Historic Furnishings Report and Visitor Experience Plan

Apollo Mission Control Center National Historic Landmark

Lyndon B. Johnson Space Center, Building 30
Houston, Texas

June 2015
TABLE OF CONTENTS

Introduction and Acknowledgements ……3

Summary of Findings……………..5

Historic Furnishings Plan …………………8
   A. Context and Objectives
   B. Significance Statement
   C. Period of Significance
   D. Treatment Approach for the NHL
   E. Standards for Restoration
   F. General Recommendations for Restoration in the NHL

Room Configurations and Furnishings: Historic Use and Recommended Changes……14
   A. Mission Operations Control Room in the Apollo Era
   B. Mission Operations Control Room: Post-Apollo Era Changes
   C. Recommended Treatment for the Mission Operations Control Room: Restoration
   D. Detailed Guidelines for Flight Controller Positions and Console Configurations
   E. Recommendations for Restoration of Additional Furnishings in the Control Room
   F. Visitors Viewing Area in the Apollo Era
   G. Visitors Viewing Area: Post-Apollo Era Changes
   H. Recommended Treatment for the Visitors Viewing Area: Restoration
   I. Detailed Guidelines for Visitors Viewing Area Furnishings and Configuration
   J. Summary Display Projection Room (“Bat Cave”) in the Apollo Era
   K. Summary Display Projection Room: Post-Apollo Era
   L. Recommended Treatment for the Summary Display Projection Room: Restoration
   M. Detailed Guidelines for Summary Display Projection Room Furnishings
   N. Staff Support Rooms
   O. Simulation Control Room in the Apollo and Post-Apollo Eras
   P. Recommended Treatment for the Simulation Control Room: Restoration
   Q. Detailed Guidelines for Simulation Control Room Furnishings
   R. Recovery Control Room in the Apollo and Post-Apollo Eras
   S. Recommended Treatment for the Recovery Control Room: Restoration
   T. Floor Plans

List of Recommended Furnishings…………..102

Administrative History……………..123
   A. National Historic Landmark Management Summary
   B. Prior Planning Documents and Documentation Reports

Historical Information and Detailed Evidence of Room Use………129
A. History of the Structure
B. Analysis of Historical Occupancy

Historic Furnishings Plan Sources and Bibliography……………. 142

Historic Furnishings Plan Appendices………147
  Appendix A: Control Room Assignments for Gemini, Apollo, and Shuttle Missions
  Appendix B: Historic Furnishings at Johnson Space Center Storage and Other Sites
  Appendix C: List of Acronyms

Visitor Experience Plan……………153

Workshop Participants……………163
Introduction and Acknowledgments

“*Apollo Mission Control should be restored to a degree of accuracy that will feel to visitors like the day we walked out.*”

—Ed Fendell, Apollo Mission flight controller (retired), 2014

On August 25 and 26, 2014, a group of Johnson Space Center (JSC) employees and National Park Service (NPS) and Colorado State University staff and consultants gathered in the JSC’s Building 20. In this modern “green” building, one of the NASA site’s newest structures, they held a workshop on the preservation and visitor experience of the Apollo Mission Control Center National Historic Landmark (NHL) in Building 30, one of the center’s oldest and most iconic structures. The workshop participants were Jeannie Aquino, Marilyn Blevins, Dennis Hehir, Elizabeth LeBlanc, Charles Noel, William Owen, Jennifer Ross-Nazzal, Sandra Tetley, and Rebecca Wright of NASA; retired NASA flight controller Ed Fendell; Greg Kendrick and Christine Whitacre of the NPS; Maren Bzdek of the Public Lands History Center at Colorado State University; and visitor experience specialist/planner Kim Sikoryak. The group contributed two days of ideas and energy to consider the future needs of this nationally significant historic site. This document provides restoration and visitor experience recommendations that grew out of that workshop.

The workshop was conducted as part of an Interagency Agreement between the National Aeronautics and Space Administration (NASA) and NPS to prepare a Historic Furnishings Report and Visitor Experience Plan for the Apollo Mission Control Center NHL. The Historic Furnishings Report documents the Apollo-era appearance of the Mission Control Center including the historic spaces, objects, furniture, wall and floor coverings, light fixtures, window treatments, clothing, books, documentation used at the computer consoles, as well as the personal and utilitarian objects used by flight controllers. Once restored, these interior spaces can evoke powerful emotional and intellectual responses from visitors who can sense that “history happened here.” This report will serve as a key planning tool in the proposed restoration of the Apollo Mission Control Center NHL. The Visitor Experience Plan provides recommendations for future visitor service operations, including what important stories should be told and how best to tell them.

The Historic Furnishings Report and Visitor Experience Plan were completed through a Cooperative Ecosystems Studies Unit (CESU) task agreement between NPS and Colorado State University. The Historic Furnishings Report was prepared by Maren Bzdek, Program Manager of the Public Lands History Center of Colorado State University, under the direction of Dr. Janet Ore. The Visitor Experience Plan was prepared by Kim Sikoryak, retired NPS visitor experience specialist/planner. Key officials on the project were Sandra Tetley of NASA and Greg Kendrick and Christine Whitacre of NPS, Intermountain Region.

Several individuals provided assistance and guidance that allowed Maren Bzdek to make the most of her limited time in the relevant archival repositories. At JSC, Sandra Tetley, Jennifer Ross-Nazzal, and Jim Brazda supplied critical documents, photographs, and other records that
allowed Bzdek to jumpstart the research process and quickly grasp a general understanding of
the agency’s internal procedures, policies, and facilities. At the University of Houston-Clear
Lake Archives, Jean Grant and Lauren Meyers facilitated access to the JSC History Collection.
Rebecca Russell at Rice University’s Woodson Research Center scanned useful documents from
the Jack McCaine NASA Papers Collection. As Bzdek rounded out the primary research effort,
staff at the National Archives at Fort Worth oversaw efficient access to key portions of Record
Group 255, an enormous, 765-cubic-foot collection from the Lyndon B. Johnson Space Center.

The Historic Furnishing Report and Visitor Experience Plan focus on five distinct, interrelated
areas that comprise the Apollo Mission Control Center. In the center is the iconic Mission
Operations Control Room, often referred to as the “MOCR,” with the consoles used by the
various flight controllers. At the front of the room are large group display screens; behind these
screens is the Summary Display Projection Room, sometimes referred to as the “Bat Cave.”
Here maps and images were projected onto the screens, many with illuminated, electro-
mechanical plotter overlays. Adjacent to the Mission Operations Control Room are two key
support rooms: the Simulation Control Room, often referred to as the “Sim Room,” where staff
conducted simulations to prepare for flight missions, and the Recovery Control Room, where
staff and U.S. Navy officials coordinated recovery efforts after splash down. At the back of the
Mission Operations Control Room (behind the mission controllers) is a wall with large windows
that separate the MOCR from the Visitors Viewing Area, where dignitaries, guests and the press
could observe the activities of the mission controllers without causing disturbances or
disruptions.
Summary of Findings

For almost twenty years, Johnson Space Center (JSC) has held a vision for a fully restored, historically accurate Apollo Mission Control Center that conveys the scientific, political, and technological achievements of this nationally significant site and engages a new generation of NASA visitors and supporters. When taken collectively, the Historic Furnishings Report and Visitor Experience Plan provide a comprehensive and detailed set of recommendations to help achieve this vision. The Historic Furnishings Report and Visitor Experience Plan recommend accurate restoration and interpretation of the Apollo Mission Operations Control Room, Visitors Viewing Area, Summary Display Projection Room, Simulation Control Room, and Recovery Control Room to reflect the later Apollo Missions, which successfully landed on the moon and explored the lunar surface.

Historic Furnishing Report: Summary of Findings

In 1996, JSC developed an extensive restoration plan for the third-floor Mission Operations Control Room to preserve and interpret the historic Apollo era. While much of that plan was never executed, the original Apollo-era console cabinets were returned to the room and some of the Apollo-era components reinstalled. Since that time, the MOCR and Visitor’s Viewing Area have experienced heavy visitation, resulting in serious deterioration of the historic fabric and furnishings. Almost all of the historic objects and documents, such as headsets, ash trays, flight manuals, and maps, which reflected the day-to-day use of the MOCR, have been removed or lost. Today, the overall condition of the rooms is poor and conveys a feeling of neglect.

The primary goal of the Historic Furnishings Report is to provide detailed information to guide the accurate restoration of the MOCR, Visitors Viewing Area, Summary Display Projection Room, Simulation Control Room, and Recovery Control Room so that visitors will experience this historic space as if the Apollo Mission flight controllers had just left the room. The report also supports the preservation of these irreplaceable historic resources in their original location as a permanent physical record of the globally significant events that took place in these rooms during the Apollo era of the late 1960s and early 1970s. The major recommendations of the Historic Furnishings Report include:

- Restoration of all consoles to the Apollo era, specifically missions 11 through Apollo 17—representing the apex of technological achievement of the Apollo Missions. Currently, many of the flight controller consoles contain a combination of Apollo-era and Shuttle-era components.
- Acquisition and installation of appropriate quantity and array of personal items, such as ash trays, manuals, headsets, books, pencils, pencil sharpeners, clocks, tape dispensers, reel-to-reel tape players, maps, charts, coffee cups, documents and other objects among the console surfaces to recreate the historic scene during active Apollo Missions.
- Acquisition and restoration or replication of missing furnishings such as ceiling-mounted group display cameras and tripod-mounted television cameras, waste receptacles, book cases, and office supplies to convey a period-specific, cohesive historic scene for visitors.
Steel bookcases should be filled with replicas of the 3-ring binders containing flight materials.

- Reactivation of the large group displays on the west wall of the MOCR with appropriate projection technology to recreate Apollo-era use of the screens.
- Restoration/repair of historic walnut railing on the north side of the consoles.
- Removal of existing carpeting and replacement with replica grey carpet tiles that existed during Apollo Missions.
- Cleaning/repairing of existing gray vinyl chairs, which closely resemble those used during Apollo Missions.
- Fitting all overhead light fixtures in each room with filters to prevent further damage to the historic furnishings from long-term exposure to unfiltered UV radiation.
- Installation of coat rack(s) with appropriate period clothing along south wall of MOCR.
- Cleaning and repairing the existing theatre-style seating and carpeting in the Visitors Viewing Area.
- Removal and relocation of non-Apollo period objects, including the podium, flag and microphone stand placed in the MOCR for ceremonies, photo murals from the Visitors Viewing Area, and window treatments in the Visitors Viewing Area and Simulation Control Room.
- Restoration of the original configuration of historic consoles and the “Selectomatic Transitubes” station in the Simulation Control Room.

