S. space program and NASA during the Apollo years. The LRL brought together scientists, engineers, and administrators to construct and operate one of the most complex laboratories in American history. Some of the most prominent biological and geological scientists from the United States and around the world became associated with the facility at some point during the lunar program. Ultimately, the LRL processed lunar materials from six Apollo missions, making samples available to a number of researchers and proving that the Moon was not harmful to Earth. Contrary to early fears, there were no “lunar bugs,” and dust from the Moon did not spontaneously combust.

At the same time, the years proceeding the first Moon landing illustrated some of NASA’s weaknesses. NASA administrators and engineers had focused almost entirely on the technical challenges of safely sending astronauts to the Moon and returning them to Earth in the earliest years of the Apollo Program. This approach had led to a certain amount of tunnel vision within the Agency and meant that NASA had not immediately recognized or put emphasis on the scientific benefits of the program. The emphasis on engineering, with little attention paid to science, meant that scientists’ concerns about back contamination and the need for an LRL did not receive the Agency’s attention at first. The remaining years before Apollo 11 became a scramble to make sure that the laboratory could be ready in time, and delays could have potentially delayed or even permanently halted the lunar program. The belief of many scientists that NASA did not take science seriously meant that the two sides did not always work together harmoniously to achieve their common goals.

The debates over the design and construction of the LRL also reflected territorialism on the part of MSC employees, NASA, other government agencies, and the scientific community. Each group felt that its own approach to the facility was the best, and they only reluctantly listened to what the others had to say. NASA valued initiative on the part of its employees in the 1960s, but because MSC personnel originally began working on the design for the laboratory on their own and did not immediately reach out to other groups outside of the Center who would have an interest, occasional conflict and differences of opinion developed. Scientists often placed heavy demands upon NASA without attempting to understand the constraints placed upon a government agency. Each side was attempting to protect its own interests, and the result was rarely the creation of an efficient plan.

Because scientists proved that lunar material was not harmful to Earth or human society, some people might argue that the LRL was unnecessary. Even if one puts aside the scientific work that laboratory workers completed during the missions, making samples available for researchers and beginning a lunar sample curation program, NASA had no choice but to take the back contamination issue seriously. Scientists knew too little about the Moon and the vast universe beyond Earth during the 1960s to risk potentially destroying the world as they knew it. Even today, as the United States and other countries plan to collect samples from planets and other extraterrestrial bodies far beyond the Earth, there is a need to learn the lessons of the LRL and be prepared to both protect the Earth from unknown threats and safeguard the scientific value of future samples.

Endnotes

[1] For complete text of speech, see John F. Kennedy, "Special Message to the Congress on Urgent National Needs," May 25, 1961, John F. Kennedy Library and Museum Web site: http://www.cs.umb.edu/jfklibrary/j052561.htm (accessed August 6, 2003).

[2] Studies of the LRL include Kent Carter, "Moon Rocks and Moon Germs: A History of NASA's Lunar Receiving Laboratory," in *Prologue: Quarterly of the National Archives and Records Administration* 33 (Winter 2001): 234-250; James C. McLane, Jr., *et al*., "Lunar Receiving Laboratory," in *Science* 155 (February 3, 1967): 525-529; W. David Compton, *Where No Man Has Gone Before: A History of Apollo Lunar Exploration Missions* (Washington, DC: NASA, 1989); John O. Annexstad, "The Lunar Receiving Laboratory: A Management Study," in Lunar Curatorial Facility Data Center, Johnson Space Center (hence LCF).

[3] Carter, "Moon Rocks and Moon Germs," 236.

[4] Space Science Board, NAS, "Conference on Potential Hazards of Back Contamination from the Planets, July 29-30, 1964 (advanced copy)," box 076-11, LRL Chronological files, University of Houston-Clear Lake Johnson Space Center Collection (hence UHCL).

[5] Aleck Bond interview, October 10, 1967, 16-17, Merrifield interviews, UHCL.

[6] Bert King, *Moon Trip: A Personal Account of the Apollo Program and Its Science* (Houston: University of Houston, 1989), 18.