Visitor Experience Plan: Summary of Findings

Johnson Space Center and Space Center Houston are working together on a difficult feat: to provide visitor access to and education about the JSC campus and Apollo Mission Control Center while balancing consideration for the ongoing protection and preservation of the historic places and resources visitors are clamoring to see. The first step in the interpretive planning process is the development of primary themes—or stories—that provide the foundation for the development of visitor experiences at the Apollo Mission Control Center. The Visitor Experience Plan recommends the following interpretive themes for the Apollo Mission Control Center:

— NASA and the Apollo Missions powerfully exemplify the human drive to explore new frontiers.
— NASA’s Apollo team met the challenge laid down by President John F. Kennedy in 1961 and, despite adversity and tragedy, safely landed Americans on the moon eight years later, and inspired the next generation of scientists, engineers, and astronauts.
— The Apollo program demonstrated that, with the commitment and support of the American people, a young, dedicated, and enthusiastic team could accomplish what was initially considered impossible.
— The creativity and inventiveness of the Apollo team produced enormous advances in a wide range of technologies and sciences that not only took us to the Moon but changed our lives forever.
**Visitors Viewing Area Experience** – The majority of visitors experience the MOCR from the Visitors Viewing Area. With the aid of their interpretive guide, their vantage point mimics the historic experience of visitors during the Apollo mission era and is ideal for understanding and appreciating the use and layout of the control room. When the curtains are removed, they will also be able to clearly see into the Simulation Control Room, offering excellent opportunities to talk about flight simulations and the importance of the “back rooms,” including the Recovery Control Room, whose critical support of operations are not immediately obvious without explanation. Visitors should be able to listen to recordings of Apollo flight conversations playing as audio loops. Visitors should also be able to see images on the large group displays in the MOCR that depict a “live feed” of Apollo-era content, such as the lunar landing.

**Visitor Loading** – The group size in the Visitors Viewing Area should be limited to the seventy-four seats available in that space. Trying to cram in a “standing room only” crowd results in a distracting “musical chairs” effect and implies to visitors that Space Center Houston and JSC managers have not sufficiently considered their comfort and quality of experience. At present, more visitors are assigned to each Space Center Houston tram tour than can be accommodated by the seating available in the Visitors Viewing Area. As a result, people stand against the walls, sit on the floor, and lean up against cabinetry, all of which detract significantly from the interpretive experience and increase wear and tear on the room furnishings. Tram tours should be limited to the number of visitors who can be accommodated by seating in this space.

**Mission Operations Control Room Experience and Access** – The best place to view and understand the Apollo missions and the operation of the MOCR is from the Visitors Viewing Area. This is a particularly appropriate vantage point since the room was specifically designed to give a comprehensive view of the Mission Operations Control Room, its various functions, and all that is happening within. Unfortunately, the high volume of VIP tours to the MOCR has contributed to the advanced deterioration of historic fabric and loss of historic objects within this historic space. These VIP tours, when conducted concurrently with the Space Center Houston tram tours, also present a serious distraction for the people in the Visitors Viewing Area. Therefore, the number of VIP tours to the MOCR should be dramatically reduced from an estimated current level of 40,000 visitors per year to about 2,000. Access to the MOCR should be coordinated and controlled by a single, designated JSC employee/office that can schedule tours and ceremonial activities outside of regular Space Center Houston tram tour hours. The number of guests should be closely monitored and limited to a maximum of perhaps 10-15 individuals per tour at a time. Guests should be carefully instructed regarding appropriate behavior before entering the space and carefully monitored when they do. No one should be allowed to sit on historic furnishings or handle original objects.
Historic Furnishings Plan

A. Context and Objectives
The purpose of this Historic Furnishings Plan is to provide detailed information about the furnishings that historically occupied the Mission Control Center and to help guide NASA’s planned and long-anticipated restoration effort. In 1996, the JSC developed an extensive plan for reconfiguring the third-floor space in Building 30, where the Mission Operations Control Room is situated, to preserve and interpret the historic Apollo era. At that time, the consoles and some Apollo components on the console panels were re-installed. The consoles were no longer wired for active use, nor were the group display screens at the front of the room. JSC’s ambitious plans at the time included bringing the console panels back to life with lights and appropriate displays on the console monitors, as well as appropriate ambient lighting levels, historic sound effects, and use of the display screens and time clocks. Much of those plans did not materialize, but nevertheless Space Center Houston – which is the official visitor center of JSC, and which is operated by the nonprofit Manned Space Flight Education Foundation, Inc. – began bringing all public tours to the third floor through a new visitor elevator and access door and ramp added to the Visitors Viewing Area. In 2003, photomurals and new television monitors were added to the Visitors Viewing Area. This furnishings plan will help guide the restoration project to its full fruition.¹

B. Significance Statement
The Apollo Mission Control Center, which was designated as a National Historic Landmark in 1985, represents one of the most significant developments of the space program in the United States during the 1960s, a pivotal Cold War period of funding and momentum for the newly established National Aeronautics and Space Administration (NASA). From the Mission Operations Control Room (MOCR) on the third floor of Building 30 at the Manned Spacecraft Center (now the Lyndon B. Johnson Space Center), flight controllers supported Gemini and Apollo program flights that contributed to and eventually achieved the ultimate goal announced by President John F. Kennedy on May 25, 1961—to send American astronauts safely to the moon and back by the end of the decade. From these rooms in Building 30, flight controllers managed the first human lunar landing with Apollo 11 on July 20, 1969. The scope and technological achievements of the Apollo program are unrivalled in the country’s history. In addition, the missions and goals of the human spaceflight program gave American citizens a common point of national identity and pride and contributed to U.S. global influence and scientific partnerships.

The Apollo Mission Control Center was established in the latter days of the Cold War. The Apollo program, and Mercury and Gemini before it, were a direct result of the “Space Race” that began immediately following World War II. The surviving sites and artifacts from the Apollo era, which culminated the Space Race with the landing of a man on the moon, thus present a lens for examining that history and the role of NASA’s Johnson Space Center in winning a major “battle” in the Cold War. While the Cold War as justification for NASA endeavors has faded, it remains as the origin story of the agency and must be preserved to be understood by the general

¹ For a more detailed administrative history, see the National Historic Landmark Management summary in this report.
public. While NASA programs that followed in ensuing years at the Johnson Space Center have their own significance, the Apollo Mission Control Center NHL preserves and tells the story of the agency’s origins and its early goals and achievements.

While competition with the Soviet Union to demonstrate the relative capabilities of the nations’ political and economic systems was the impetus for the establishment of NASA’s initial goals, programs, and funding, that context does not fully capture the meaning of the Apollo program. The story also is one of human exploration and courage, big science, large-scale systems and engineering, and a demonstration of the role of effective government at the federal level. All of these themes contribute to the meaning of the NHL and provide an overwhelming rationale for its national and global significance.²

C. Period of Significance: The late Apollo missions (1969-1972)
Gemini IV in June 1965 was the first flight controlled from the third-floor MOCR, and Apollo 4 in November 1967 was the first Apollo mission controlled from that room. The period of significance upon which this plan is based, however, covers the final seven Apollo missions – from Apollo 11, July 16-24, 1969, to Apollo 17, December 6-9, 1972. These seven flights span the period from the globally significant first lunar landing to the period of lunar exploration and experiments conducted before the program’s termination. As a group, these flights that involved actual moon landings are now understood as the culmination of the Space Race and the result of the United States’ commitment to demonstrating what the combination of capitalism and western technology could achieve. The final missions also represent the height of the Apollo program’s physical configuration in the Mission Control Center and its greatest technical and scientific demands. The emphasis on the latter missions period for the restoration of the NHL recognizes the emphasis placed on the lunar landing achievement of Apollo 11 in Harry Butowsky’s original NHL nomination but also allows the historic interpretation of the NHL to highlight the control room’s role in avoiding near tragedy during Apollo 13, as well as the complexity of activity in mission control associated with the final four missions, which contributed to the world’s scientific understanding of our moon and orbital spaceflight. Finally, it also provides an opportunity to discuss the physical and organizational changes that followed immediately at the Johnson Space Center in the transition period from Apollo to Apollo-Soyuz, Skylab, the Shuttle program, and the International Space Station.

Each Apollo flight required adjustments to the hard-wired consoles and room configuration to meet the evolutionary changes of the subsequent missions, which built on knowledge gained in previous missions. Because the consoles were always changing, choosing a particular moment in time to create an accurate historic scene that represents the period of significance is difficult. Apollo 11 is an obvious choice for recreating a meaningful historic scene that is recognizable and inspiring for many. While the restored control room as a whole can tell the story of Apollo 11’s success and show its iconic images on the group display screens, the technical details of individual console configurations presented in this plan are based on Apollo 15. The reason for this is purely pragmatic: The detailed “MCC Operational Configuration” guide for Apollo 15 seems to be the only readily available extant document of its kind from the period. It also

contains room layouts and provides an essential source for restoring the consoles to a reasonable degree of accuracy for the period of significance. While those engaged in the restoration process will need to make some decisions about what to display on the console and group display screens in order to highlight the Apollo 11 lunar landing, the other furnishings in the MOCR, the Visitors Viewing Area, and adjacent Simulation Control Room and Recovery Control Room are not mission-specific for the most part. The guidelines in this plan capture how the control room looked and functioned during and in the wake of the historic Apollo 11 lunar landing while providing the opportunity to interpret for visitors how the later scientific activities pushed the Apollo program to its apex of technological achievement, including extended lunar rover activities, before the program ended. Retired flight controllers Gene Kranz, Ed Fendell, Jerry Bostick and others have conveyed their general support for this period of interpretation and have volunteered to provide consultation on the details of the console and control room restoration project for the Johnson Space Center.3

D. Treatment Approach for the Apollo Mission Control Center NHL

There are four basic approaches to the treatment of historic buildings: preservation, rehabilitation, restoration, and reconstruction. To treat an interior space properly, the entity responsible for the property must choose a treatment approach for the entire site or for individual rooms within the site. The Secretary of the Interior provides individual sets of standards for each approach as guidelines and takes into consideration the relative importance of primary and secondary facades or interior spaces. The choice of treatment depends on consideration of the property’s historic significance, existing physical integrity, proposed use, and interpretive plans. All treatment approaches take code requirements into consideration and provide guidelines for meeting Americans with Disabilities Act (ADA) and abatement needs while minimizing loss of historic fabric and visual impact.

Restoration is the recommended approach for the Apollo Mission Control Center NHL. This approach will allow permanent retention of the existing Apollo-era materials and features while also providing latitude to replace missing features and items. Repair of damaged original furnishings and materials will be prioritized, unless the damage is severe enough to warrant replacement. Decisions about furnishings used in the room will require documented evidence to support their validity. The restoration approach will require removal of some items that were not used during the mission activities of Apollo 11 through Apollo 17.

A preservation treatment approach, as defined by the Secretary of the Interior, is not recommended because it would require the JSC to retain any changes to the rooms since the period of significance, including those representing the post-Apollo era, which would dilute the visitor experience and interfere with the intentions of our overall recommendations. The reconstruction approach is also not appropriate. With the possible exception of some missing console panels and other minor items in the rooms, the relevant interior spaces associated with the NHL in Building 30 have been preserved and retain or include reintroduced original historic fabric and furnishings. Rehabilitation is also not the appropriate treatment approach because it applies to situations where a property will be used for a new, compatible use.

3 August 25-26, 2014, preservation and interpretation workshop at Building 20, JSC; personal communications between flight controllers and Sandra Tetley, JSC Historic Preservation Officer.
E. Secretary of the Interior’s Standards for Restoration
1. A property will be used as it was historically or be given a new use which reflects the property’s restoration period.
2. Materials and features from the restoration period will be retained and preserved. The removal of materials or alteration of features, spaces, and spatial relationships that characterize the period will not be undertaken.
3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate and conserve materials and features from the restoration period will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.
4. Materials, features, spaces, and finishes that characterize other historical periods will be documented prior to their alteration or removal.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period will be preserved.
6. Deteriorated features from the restoration period will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials.
7. Replacement of missing features from the restoration period will be substantiated by documentary and physical evidence. A false sense of history will not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically.
8. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
9. Archeological resources affected by a project will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
10. Designs that were never executed historically will not be constructed.4

F. General Recommendations for Restoration in the NHL
In recognition of its ongoing efforts to preserve the Apollo Mission Control Center National Historic Landmark in Building 30, the Johnson Space Center should take additional steps to complete the restoration process and protect its initial investment, which has led to renewed interest in the Apollo era and acknowledgment of its legacy and importance in NASA history. That initial effort, which began in 1996, is now negatively impacted by deterioration of the existing historic interiors due to heavy use for visitor and VIP tours and other agency activities. Degradation and absence of a full array of historic furnishings in the NHL creates a negative impact on visitor experience, but there is an excellent opportunity to improve the accuracy, quantity, and level of detail of the furnishings and thus to improve the visitor experience. A renewed effort to complete the restoration of the space, combined with a strict protocol for access to the control room, will reverse the current downward trajectory of preservation and care that is devaluing and endangering the historic resources in the NHL.

While the current configuration of the MOCR captures a rough sense of how the room appeared, it contains only minimal furnishings. The inactive consoles, display screens, and group time and data display units fail to bring the room to life for visitors. The rooms are poorly maintained and infrequently cleaned, suggesting an overall air of neglect. To convey the period of significance (1969-1972) the JSC should source and display an accurate layout of consoles to reflect the controller positions of the late Apollo era. Historic recordings of Apollo 11 through 17 flight controller conversations with the flight crews and Apollo-era displays on the large screens will round out an experience that transports visitors to a more accurate facsimile of how the room appeared in the late 1960s and early 1970s.

The furnishings in the Visitors Viewing Area, Summary Display Projection Room, and the Simulation Control Room and Recovery Control Room that are visible from the MOCR should be improved and protected to convey the fuller story of how mission operations fundamentally relied upon “back room” staff and equipment and also the overarching importance of visual access and visual display.

1. Restoration activities should be restricted to room design and configurations that are supported by historical evidence in photos and diagrams.
2. The JSC should engage in mitigation of UV damage and improve monitoring and protection from UV damage with light filters and dimmed lights. The NPS Checklist for Preservation and Protection of Museum Objects recommends regular monitoring of UV radiation levels. If the level exceeds 75 microwatts/lumen, mitigation efforts should include filter sleeves for fluorescent lights. Light-sensitive materials include paperboard, wall-mounted, four-color mission plaques, a few of which are already badly faded by close exposure to UV radiation-emitting fixtures, as well as wall coverings, upholstered fabric, console cabinets, and printed materials and drawings.\(^5\)

3. The JSC should clean and maintain all room surfaces and furnishings following the Secretary of the Interior’s guidelines to minimize the degrading effects of dirt, insects, oil from human hands, food and drinks placed on the consoles during current JSC activities, and other environmental impacts on surfaces.
4. Changes to the rooms to create a historic scene representing Apollo 11 to 17 are allowable but must not be indistinguishable from original historic materials.
5. In general, the JSC should remove and document all non-Apollo era historic items and all evidence of post-Apollo use, with the significant exception of the wall-mounted plaques that are not representative of how the room was furnished from 1969-1972. In deference to the ceremonial placement of the plaques, these flight director retirement plaques, Apollo mission plaques from flights controlled in the other MOCR, and Shuttle-era mission emblem plaques could be retained in the NHL control room. They should be noted for visitors as later additions that convey the ongoing historic use of the room after the Apollo program.
6. To determine options and costs for improving lighting, adding audio loops, and obtaining original furnishings, replacements, and facsimiles, the Historic Preservation Officer (HPO) should consult with appropriate JSC personnel and professional consultants and service providers.
7. To complement the restored, furnished space, the JSC should develop standard operating procedures for maintenance and evaluation of conditions that includes an appropriate role for

---

the Facility Engineer. With proper guidelines for use and maintenance of the space, the rooms associated with interpretation of the NHL can coexist comfortably within the same management environment of actively used operational spaces.
Room Configurations and Furnishings: Historic Use and Recommended Changes

A. Mission Operations Control Room in the Apollo Era
The Mission Operations Control Room (MOCR) is the central room of the suite of physical spaces that make up the Apollo Mission Control Center National Historic Landmark as it appears today. The room measures approximately 65 feet in length along its east-west orientation and 52 feet in width along the north-south orientation. The ceiling height is 16 feet and 6 inches. Its interior finishing features carpeted flooring throughout and painted gypsum board walls. The acoustical-tile ceiling contains four rows of 11 rectangular, recessed fluorescent fixtures, 28 square, dimmable recessed incandescent light fixtures, and 9 flush-mounted air diffusers and intercom audio speakers. During active use of the control room, the overhead lighting was dimmed to reduce glare and shadows and thus improve visibility of displays on individual console monitors and group display screens. Group display cameras hung from ceiling-mounted brackets in the northwest and southeast corners and in the center of the east wall just above the viewing room windows.

The MOCR was designed to function like a small auditorium with rows of consoles arranged on a tiered, carpeted floor facing the west wall of the room, where group displays appeared via rear projection and group display cameras on large screens. Rear projection was selected to keep distracting projection devices out of the control room and to provide the opportunity to avoid conflicts between projection needs and room illumination needs. The rows of consoles and console chairs were the major furnishings of the room, but secondary functional furnishings included industrial steel coat racks, bookcases, and waste receptacles. During active use in the Apollo era, maps, clipboards, office supplies, personal items, and NASA manuals littered the console surfaces and spilled from the small bookcases arranged near the consoles for easy access. Wall-mounted objects were primarily commemorative, and included the mission insignia from the flights controlled from the MOCR. The functional contents, furnishings, and endings of the MOCR were the product of Philco-Ford’s unified design concept. While the console configurations changed as NASA adapted the room for each subsequent mission, the basic configuration of the room and its contents remained in place throughout the Apollo era.

A clockwise tour of the room in the Apollo era begins at the primary entrance to the MOCR via Corridor 315 through a solid metal swing door on the south wall. This door opened inward onto the open main floor area on the west end of the room. The open area in front of the group display screens on the west end of the room was 41 feet wide. The original plans for the control rooms called for a larger area that was 56 feet wide, which would ensure an unobstructed view of the large group displays. The installed flooring in this area and throughout the room was removable, light gray-carpeted tiles.

---

6 Comments and suggestions to Kaiser Engineers, October 22, 1962, Box 823, Philco NAS 9-366 General Info Folder, NASA Johnson Space Center Contract Administration Files, Record Group 255, National Archives Fort Worth.
7 Philco Western Development Laboratories, “Facility Requirements and Building Specifications,” July 1, 1962, Box 7, MCC and RTCC Subseries, Center Series, JSC History Collection, University of Houston-Clear Lake Archives, 3.1.4-3.
8 Ibid.
The angled west wall formed a bay at the front of the room for the group display screens. These included four 10-foot-by-10-foot screens and one 10-foot-by-20-foot screen that displayed television and plotting data for all of the controllers, NASA staff, and VIPs in the Visitors Viewing Area to view with ease. The large screen often displayed a map of the globe, the lunar trajectory, or a map of the moon. The displays on the smaller screens changed with the phases of the mission. These group-display monitors could display the same computer-driven data displays as the individual console monitors, as well as external television feeds from the Kennedy Space Center and the spacecraft. They also displayed input from other cameras within the building and from opaque televiewers, which were cameras mounted over tables in other rooms to capture hand-drawn and edited documents such as changes to the flight plan, drawings, and trend plots. Television monitors in the viewing room and the MOCR could also serve as display terminals for these displays. Over the screens, the group time and data displays provided reference timing and event indications for the control room.

The open area in front of the screens mostly was free of furnishings through the Apollo program, with one significant exception that is visible in early historic photos. During the Gemini program, the flight controllers began to receive displays of flight trajectories generated by newly developed projection-plotting devices. Because their reliability was still in question, the MOCR also contained five backup manual X-Y plotboards positioned at the front of the room below the group displays. These backup plotboards, of the type used for the Mercury and Gemini programs, were eliminated from the room early in the Apollo program as the reliability of the projection-plotting devices was established. A United States flag hung loose on a floor stand in the northwest corner until the completion of the Apollo 11 mission. After this time, it was replaced with a replica of the lunar landing flag, with the horizontal support that allows the flag to display fully. Next to the flag’s mounting bracket hung a stainless steel-on-wood replica of the commemorative plaque that was mounted on the Apollo 11 lunar module.

Beginning with Apollo 15 in 1971, a NASA color television camera was placed just in front of the flag and pointing towards the consoles during the mission flights to provide coverage for the television pool. Use of the camera was prohibited in critical mission phases, but otherwise it remained in place during the active flight period and ready for use in non-critical phases. The camera remained in a fixed position when in use, rather than on a dolly or truck, but it could be repositioned in the room as long as it never interfered with the controllers’ view of the displays. Historic American Engineering Record historian Douglas Jerolimov points out that television camera access to control room operations served an important purpose for NASA from the beginning of its manned spaceflight operations. It allowed the agency to maintain transparency with “its ultimate clients, the American taxpayer.” In his analysis, the cameras represent an interface of both social and technical elements that brought visitors to the room remotely.

---

11 Robert J. Shafer, Deputy Assistant Administrator for Television, to Jack King, Manned Spacecraft Center, March 24, 1972, UHCL JSC History Collection, HSI-44870, received via email from archivist.
12 Douglas Jerolimov, “NASA Johnson Space Center: Apollo Mission Control” (Washington, D.C., HAER TX-109-C,
Along the north wall of the room was an open, carpeted corridor. It led to two pairs of solid metal swing doors in the northwest and northeast corners of the control room and the access door in the wall for the two adjacent staff support rooms. The northwest set of doors opened inward to the control room from the projection room. Along the south wall of the corridor, just below the stairwell leading up to the viewing room, were two small closets with panels of switches to operate and dim the lighting in the control room and viewing room. The northeast doors at the end of the corridor opened outward into the exterior corridor. The north wall of the MOCR included uncovered glass windows that revealed the Simulation Control Room and Recovery Operations Control Room beyond. Transparency between functional rooms was a core component of the original design concept for the mission operations control facilities. Philco-Ford originally recommended windows around the control rooms and staff support areas, which would permit control of unauthorized access but allow for necessary visibility between the rooms to promote teamwork between controllers and their support staff. While Kaiser Engineers eliminated the idea of glass windows around the MOCR, the windows into the adjacent Staff Support Rooms and the Visitors Viewing Area served that original design principle. Mounted to the wall in display rows over the windows were four-color, paperboard mission insignia from the Gemini and Apollo flights that were controlled from this room.

On the north side of the MOCR, as well as the south, occupants could climb the open ends of three tiers of carpeted risers. Each riser was 35 feet long, 8 feet wide and 14 inches high and contained two stair steps per level. On the north end, a handrail of oil-finished solid walnut was attached with black-painted steel brackets to a frame of aluminum tubing and caps. The handrail was positioned just north of the steps that climb the flooring tiers on the north end of the console area along the stairs. A structural column, H-14, sat just inside the railing on the second tier stair platform.

The east wall of the room featured a ribbon of five glass viewing windows arranged along the center line of the vertical wall, beginning at roughly waist height. The two smaller windows in each end of the row provided viewing access for occupants of the JSC Director’s Office and the Headquarters Flight Operations Representative’s Office, which were accessible through the east entrances to the Visitors Viewing Area. The three rectangular, central viewing windows were positioned directly in front of the theater-style seating in the main viewing room. Below and above the windows was roughly two or three feet of solid gypsum wallboard covered with a woven-style wallcovering. Group display cameras hung from ceiling mount brackets along the east wall and pointed towards the screens.