[7] Ibid., 18-19.

[8] Ibid., 60.

[9] Elbert A. King, Jr., interview, May 27, 1971 (interviewed by Loyd Swenson, Jr.), 1-2, Oral History collection, UHCL; King, *Moon Trip*, 20; John M. Eggleston interview, March 14, 1968, 12, Merrifield interviews, UHCL.

[10] Eggleston interview, March 14, 1968, 13-14.

[11] "History of the LRL: Development of Scientific Criteria and the Role of Scientific Advisory Committees," c. 1968, 1, in LCF.

[12] Aleck C. Bond to Chief, Office of Technical Information and Engineering Services, "Sample Transfer Facility," April 14, 1964, box 076-11, LRL Chronological files, UHCL.

[13] Ibid.

[14] E.A. King and D.A. Flory to Assistant Director for Engineering and Development, "Requirements for a facility to receive and accomplish initial lunar sample investigation at MSC," July 7, 1964, box 076-11, LRL Chronological files, UHCL.

[15] Bond interview, Oct. 10, 1967, 18.

[16] Conference on Potential Hazards of Back Contamination, 4, 8-11, 14-15.

[17] King, *Moon Trip*, 61-63.

[18] Willis B. Foster to Director of MSC, "Requirement for laboratory facilities for receiving, unpacking and preliminary examination of lunar samples," August 17, 1964, box 076-11, LRL Chronological files, UHCL.

[19] Maxime A. Faget to Willis B. Foster, "Apollo Sample Handling Facility," August 26, 1964, box 076-11, LRL Chronological files, UHCL.

[20] Edward M. Davin to Maxime A. Faget by way of Director, MSC, "Lunar Sample Receiving Laboratory," September 11, 1964, box 076-11, LRL Chronological files, UHCL; James C. McLane, Jr., to Manager, Systems Tests and Evaluation, "Lunar Sample Receiving Laboratory," November 13, 1964, box 076-11, LRL Chronological files, UHCL; J.G. Griffith, "Lunar Sample Facility," memo for record, October 9, 1964, Funding 1964 files, Bryan Erb personal collection.

[21] Eggleston interview, March 14, 1968, 14; James C. McLane, Jr., interview, November 13, 2000, Oral History Collection, UHCL.

[22] Eggleston interview, March 14, 1968, 14.

[23] James C. McLane, Jr., to Chief, Facilities Division, "FY 67 C of F Program," January 20, 1965, box 076-11, LRL Chronological files, UHCL; John M. Eggleston to Calvin Perrine, W.G. McMullin, Hugh M. Scott, Harold Lambert, Richard McComb, Jerry Goodman, Dick Mayo, Jim McLane, Gordon Griffith, and E.A. King, "MSC Requirements for Apollo Operational Lunar Sample Measurement," December 29, 1964, box 076-11, LRL Chronological files, UHCL.

[24] James C. McLane, Jr., to Manager, Systems Tests and Evaluation, "Lunar Sample Receiving Laboratory," November 13, 1964, box 076-11, LRL Chronological files, UHCL.

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13. ABSTRACT *(Maximum 200 words)*

As early as 1959, the Working Group on Lunar Exploration within NASA advocated that "one of the prime objectives of the first lunar landing mission should be the collection of samples for return to Earth, where they could be subjected to detailed study and analysis." Within NASA, neither this group nor any other scientists working with the Agency were concerned about back contamination issues. Outside of NASA, back contamination concerns had been raised as early as 1960. Although NASA did not seem to pay any attention to the concerns at that time, the scientific community continued to be interested in the topic. In 1962 and again in 1963, as the Apollo Program loomed large, further discussions were held. These early discussions of back contamination did not make their way into NASA's administration, however, and when Manned Spacecraft Center personnel began to articulate early concepts for the Lunar Receiving Laboratory (LRL), the back contamination issue was not considered. Once this concern became a major focus, however, the LRL's development became increasingly complex. This is the history of that development.

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