From a vantage point at the rear of the room or from the Visitors Viewing Area, the rows of consoles lined up facing the group display screens on the tiered flooring system sloping down towards the west wall. Philco-Ford’s design of the pale green, steel consoles was based on a human factors study that considered angle of view, optimal height, and distance from the console

---


14 Architectural drawings for Building 30.
while seated. Adjustable gray, vinyl-and-steel chairs compensated for varying flight controller heights. Multiple studies optimized the console design to compensate for anticipated working conditions and variable human factors. Examples of studies included “Bend Angle Study for MOCR Personnel,” “Mounting of Safety Covers on Push Button Indicators,” “Advantages of Desk Top Loading and Delivery of the Carrier from the Pneumatic Tube Consoles in the MOCR,” “A Study of Potential Lighting Problems in Operation and Support Areas of the IMCC,” “Information Handling Rates for the MOCR,” “Design of the Characters for the Charactron System,” “Methods for Resolving Cathode Ray Tube glare in the IMCC,” and “Agent for Anti-Glare on TV Monitor Faces.” As Jerolimov notes, these studies reflect the holistic design process for the rooms of the Mission Control Center that considered carefully the interaction of spaces throughout the building and personnel within those interior spaces. He also notes that flight controllers participated in the final design for each console according to the specific needs of that position, which included location in the room, required display indicators and parameters, and even the colors of indicator lights. The cultural associations of colors for each controller could potentially affect response time in emergency situations. Red might mean “take action—there’s a problem” for one person, and “status quo” for another. Overall, the displays were meant to be simple and flexible combinations of visual elements—meters and lights—and aural features—tone generators and the voice intercom system accessed via communication panels and headsets.

**Apollo-Era Console Components**

- **Cathode ray tube television monitor:** At each console, 14-inch monitors allowed flight controllers to receive computer-driven, mechanically created displays such as alphanumeric tabulations, time-history plots, and X-Y plots. The usable viewing area was 7.5 inches by 10 inches. The cathode ray tube (CRT) television monitors displayed the data the controllers requested in a monochromatic display constructed by the Display and Control System. Displays were programmed in assembly code and required a number of parameters that controllers needed to monitor; the displays grew with the complexity of each manned spaceflight program. Mercury controllers monitored 97 parameters, while Gemini controllers tracked 338, and Apollo controllers tracked 403. In the Shuttle era, the number of parameters had grown to 12,000 derived parameters. In the early Apollo missions, a complement of 28 computer-driven television channels was adequate but the number increased to 36 for the Apollo lunar-landing missions. This system used a Digital-to-Television (D/TV) element that converted the data processed in the Real Time Computer Complex on the first floor into a pre-set computer-driven display format. A video camera captured this data, combined with a background image from a 35mm slide, into a semi-transparent optical element sent to the console’s CRT monitor. According to Jerolimov, in one twelve-hour-and-fourty-five-minute period during the Apollo 11 mission, flight controllers averaged 1,044.9 such requests per hour, and spent

---

17 Bridget Mintz Testa, “Mission Control,” *Invention & Technology* (Spring 2003), 20.
approximately 5.3 minutes viewing each resulting display.\textsuperscript{18}

- **Pneumatic tube delivery system:** In all phases other than launch phase, flight controllers could also send and receive hardcopies of the computer-driven data displays and other internal communications via the pneumatic tube delivery system. During launch phase, only the Network Controller, Assistant Flight Director, or Operations & Procedures Officer could send teletype messages out to the network. The pneumatic tube system, a nineteenth-century technology, used a vacuum propelled air pressure system to deliver cylindrical, 12-inch by 3-inch aluminum canisters through a central exchanger to the pneumatic tube (“P-tube”) send/receive station at the consoles. Wall-mounted send/receive stations in the building were found in the Real Time Computer Complex and the Staff Support Rooms. Average transmission time between stations was 45 seconds, although it took two minutes to send a canister from the MOCR to the Flight Crew staff support room. Jerolimov noted, “Of all the remarkable and distinctive characteristics of the Mission Operations Control Room during the Apollo program, the sound of the ‘pneumatic P-tubes coming and going,’ stood out for J. Milton Heflin, who became a flight controller after the Apollo Program, but while the original consoles were still in place.”\textsuperscript{19} Controllers used the P-tube system heavily and steadily through active missions. The hardcopies that arrived via a P-tube canister were generated by the video hardcopy system. Each console user had the option to request a printout of his 945-line video display on the CRT. Pressing the hardcopy request button activated a camera that took a 35mm photograph of the video channel, automatically processed the image, and dried it within 20 seconds. The hardcopy equipment operator then sent the print into the P-tube canister for delivery to the console.\textsuperscript{20}

- **Event module:** These display devices on each console were designed for expansion but those developed for the Gemini and early Apollo missions contained only eighteen or thirty-six events, based on the logic that only those events that were applicable to all mission phases should be included. Other event displays would be delivered on the console monitors. As it turned out, only a few events were relevant for all phases of the mission so the event modules expanded to high-density displays of seventy-two event lights. Each console could contain multiple sets of these seventy-two-event modules. Controllers relied on event lights for monitoring the status of tolerance limits of prime system parameters generated in the Real Time Computer Complex on the first floor.\textsuperscript{21}

- **Voice communication panel:** Controllers pressed the talk-listen key and multi-access keys to establish connections to multiple voice connection “loops” such as the flight director’s loop and the air-to-ground loop to communicate with other personnel. Dialogue was based on a strict protocol and kept as brief as possible. The controller identified the position he was calling, then himself, then the loop he was using, and/or the loop on which he wanted to receive a response, e.g. “EECOM, EPS on MOCR SYS-1, and/or


\textsuperscript{19} Jerolimov, 15; Flight Control Division, “Flight Control Operations Handbook, Revision 3,” IV-35.

\textsuperscript{20} Ray Loree, “MCC Development History,” 4.

“meet me on VEH SYS-1.” If the button for a particular loop was yellow, the loop monitor was on. Flashing white indicated the controller was actively using the loop. Solid white indicated that another controller was using the loop. The rotary dials on the panels allowed access to the private automatic branch exchange (PABX) system, which was the internal telephone network at the control center. Each station keyset unit had a corresponding headset with a push-to-talk switch or a push-to-talk foot switch. Voice recorder-reproduces in support rooms captured historical recordings on magnetic tape.\textsuperscript{22}

- **Summary message enable keyboard (SMEK):** Controllers used this keyboard to enable a program to compile telemetry data into a format that could be transmitted via teletype message. All of the keys on this module were white.

- **Manual selection keyboard (MSK):** The controller used this keyboard to select a video input channel and a digital display format that would appear on the console monitor. It also included a function to allow the controller to make a hard copy of the screen image. During the launch phase, only control room positions with abort request capability could request hard copies. If an abort command was necessary, the D/TV displays automatically hardcopied on the consoles capable of sending the command.

- **Display Request Keyboard (DSK):** Controllers used this semi-automatic version of the MSK to access selected display formats without delay. Features included console monitor selection, group television selection, and plotting projector selection.

- **Status report module:** This module included red, yellow, and green status report indicator colors and an “abort requested” key.

- **Analog meters:** Not all display types on the original consoles remained in use throughout the Apollo program. Console configurations for early Apollo missions also included analog meters as display devices, a decision that reflected general wariness about relying on computers. As the Apollo program evolved, analog meters were used mainly in the staff support rooms for detail analysis, as the flight controllers began to rely more heavily on computer-driven TV displays, but some analog meters remained on consoles in the control room.\textsuperscript{23}

Among the rows of consoles were nine pneumatic tube stations for sending and receiving hardcopy prints of display screens and other critical mission documents. The stations connected to staff support rooms through the pneumatic tube system installed in Building 30. Each station contained a set of cylindrical metal carriers (canisters) in shelf slots. The operational

\textsuperscript{22} Philco WDL, “Manned Spacecraft Control Center Maintenance and Operations Activity Indoctrination Booklet,” July 1964, Box 5, MCC and RTCC Subseries, Center Series, JSC History Collection, University of Houston-Clear Lake Archives, 10, 13; Panel configuration and module functions as described by former EECOM Sy Liebergot for Andy Anderson’s research on the EECOM console details for Apollo 13. Also cited is George Conway, SCP. No. CSM-B5, “Communication Panel Utilization,” April 16, 1969. Author received document and EECOM information directly from Anderson in UHCL Archive, August 2014.

\textsuperscript{23} Hoover, “Apollo Experience Report,” 7.
configuration diagram from PHO-TR155 for Apollo 15 (included on page 27 in this document) indicates the proper location for those nine P-tube stations within the console configuration.

At the ends of the console rows and between certain consoles, low industrial steel bookcases provided housing for relevant NASA mission documents, which were contained in ring binders and placed in loose stacks. These documents were also scattered on console surfaces during active mission periods. Other assorted small furnishings included freestanding vinyl-and-steel stationary chairs that provided extra seating and steel trash receptacles with pyramidal, self-closing caps. Freestanding television monitors were placed next to the Public Affairs Officer console at least during Apollo 11, and possibly for subsequent missions.

Along the south wall were two freestanding steel coat racks. A tall steel bookcase containing ring binders of mission-related documented stood between the coat racks. Photographs from the Apollo era also show a wall-mounted board, possibly a whiteboard, which may have been used as a calendar or for some other coordinating purpose. A wall-mounted, metal drinking water fountain was positioned near the main entrance.

B. Mission Operations Control Room: Post-Apollo Era Changes
On January 22, 1973, exactly one month after the Apollo 17 mission marked the end of the Apollo program, former President Lyndon B. Johnson died. In recognition of the role Johnson played in establishing the NASA site in Houston, NASA renamed the Manned Spacecraft Center as the Lyndon B. Johnson Space Center (JSC). As the Apollo program was winding down, the Houston site was changing in more than name only. Funding for NASA programs had dropped precipitously even as President Richard Nixon announced the new Space Shuttle program in January 1972. Facing tepid congressional support and increased scrutiny, the agency emphasized efficiency and making do as the Shuttle program began. By May of 1973, the JSC had deactivated the third-floor MOCR, and it was left unused for three years in anticipation of reconfiguration for the new Shuttle program. It is reasonable to assume that NASA’s evolving policies requiring efficient use of available equipment, combined with budgetary constraints, meant that some of the smaller furnishings, equipment, and objects from the MOCR may have been moved to other rooms or excessed at this time.

Working under a new contract for the Space Shuttle program, Aeronutronic-Ford (formerly Philco-Ford) began in August 1976 to install the new Approach and Landing Test Data System (ALTDS) in the third-floor control room. By December, the systems required to control the Space Shuttle flights were fully integrated with the existing consoles in the third-floor MOCR, and the JSC staff began to refer to the room as Flight Control Room 2 (FCR2). The new system supported the Captive-Active flights and Free-Flights until it was deactivated on November 9, 1977. The JSC then removed all of the equipment from the third-floor FCR2 and began to prepare it for the Space Shuttle’s operational phase.24 In 1983 and 1984, the second-floor control room was converted to the new Console Input System (CONIS) technology and began supporting simulations; meanwhile, the third-floor control room conversion took place. In both cases, the consoles were removed, refurbished, and fitted with the new technology. All of the cathode ray tube, console-mounted television monitors were removed and replaced with solid

---

24 Archaeological Consultants, “Mission Control Center/Building 30 Historical Documentation,” (Sarasota, FL: October 2010), 14.
state units. Reinstallation in the control rooms included the addition of new Shuttle-specific console positions. Because the third floor FCR2 would be used for all Department of Defense missions, its reconfiguration also included the installation of a secure operations system. Additional facility modifications while the various rooms in Building 30 were empty included removal and relocation of the modular walls in the support room areas and renumbering of the rooms. The original Eidophor projectors in the “Bat Cave” were replaced with GE light-valve type projectors. During this period in the early 1980s, other “items of interest from the Mission Control Rooms” such as chairs and other furniture were excessed and sent to the Kelly Air Force Base Redistribution and Utilization Resources.  

Despite these updates, the Shuttle program continued to rely on the mainframe-console system for mission operations throughout the 1980s, although the agency was aware of the potential advantages for converting to more powerful and flexible workstations and desktop computers that would be capable of more robust and speedy calculations and eliminate the need to reconfigure hardware for every alteration and upgrade. As early as Apollo 11, flight controllers had brought desktop computers into the control room to calculate key parameters more quickly; at that time Olivetti P101 machines were in use.

By the mid-1980s, free-standing, offline personal computers were common alongside the consoles, and the Mission Control Center (MCC) management was planning to replace consoles altogether with workstations. When the Challenger disaster on January 28, 1986 put the Shuttle program on hiatus, the execution of that plan also halted temporarily. All effort was directed toward evaluating the program management structure, re-engineering the Shuttle’s solid rocket boosters, and reviewing and reassessing critical items and the launch and abort rules. By 1989, however, all of the consoles and related equipment had been replaced with workstations and local area networks, and some of the old equipment was moved to a new temperature-controlled, secure area in Building 425. In December 1989, JSC installed two new rear projectors for both control rooms and two new 10-foot-by-20-foot glass center display screens because the original coating had deteriorated. The new screens are one-half-inch thick and have better clarity and off-angle properties than the originals. Unlike the original screens, they are washable. The original screens were carefully stored for potential future use in a recreated Apollo-era control room. Other items placed into this storage area at that time included a pneumatic tube station, twelve headsets, the original scale models of the MCCU, 1; Minutes of July 11, 1990 Historic Preservation Committee Status Meeting, July 17, 1990, NASA.gov; Archaeological Consultants, “MCC/Building 30,” 15.


27 Loree, MCC Development History, 26, NASA.gov.

28 Linda Copley, “Replacing the irreplaceable,” Space News Roundup (Vol. 29, no. 1, January 5, 1990), 1; Minutes of Status Meeting, JSC Historic Preservation Committee, September 12, 1989, UHCL JSC History Collection, Center Series, Apollo 11 Mission Control Historic Preservation Subseries, Box 1, Folder “JSC Historic Preservation
Several years later, in cooperation with production of the 1995 Apollo 13 feature film, the JSC provided access to the room for Director Ron Howard and Producer Brian Grazer. To prepare for the re-creation of the Apollo-era MOCR on Stage 27 at Universal Studios in Los Angeles, cinematic architect Michael Corenblith and his team shot more than 500 rolls of film in the control room and created more than 30 pages of blueprints. The JSC also loaned the stored MOCR floor plan model and nineteen vertical and horizontal keysets from the original consoles to the film production company.29

The second-floor MOCR had been serving as the accessible control room for visitors since 1982, when the JSC constructed the Visitors Lobby with an elevator that led only to the second floor. This new traffic pattern kept visitors away from the secured Department of Defense Shuttle operations on the third floor. According to the “Man in Space Alternatives Study” conducted in 1987, large numbers of people were visiting the JSC on self-guided tours, but their understanding of the historic Apollo-era control room activities was limited to what they could see and understand from the second-floor viewing room.30 Because the JSC needed to reconfigure and reclassify the use of the second-floor control room to serve the International Space Station and Shuttle simulations and operations, the JSC took steps in 1996 to focus its historic preservation efforts on only the third-floor control room and its adjacent Visitors Viewing Area and “Bat Cave.” They planned to coordinate with Space Center Houston to conduct tours to the third floor once a new visitor elevator and walkway into the viewing room was installed.31 The record of reconfiguration and removal of original furnishings in the second-floor control room reveals something about what historic furnishings remain in its third-floor counterpart. The JSC removed the tiered flooring and consoles and installed modern consoles and associated equipment in the second-floor control room. The water fountain and pneumatic tube stations were also removed, and items deemed “of historical importance” were stored. The room was re-carpeted and painted, and the unused wiring was removed and replaced with an underfloor grounding grid.

The JSC never implemented the full extent of the SHPO-approved plans for re-creating an authentic Apollo-era environment in the third-floor control room. Plans from the late 1990s included “look-alike control panels with power to light up the panels” and black-and-white displays on the old cathode ray tube monitors, an intact but inactive pneumatic tube system, and videos of Apollo mission launches, lunar surface activities, activated countdown clocks, and Earth/Lunar ground track on the display screens. The planning documents also mentioned that plaques from missions controlled in the third-floor MOCR would be displayed on the right wall;

---

those controlled from the second floor would be on the left wall. None of these ideas came to fruition.

Despite the aim for authenticity in the refurbishing of the room as a historic Apollo-era environment, the JSC removed all functional components of the pneumatic tube system from the control room in 1998, labeling it as “obsolete and no longer needed.” The work order requested removal of “all P-Tube conduit, hangers, deflector valves and wiring in Room 331, Bldg.30N, back to the CX Exchanger in Room 130 and excess all removed equipment.” The same work order called for installing new carpet for the area around the consoles “to keep the area in a presentable condition.” Only the P-Tube receivers were retained and reinstalled in the newly placed consoles. Also at this time, the arrival of another film crew—this time for a Family Channel production of “Apollo 11”—prompted removal of the newer DVIS communications keysets and reinstallation of the original VIS keysets.

A comparison of today’s second-floor control room and the historic Apollo-era control room on the third floor convey the evolution of technology after the Apollo era ended in the early 1970s. Changes included an electronic data system that replaced the pneumatic tube system, color displays on monitors, a selective digital voice system that replaced the hardwired voice loops, commercial hardware and software that replaced the unique hardware and software designed specifically for the building, and reconfigurable work stations that replaced the unique console configurations for each controller. Additionally, the original slide to a television display system evolved to a software display system, and the computing power and weather facilities were vastly greater and state-of-the-art.

The JSC has not made significant changes to the Apollo Mission Control Room on the third floor since the late 1990s. A 2003 modification plan included the addition of the “console identifier placards” at each console and again called for reactivating lights on the consoles and CRT monitor images. This plan also recommended dimming the lights in the MOCR and viewing room, putting a spotlight on the Flight Director console, and displaying maps and charts on the group display screens. The 2003 plan also recognized that employees were using the room as a shortcut passageway, which conflicted with the visitor experience in the historic space. Thus, the plan called for installation of small signs on the exterior doors of the Control Room to prevent employees from using it as a passageway while visitors were in the viewing room. None of these recommendations were implemented.

C. Recommended Treatment for the Mission Operations Control Room: Restoration
The Mission Operations Control Room should be accurately restored to its appearance during the latter Apollo missions (1969-1972) to achieve an authentic experience and feeling for visitors that the flight controllers have “just walked out of the room” during an active mission. This restoration will entail close coordination and communication with retired flight controllers and also require the removal of the furnishings from other periods. A restoration treatment of the NHL will build on the JSC’s existing investment and effort to depict a historic Apollo-era mission control room while improving the accuracy of the appearance of the room, the protection of resources from degradation and damage, and the delivery of a clear and engaging visitor experience. Of the five rooms discussed in this report, the MOCR is the primary interior space with the most historical significance and the best opportunity for restoration. Unlike the viewing rooms, the control rooms were never meant for heavy traffic and public access. Reducing and restricting direct access to the MOCR, which is fully visible from the adjacent viewing area through the original glass windows installed for that purpose, is thus more consistent with the room’s historic use patterns of exclusive access to the MOCR. This plan will allow the JSC to maintain the existing historic materials and arrest their further deterioration without compromising those standards due to visitor safety requirements, security issues, theft protection, and resource impact associated with loosely restricted access to this primary space. Visitors who wish to have a “hands-on” experience with NASA history at the Johnson Space Center should be directed to the exhibits at Space Center Houston and also educated about the importance of protecting aging historic resources from further deterioration.

Immediate Actions
1. Configure all consoles to the correct array for each controller position using available inventory. To create a reasonable approximation of the furnishings and related objects in use during the Apollo era from 1969-1972, identify and select equipment that was present during the latter missions and that represent the period of success and scientific achievements characterized by Apollo 11 through Apollo 17, particularly the apex of technological achievement and function in the room represented by Apollo missions 15, 16, and 17. Each console shell should have an accurate array of hardwired devices that are appropriate for each position.
2. Install appropriate quantity and array of personal items, such as ashtrays, coffee cups, pencils, headsets, and documents among the console rows and bookcases to approximate historic appearance during active missions.
3. Repair the minor damage to the walnut-and-aluminum handrail to prevent further deterioration.
4. Remove non-historic existing carpet, which was installed in 1998 and is in poor condition. Reproduce original carpeting, which consisted of light-gray, carpeted tiles.
5. Restore missing furnishings such as ceiling-mounted and tripod-mounted television cameras, waste receptacles, book cases, office supplies and personal items to convey a period-specific, cohesive historic scene for visitors.
6. Install UV protection in all overhead lighting to prevent further deterioration and fading of consoles, wall-mounted mission plaques, and other interior finishes.

Long-term Recommendations
1. Reactivate the consoles and group displays to bring the active control room environment back to life. Consult with Apollo-era flight controllers on console configurations. For example, software-driven displays at each console can re-create Apollo-era monochromatic displays on the cathode ray tube monitors and the event lights that guided controller activities.

2. Consider secondary elements to enhance the re-creation of the historic environment of the Apollo-era control room, including audio loops of flight controller communications.

The current control room configuration presents an inaccurate representation of the Apollo-era historic configuration and appearance.

D. Detailed Guidelines for Flight Controller Positions and Console Configurations

The green, steel cabinets developed by Philco to serve as the Apollo-era consoles contained hard-wired panels in customized configurations for each flight controller position. The control room today contains the original Apollo-era console cabinets but many consoles will require significant re-configuration to accurately represent the late Apollo era displays from 1969 to
The installed control panels need careful review at each flight position to restore them to the appropriate configuration and Apollo-era modules. While most groupings of control panels roughly approximate the function and controller position, they include many later versions of the controls that were used during the Space Shuttle era. As just one example, all of the CRT monitors installed in the room are solid-state, Shuttle-era CRT monitors instead of the original type C2/1 vacuum tube CRT monitors. To guide the detailed process of restoration needed to create a late Apollo-era historic scene, this section of the plan includes an evaluation of the historic accuracy of each console and recommendations to restore the consoles to the period of significance, 1969 to 1972. The quality of the restoration results will depend on the existing inventory of the original panels and funding to create facsimiles, if needed. Console configurations presented here are from the “MCC Operational Configuration: Mission J1 Apollo 15” document (PHO-TR155, 03-26-71), which seems to be the only readily accessible version of this document from the late Apollo-era missions between 1969 and 1972.
Controller console and P-tube station positions by equipment location number, corresponding with the Operational Configuration diagram. Note that console numbers and position numbers do not correspond directly, e.g. the DOD manager is listed as position 01 at Console 15. (PHO-TR155, 03-26-71)
CONSOLE 01: MISSION DIRECTOR


Apollo 15 configuration diagram (PHO-TR155, 03-26-71)
Mission Director Console: Apollo 15 Configuration Requirements

- The yellow highlighted panels appear to be correct.

Replace Shuttle-era panels as follows:

- Install console MTD telephone type COMMTP at location 01.
- Install telephone line select panel type COMTLS at location 07.
- Replace manual select keyboard at location 09 with M5K Type A6A/24 at location 09.
- Replace the abort requested panel at location 11 with a type D9/481 panel.
- Replace existing monitors with 14” precision TV monitors, type C2/1.
- Arrange appropriate personal items on desktop and console: ashtray, coffee mug, headsets, copies of documents, flags wedged between panel screws.
CONSOLE 02: FLIGHT DIRECTOR

Apollo 15 image of the Flight Director console. NASA.gov.

1970 image of the Flight Director console. NASA.gov.

Flight Director Console 02, Apollo 15 configuration (PHO-TR155, 03-26-71)
Apollo Mission Control Center — Historic Furnishings Report and Visitor Experience Plan

Flight Director Console: Apollo 15 Configuration Requirements

- The yellow highlighted panels appear to be correct.
- Install a two-shelf panel at location 19. Stock it with copies of documents as shown in historic photos.
- Remove the panel at location 2.
- Install desktop items such as coffee mug, pencil sharpener, ashtray, headset, copies of documents, mounted document holder, flag wedged between panel screws.

Replace Shuttle-era panels as follows:
- Replace existing monitors with 14” precision TV monitors, type C2/1.
- Install type D9/58 event indicator panels at 08 and 13.
- Install a manual select keyboard type A6A/24 at location 09.
- Install a single type D9/4A1 PBI switch at 10.
- Install type D9/9B toggle switch/indicator panel at 11.
- Install a type D9/10C toggle switch/indicator at 15.
- Install a type D9/4D3 two-PBI switch at 12.
CONSOLE 03: ASSISTANT FLIGHT DIRECTOR

Assistant Flight Director console during Apollo 12 lunar landing. NASA.gov.
Apollo 15 configuration (PHO-TR155, 03-26-71)

Assistant Flight Director Console:
Apollo 15 Configuration Requirements

- The yellow highlighted panel appears to be correct.
- Install a two-shelf panel at location 20. Stock it with copies of documents as shown in historic photos.
- Install desktop items such as coffee mug, pencil sharpener, ashtray, headset, copies of documents, flag wedged between panel screws.
- Remove additional console bay.

Replace Shuttle-era panels as follows:

- Replace existing monitors with 14” precision TV monitors, type C2/1.
- Install a type D9/5B event indicator panel at 02.
- Install a type B12/3 stop clock at location 10.
- Install a manual select keyboard type A6A/24 at location 06.
- Install a type H48MFD voice communication panel at location 21.
CONSOLE 04: PROCEDURES/INCO

This 1969 image shows the Procedures/INCO console before the additional bay was added, as shown in the Apollo 15 configuration diagram. NASA.gov.

<table>
<thead>
<tr>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>SITE INDICATOR</td>
<td></td>
<td></td>
<td>14</td>
<td>SWITCH MODULE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>TV MONITOR 14&quot; PRECISION</td>
<td>C2/1</td>
<td></td>
<td>15</td>
<td>STOP CLOCK (4 DIGIT)</td>
<td>B12/3</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>TV MONITOR 14&quot; PRECISION</td>
<td>C2/1</td>
<td></td>
<td>16</td>
<td>LOAD NUMBER INDICATOR</td>
<td>D9/41B</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>EVENT INDICATOR</td>
<td>D9/5B</td>
<td></td>
<td>17</td>
<td>SWITCH MODULE</td>
<td>D9/40E</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>MANUAL SELECT KEYBOARD</td>
<td>A0/2</td>
<td></td>
<td>18</td>
<td>SWITCH MODULE</td>
<td>D9/40E</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>EVENT INDICATOR</td>
<td>D9/5B</td>
<td></td>
<td>19</td>
<td>SWITCH MODULE</td>
<td>D9/40E</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>STATUS/STATUS REPORT</td>
<td>D9/1A</td>
<td></td>
<td>20</td>
<td>SWITCH MODULE</td>
<td>D9/40E</td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>ANALOG METER (5)</td>
<td>D9/29C</td>
<td></td>
<td>21</td>
<td>VOICE COMM POSITION-3005</td>
<td>H4MF0D</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>EVENT INDICATOR</td>
<td>D9/5B</td>
<td></td>
<td>22</td>
<td>VOICE COMM POSITION-3006</td>
<td>H4MF0D</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>EVENT INDICATOR</td>
<td>D9/5B</td>
<td></td>
<td>23</td>
<td>RTA REMOTE CONTROL</td>
<td>D9/20</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>TV MONITOR 14&quot; PRECISION</td>
<td>C2/1</td>
<td></td>
<td>24</td>
<td>BLANK PANEL</td>
<td>D11/6</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>STOP CLOCK (4 DIGIT)</td>
<td>B12/3</td>
<td></td>
<td>25</td>
<td>BLANK PANEL</td>
<td>D11/3</td>
<td></td>
</tr>
</tbody>
</table>

INCO and Procedures (O&P) Console 04, Apollo15 configuration (PHO-TR155, 03-26-71)
Procedures/INCO Console: Apollo 15 Configuration Requirements

- This should be a four-bay console and requires full replacement and reconfiguration.
- Arrange appropriate personal items on desktop and console: ashtray, headsets, flags wedged between panel screws.

Replace Shuttle-era components as follows:
- Install type D9/5B event indicator panels at locations 05, 07, 10, and 11.
- Replace monitors with type C2/1 14-inch CRT monitors and add a third monitor at 12, 3, and 4.
- Install type B12/3 four-digit stop clocks at locations 15 and 18.
- Install a type D9/41B load number indicator at 16.
- Install a type D9/52 site indicator at 02.
- Install a type D9/29C analog meter at 9.
- Install a type H48MFD voice communication position at 22.
- Install five type D9/40E switch modules at locations 14, 17, 18, 19, 20.
- Replace the manual select keyboard with a type A6E/2 at location 6.
- Install a type D9/1A status report panel at location 8.
- Install a type D9/20 RTA remote control panel at 24.
- The P-tube station (No. 22) to the right of this console is in the correct position.
CONSOLE 05: LIFE SYSTEMS OFFICER

Life Systems Officer (Flight Surgeon) console in 1969. NASA.gov.

Flight Surgeon (Life Systems Officer) Console 05, Apollo 15 configuration (PHO-TR155, 03-26-71)
Life Systems Officer Console: Apollo 15 Configuration Requirements

- The yellow highlight panels appear to be correct.
- Arrange appropriate personal items on desktop and console: ashtray, headsets, flags wedged between panel screws.

Replace Shuttle-era components as follows:

- Install a type D9/45C TLM input selection and display panel at 08.
- Install a type C4/2 cardioscope control panel at 09.
- Install a type C2/1 14-inch CRT monitor at 06 and 07.
- Install a type C4/1 cardioscope display monitor at location 02.
- Install three type D8/6 8-unit digital rate display panels at 10, 14, and 15.
- Install a type A6B/1 manual select keyboard at location 11.
- Install a type D9/1A status report module at location 12.
CONSOLE 06: CAP COM

Close up images of the right side of the CAP COM console in 1969 (left) and 1971 (right). NASA.gov.

CAP COM Console 06, Apollo 15 configuration (PHO-TR155, 03-26-71)
Cap Com Console: Apollo 15
Configuration Requirements

- Arrange appropriate personal items on desktop and console: ashtray, headsets, flags wedged between panel screws.

Replace Shuttle-era components as follows:
- Install type C2/1 CRT monitors at locations 7 and 9.
- Install a type B12/2 stopwatch at location 03.
- Install a type A6A/1 manual select keyboard at location 11.
- Install a type D8/1 6-digit clock at location 4.
- Install a type D8/3 7-digit clock at location 5.
- Install a type H48MFD voice communication position panel at location 6.
- Install a type D9/1A status report panel at location 14.
- The five blank panels at 01, 02, 13, and 15 are correct.
CONSOLE 07: EECOM

1965 image of the EECOM console. NASA.gov.

---

EECOM Console 07, Apollo 15 configuration (PHO-TR155, 03-26-71)
Apollo Mission Control Center — Historic Furnishings Report and Visitor Experience Plan

**EECOM Console: Apollo 15**

**Configuration Requirements**

- The yellow highlighted panels appear to be correct. Arrange appropriate personal items on desktop and console: ashtray, headsets, copies of documents, flags wedged between panel screws.
- Panels at locations 20, 15, 16, 4, 6, and 14 should be blank.

Replace Shuttle-era panels as follows:

- Install a type D9/29B analog meter at location 18.
- Install type D9/28 72-button event indicator panels at locations 3, 5, and 9.
- Diagram for location 19 does not match panel description. Investigate.
- Install two type C2/1 14-inch monitors at locations 7 and 8.
- Install a type A68/1 manual select keyboard at location 12.
- Install a type D9/1A status report panel at location 13.
CONSOLE 08: GNC

1970 image of GNC console. NASA.gov.

GNC Console 08, Apollo 15 configuration (PHO-TR155, 03-26-71)
Guidance, Navigation, and Control (GNC) Console: Apollo 15 Configuration Requirements

- The yellow highlighted panels appear to be correct.
- Arrange appropriate personal items on desktop and console: ashtray, headsets, copies of documents, flag wedged between panel screws.
- Move the summary message enable keyboard, type A19/A, from location 8 to the immediate left at location 13.
- Remove status report panel at location 13.

Replace Shuttle-era panels as follows:
- Install type D9/58 event indicator panels at locations 4, 14, and 18.
- Install a type B12/3 four-digit stop clock at location 1.
- Install 72-key event indicator panels, type D9/26, at locations 2 and 3.
- Install type C2/1 14-inch CRT monitors at locations 6 and 7.
- Install a type A6B/1 manual select keyboard at location 11.
- Install a type D9/1A status report panel at location 12.
- The P-tube station (23) to the right of this console is in the correct position.
CONSOLE 09: TELMU

TELMU Console 09, Apollo 15 configuration (PHO-TR155, 03-26-71)
Telmu Console: Apollo 15
Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Remove extraneous elements at locations 11, 16, and 17.

Replace Shuttle-era panels as follows:
- Install a type V48MFD voice communication position panel at location 11.
- Install a type D9/29B analog meter at location 07.
- Install a type D9/1A status report panel at location 15.
- Install type D9/5B event indicators at locations 01, 02, 03, 04.
- Install type C2/1 14-inch CRT monitors at locations 8 and 9.
- Install a type A6B/1 manual select keyboard at location 14.
- The stop clock at location 19 should be type B12/3.
- The voice communication position panel at location 6 should be type H48MFD.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.
CONSOLE 10: BOOSTER SYSTEMS ENGINEER

1969 image of Booster Systems Engineer Console in background. NASA.gov.

![Image of Booster Systems Engineer Console]

---

Booster Systems Engineer Console 10, Apollo 15 configuration (PHO-TR155, 03-26-71)
Booster Systems Engineer Console:
Apollo 15 Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.

Replace Shuttle-era components with the following:
- Install a type D9/9A toggle switch indicator at location 15.
- Install a type D9/1A status report panel at location 14.
- Install a 7-digit clock, type D8/3, at location 4.
- Install type A6B/6 manual select keyboard at locations 16 and 19.
- Install three type C2/1 14-inch CRT monitors at locations 8, 9, and 10.
- Install a type H4 8MFD voice communication panel at location 18.
- The event indicator panels at locations 01, 02, 03, and 05 all should be type D9/5B. There are two types shown here.
CONSOLE 11: FLIGHT DYNAMICS OFFICER

Flight Dynamics Console 11, Apollo 15 configuration (PHO-TR155, 03-26-71)
Flight Dynamics Officer Console: Apollo 15 Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.

Replace Shuttle-era components with the following:

- Install a type A22/4 phase control keyboard at location 03.
- Install a type A22/5 phase control keyboard at location 13.
- Install a type D9/58 18-button event indicator at location 05.
- Install a type D8/1 six-digit clock at 07.
- Install a type D8/3 seven-digit clock at 08.
- Install a type A6A/1 manual select keyboard at 15.
- Install a type D9/1A status report panel at location 18.
CONSOLE 12: GUIDANCE OFFICER

<table>
<thead>
<tr>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>VOICE COMM POSITION-3020</td>
<td>V488FD</td>
<td></td>
<td>14</td>
<td>EVENT INDICATOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>6 DIGIT CLOCK</td>
<td>DB/1</td>
<td></td>
<td>15</td>
<td>EVENT INDICATOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>7 DIGIT CLOCK</td>
<td>DB/3</td>
<td></td>
<td>16</td>
<td>SWITCH MODULE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>VOICE COMM POSITION-3021</td>
<td>V488FD</td>
<td></td>
<td>17</td>
<td>SWITCH MODULE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>TV MONITOR 14&quot; PRECISION</td>
<td>C2/1</td>
<td></td>
<td>18</td>
<td>SWITCH MODULE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>TV MONITOR 14&quot; PRECISION</td>
<td>C2/1</td>
<td></td>
<td>19</td>
<td>BLANK PANEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>TV MONITOR 14&quot; PRECISION</td>
<td>C2/1</td>
<td></td>
<td>20</td>
<td>BLANK PANEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>DISPLAY REQUEST KEYBOARD</td>
<td>A16/8</td>
<td></td>
<td>21</td>
<td>EVENT INDICATOR (72)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>STATUS/STATUS REPORT</td>
<td>D9/1A</td>
<td></td>
<td>22</td>
<td>EVENT INDICATOR (72)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>TWO PBI SWITCH</td>
<td>D9/40E</td>
<td></td>
<td>23</td>
<td>LOAD NUMBER INDICATOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>MANUAL SELECT KEYBOARD</td>
<td>A6A/33</td>
<td></td>
<td>24</td>
<td>EVENT INDICATOR (72)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Guidance Officer Console 12, Apollo 15 configuration (PHO-TR155, 03-26-71)
Guidance Officer Console: Apollo 15
Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.

Replace Shuttle-era components with the following:

- Install a two P61 switch, type D9/4D5, at location 12.
- Install type D9/5B event indicators at locations 14 and 26.
- Install type D9/28 event indicators (72) at locations 24 and 25.
- Install type D9/1 six-digit clock at location 03.
- Install type D9/3 seven-digit clock at location 04.
- Install type C2/1 14-inch CRT monitors at locations 07, 08, and 09.
- Install a type A6A/38 manual select keyboard at location 13.
- Install a type D9/1A status report panel at location 11.
CONSOLE 13: RETROFIRE OFFICER

1969 image showing RETRO console in background. NASA.gov.

Retrofire Officer Console 13, Apollo 15 configuration (PHO-TR155, 03-26-71)
Retrofire Officer Console: Apollo 13 Configuration Requirements

- Yellow highlighted panel appears to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.
- P-tube station 26 at left is correct.

Replace Shuttle-era components with the following:

- Install a type D8/1 six-digit stop clock at location 01.
- Install a type D8/3 seven-digit stop clock at location 02.
- Install two type B12/2 stop clocks at locations 16 and 17.
- Install a type B13/1 coincidence time panel at location 13.
- Install two type D9/5A1 switch modules at locations 03 and 12.
- Install a type D9/5G3 switch module at location 14.
- Install a type D9/1A status report panel at location 09.
CONSOLE 14: PUBLIC AFFAIRS OFFICER

1969 image of Public Affairs Officer console. NASA.gov.

PAO Console 14, Apollo 15 configuration (PHO-TR155, 03-26-71)
Public Affairs Officer Console: Apollo 15 Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.
- Retain the portable “squawk box” speaker sitting on top of the console.

Replace Shuttle-era components with the following:

- Install type C1/3B pan/tilt control panels at locations 08, 11, and 18.
- Install another type C1/3A zoom control panel at location 16.
- Install a type D9/23A TV monitor select panel at location 10.
- Install a type G6F special TV monitor control panel at location 7.
- Remove the indicator panel at location 17 and leave that space empty.
- A type D9/4A1 single PBI switch should be added to location 14.
CONSOLE 15: DOD MANAGER

1969 image of DOD console. NASA.gov.

DOD Console 15, Apollo 15 configuration (PHO-TR155, 03-26-71)
DOD Representative Console: Apollo 15 Configuration Requirements

- Yellow highlighted panel appears to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.
- Retain the red phone on the top of the console.

Replace Shuttle-era components with the following:

- A voice communication position panel should be added at location 04.
- Replace the indicator panel installed at location 10 with a type D5/4B1 “abort requested” panel.
- Install a type A6A/5 manual select keyboard at location 09.
- Install type C2/1 14-inch CRT monitors at locations 05 and 06.
CONSOLE 16: LM CONTROL ENGINEER

LM Control Engineer Console 16, Apollo 15 configuration (PHO-TR155, 03-26-71)
LM Control Console: Apollo 15
Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.

Replace Shuttle-era components with the following:

- Install type D9/58 event indicators at locations 01, 02, 03, 04, 05, and 10.
- Install type D9/28, 72-key event indicators at locations 06, 07, and 20.
- Install type C2/1 14-inch CRT monitors at locations 08 and 09.
- Install type D9/1A status report panel at location 13.
- Install a type A6A/1 manual select keyboard at location 15.
- Install a type H48MFD voice communication position panel at location 16.
- Install a type D9/41B load number indicator at location 19.
CONSOLE 17: FLIGHT ACTIVITY AND EXPERIMENTING OFFICER

1969 image of Activities and Experimenting Officer console. NASA.gov.

Flight Activity and Experimenting Officer Console 17, Apollo 15 configuration (PHO-TR155, 03-26-71)
Flight Activities and Experimenting Officer: Apollo 15 Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Arrange loose items on desk top: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.

Replace Shuttle-era components with the following:

- Install type C2/1 14-inch CRT monitors at locations 06 and 07.
- Install a type D9/1A status report panel at location 11.
- Install a type A6A/1 manual select keyboard at location 09.
- P-tube stations 20 (left) and 18 (right) flank this console. P-tube station 20 needs improvement and the addition of canisters.
CONSOLE 18: NETWORK CONTROLLER

1969 image of the Network Controller console shows an additional console to the right. NASA.gov.

This 1967 image of the Network Controller console matches the operational configuration diagram for Apollo 15. NASA.gov.

Network Controller Console 18, Apollo 15 configuration (PHO-TR155, 03-26-71)
Network Controller Console: Apollo 15 Configuration Requirements

- Yellow highlighted panels appear to be correct.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.

Replace Shuttle-era components with the following:

- Install a type D8/2 six-digit clock at location 07.
- Install type D9/5B event indicators at locations 03 and 18.
- Install type C2/1 CRT monitors at locations 05, 06, and 13.
- Install a type A6A/19 manual select keyboard at location 09.
- Install a type A6G/3 manual select keyboard at location 14.
- Install a type D9/26B source indicator (CS1) at location 17.
- Install a type C1/98 pan/tilt control at location 15.
- Install a type D9/14A status report panel at location 10.
CONSOLE 67: DIRECTOR OF FLIGHT OPERATIONS

1970 image of the Director of Flight Operations console. NASA.gov.

Flight Operations Director Console 67, Apollo 15 configuration (PHO-TR155, 03-26-71)
Flight Operations Director Console:
Apollo 15 Configuration Requirements

- Yellow highlighted panels appear to be correct.
- The P-tube station (19) is in the correct position.
- Arrange loose items on desktop: ashtray, headsets, flag wedged between panel screws, copies of appropriate Apollo-era documents.

Replace Shuttle-era components with the following:

- Install type C2/1 14-inch CRT monitors at locations 03 and 06.
- Install type D9/481 abort requested panel at location 09.
- Install type A6A/24 manual select keyboard at location 10.
E. Recommendations for Restoration of Additional Furnishings in the Control Room

The carpeting in the MOCR is not original and is in poor condition. It should be replaced with light-gray carpet tiles throughout.

Utility doors in the control room’s north corridor provide access to the original, functional lighting control switches.
Lighting was carefully designed to maximize control room operations. Restoration should include lighting settings that create a similar interior environment. In this photo from October 11, 1968, Flight Director Glynn Lunney is seated at his console on the first day of the Apollo 7 mission. Note the dimmed overhead lighting to improve visibility of the black and white console monitors and group displays at the front of the room. Rear projection on to the group display screens eliminated competition between lighting in the control room and the display clarity. NASA image S-68-49299.

All overhead light fixtures should be fitted with filters. Long-term exposure to unfiltered UV radiation from fluorescent fixtures has faded the mission emblem plaques. In this example, the oldest plaque for Gemini IV, also placed directly next to a light fixture, has suffered the greatest amount of fading. Photo by Maren Bzdek.
The group display screens on the west wall of the control room should be reactivated with appropriate retrofitted projection technology to create a reproduction of Apollo-era use of the screens during mission control activity. The time display clocks at the top of the screens should also be reactivated, if possible. Each screen should contain displays according to original function, i.e. plotboard displays and closed circuit and broadcast television channels.

The image at left shows the U.S. flag hanging on a freestanding pole. After Apollo 11, the room contained a wall-mounted lunar flag with the horizontal support arm. Images from Archive.org.
The railing on the north side of the console risers is original and should not be removed from the control room. It is constructed of solid oiled walnut, steel brackets, and an aluminum tube frame and caps. Its counterpart was removed from the second floor and destroyed. The aluminum is damaged along the edges but otherwise condition is good. It should be cleaned and edge damage repaired by a restoration expert.

This early image of the MOCR shows the gray carpet and console chairs. Photo evidence indicates the chairs were replaced in 1971. The gray vinyl chairs now installed in the MOCR are very similar to the original chairs and should be retained. 866-17807, NASA.
This 1968 image includes several important furnishing types that should be included in the restored Apollo-era NHL control room, including the freestanding steel trash receptacles with a pyramidal, self-closing cap, the row of steel bookcases to the left of the PAO console, and a freestanding stationary chair in the style that was found scattered around the console rows to provide supplemental seating. NASA.gov.

Several items in this image should be included in the furnishings of the restored control room. Note the telephone attached to the back of the Flight Operations Director console, as well as the maps and documents attached with tape. The three cameras in the rear of the room are visible in this image. The hardware still hangs from the ceiling but the cameras are missing. Image from Archive.org.
This felt-tip pen on paper drawing by artist Maxine McCaffrey is labeled: "Mission Control—Apollo 9 Manned Spacecraft Center, Houston, Texas March 1969." It captures minor furnishings including the special DOD phone, the console mounted telephone on the Network Controller console, and the position of waste receptacles and small bookcases. The artist also captured important personal items such as coffee cups and ashtrays. From http://airandspace.si.edu/collections/artifact.cfm?object=wasm_A19760422000.

Note the freestanding NASA color TV camera next to the wall-mounted U.S. flag. This camera was used first during Apollo 15. NASA image.
This 1971 image includes the portable reel to reel recorder sitting on the far right of the flight surgeon’s console. Image 7141759, NASA. The inset provides a closeup of controllers using the machine. NASA.

This 1969 image shows a two-shelf steel bookcase between the PAO and Director of Flight Operations consoles. The shelves face in the direction of the Flight Director and Assistant Flight Director consoles and contain mission documents in labeled ring binders. Image 6944126, NASA.
This Apollo 11 image shows that the row of steel bookcases next to the PAO console supported two stacked television sets facing in opposite directions. Also note the extra desk placed against the rear wall. Image 6944094, NASA.

The south wall of the control room should contain the basic functional furnishings from the original configuration. Some of these furnishings are already in place, including a single coat rack and a bookcase. Other appropriate Apollo-era furnishings and objects depicted in this photo that should be included in the restoration are the maps taped to the back of the console, a second steel coat rack, reference documents in ring binders for the bookcase, and the wall-mounted calendar or white board. Note there were no commemorative plaques or mission insignia on this wall in the Apollo era. Image 6944024, NASA.
F. Visitors Viewing Area in the Apollo Era

The Visitors Viewing Area directly adjacent to the MOCR allowed important visitors and guests to watch activities in the MOCR through large glass windows that separated the rooms; seventy-four reddish-orange upholstered theater seats provided seating in rows facing the windows. Agency and political officials, members of the press, family members, and NASA and contractor personnel might be among the audience at any given time. Visitors were cleared for admittance prior to the flight and issued entry cards. Some high-level Flight Operations Directorate personnel had access to the viewing room badges during all mission periods on a “standing room only” basis. The flight directors had a “V” on their mission operation badges to allow them to enter the room at any time to confer with its occupants, or simply to observe the activity in the control room during low-activity mission periods.\(^{37}\)

In his Historic American Engineering Record documentation of the MOCR, Jerolimov emphasized that the viewing area allowed dignitaries to serve as a live audience for the action in NASA’s stage-like “front room,” the MOCR, while the rest of the audience participated from home via the television broadcasts.\(^{38}\) Demand for access to the Visitor Viewing Area, known informally as the viewing room, reached a maximum during the Apollo 11 mission and blurred the functional lines that normally separated the MOCR from the viewing room. While the

\(^{37}\) Apollo 12 Flight Director Mission Logs, Center Series, JSC History Collection, University of Houston-Clear Lake Archives.

mission was controlled from the third-floor MOCR, and the adjacent viewing room provided the ideal location for visitors, the second-floor viewing room was used to accommodate additional visitors on a space available basis. In addition, the second-floor MOCR and Building 30 auditorium also provided special access opportunities to witness control center operations during Apollo 11. In the second-floor MOCR, NASA’s Flight Operations Directorate personnel (civil service, military, and contractors) were permitted to enter and listen to the piped-in flight director’s audio loop and the GOSS conference loop. Some of the large displays were activated as well. Accommodations to seat 200 personnel inside the MOCR were prepared.  

The Visitors Viewing Area was 65-feet long on its north-south orientation and 26-feet wide. The ceiling height varied from 8-feet to 10-feet high and was finished with acoustical tiles. There were eight, square, recessed, dimmable, incandescent light fixtures alternating with six air diffusers, as well as rows of fluorescent, rectangular recessed fixtures. The gypsum wallboard was covered with a woven-style, buff-colored wallcovering. Access to the viewing room was provided by two short flights of stairs, each ascending beneath a sloped ceiling from the corridor to the two Communication Booths on the northwest and southwest corners of the room. Wood-swing doors provided access to the two booths—each roughly 8-feet long by 7-feet wide with windows on the south, west, and east walls and a single square, recessed incandescent light fixture on the ceiling. In addition to serving as functional space for audio-visual communications, these booths provided private viewing areas of the MOCR for the Center Director and NASA Headquarters officials.  

From the northwest entrance, an aisle next to the seating allowed visitors to climb the five risers to the top of the room via carpeted stairs. On the northeast end, recessed in the wall adjacent to the mechanical duct space for the room, was a set of telephone booths with doors that opened outward into the viewing room. Each room contained a telephone and a small, mounted desk surface.  

Along the east wall and running the length of the seating area, a plywood and metal standing desk was installed immediately behind the top row of seats. The plywood surface was covered in a woven-style paper covering applied with adhesive. A matching set of telephone booths in the southeast corner of the room provided additional telephone access for members of the press and NASA visitors. The rows of red-orange, upholstered, theater-style seats descended toward the viewing windows into the control room in five levels; each was seven inches lower than the previous level. The total number of seats in these rows was 74. The seats were upholstered in heavy-duty fabric with piped edging; they were folding seats with steel buckets, frames, and seat pans, and plywood backs and end caps. Metal ash trays were mounted to the plywood backs of alternating seats for the use of visitors in the row behind. A 1969 artist’s rendering of the room during Apollo 11 also shows a freestanding metal ashtray at the end of one of the seating rows. Ceiling mounted television monitors were positioned in the southwest and northwest corners of the room to be visible from the theater seats. Along the west end of the room, a wooden shelf surface was mounted directly under the viewing windows that looked down into the control room. Thirteen small, rectangular, white plastic plaques that read “Reserved” were mounted to

39 Chief, Mission Planning and Analysis Division to Personnel, re: Admission to the MOCR during Apollo 11, July 16, 1969, UHCL JSC History Collection, HIS-209407, sent by archivist via email.
the vertical edge of the shelf, marking the first row of seats as reserved. Headset jacks were installed along the shelf for these front-row visitors, allowing them to listen to the voice communication loops. An electric, lit sign over the viewing room windows read “Quiet Please.”

**G. Visitors Viewing Area: Post-Apollo Era Changes**

JSC Real Property records indicate that in March 1990, JSC made lighting alterations or replacements at a cost of $1,713 in the Viewing Room. No description or reason for the work order is indicated in the records. In 1998, to accommodate visitor traffic from the Visitors Lobby to the third floor, JSC extended the elevator to this level and added a new elevator door by cutting an opening through the PEAF panel and constructing a new entrance into the viewing room along the east wall similar to the existing visitor entrance on the second floor. The new entrance included a ramp and handrail for ADA-compliant access to the viewing room.

In 2003, the JSC made several changes to the Visitors Viewing Area as part of a larger effort to improve interpretive information in the building for visitors. The television units mounted in the front corners of the viewing area were replaced with flat-screen, speaker-enhanced models using the existing mounting bracket system. Photomurals were installed on each sidewall, and six moon landing photos installed on the back wall with a mounting system that would not mark the walls. Space Center Houston tram tour guides could control the new televisions; new projectors in the “Bat Cave” were controlled via infrared remote control from the viewing room. Other changes in the building included modifications to the first-floor visitor lobby exhibits, installation of the Bob McCall artwork exhibit in the third-floor foyer outside of the Visitors Viewing Area, and the addition of photographs in the tourist-access stairwell.

**H. Recommended Treatment for the Visitors Viewing Area: Restoration**

Restoration is the most appropriate treatment plan for the Visitors Viewing Area. Restoration will allow the JSC to continue to maintain this room as a highly significant, if heavily used, companion space to the control room. Because the viewing area provides a critically important opportunity to handle heavy annual visitor traffic and ADA compliance needs, the JSC will have to take a pragmatic approach that maximizes retention of the historic furnishings but also considers upkeep of the existing features that provide access based on ADA standards as they relate to historic properties. Retaining the elevator, ramp, and railings in the Visitors Viewing Area allows all members of the public to enter the NHL space through the historic primary entrance for visitors and view the MOCR from the historic vantage point.

**Immediate Needs**

1. Clean and restore theater-style upholstered seating.

---

41 JSC Building 30 Real Property Records, 12. Document number J24292 is listed as reference.
42 John O'Neill, Director, Mission Operations, to JA/Director, Center Operations, July 31, 1996, NASA.gov.
2. Remove the post-Apollo era photo murals from the walls and minimize tour-related signage. All necessary tour-related signage should be displayed on removable tripods or other temporary display options.

3. Install filtering sleeves on overhead lights to reduce UV radiation damage to upholstered seating and other historic furnishings.

4. The standing desk in the back of the room is in very poor condition. Repair the torn and peeling edges of covering material, which appears to be similar to or the same as the original wallcovering material in the viewing room and control room. It should be carefully repaired rather than replaced, if possible.

5. Add black rotary telephone units to the desks in the four telephone booths.

6. Clean carpet and make minor repairs.

7. Remove non-Apollo era objects and furnishings from the Communications Booths at the front of the room, as well as the blinds covering the windows.

8. Consult the photograph of the Communications Booth in use during a 1970 mission (see photo on page 79) to research the type and function of the desktop objects and source them for restoration of this space.

9. Consult with flight controllers from the Apollo era to determine the accuracy of the configuration drawing below with respect to placement of the Audio-Visual Controller console. The diagram shows it in one of the telephone booths for Apollo 15, rather than the more logical site, the Communications Booth in the northwest corner.

I. Detailed Guidelines for Visitors Viewing Area Furnishings and Configuration

The Apollo 15 operational configuration diagram reflects the individual spaces in the Visitors Viewing Area as follows: two Communications Booths on the west wall of the room, four telephone booths on the east side of the room—one of which may have been used to house Console 68 for the Audio-Visual Controller, and the main interior space occupied by theater-style seating and facing a window wall on the east side. Two short flights of stairs lead up to the room on the south and north ends.
This 1970 photo shows the north Communications Booth with its Apollo-era configuration and equipment, including desk-mounted keyset units and desktop television monitors and telephones. Image 7035012, NASA.

The desk surface is now covered with a Shuttle-era console unit that should be removed so that the room can be restored to the above configuration.
The south Communications Booth contains the original desktop surface. The room contains a miscellaneous assortment of items that do not appear to be from the Apollo era. The blinds covering the windows of both booths are a later addition and should be removed.

A Franklin McMahon pencil-on-paper sketch of the viewing room during Apollo 11 features Dr. Werner Von Braun (with glasses) and associates. Note the artist captured the upholstery piping detail. From http://airandspace.si.edu/collections/artifact.cfm?object=nasm_A19760554000.

The NASA image at top right shows the ceiling-mounted television monitor. The modern flat-screen televisions mounted there today for interpretive activities are an appropriate substitution. The NASA image at lower right indicates that the booth windows were untreated.
Existing original seating should be cleaned, repaired, and preserved. This vantage point provides the best and most secure opportunity to view the control room without further damaging the historic furnishings.
The plywood shelf that runs along the west wall of the viewing room under the windows is original and in good condition. All of its elements should be preserved. The “reserved” plaques and jacks should be left in place undisturbed. Visitors should be prohibited from touching the counter or placing objects on it while in the viewing room.

The electric “Quiet Please” sign over the windows should be left in place, inspected for mechanical or safety concerns, and illuminated if possible. It is part of the original furnishings of the viewing room.
These images show the upholstery, plywood and steel details on the theater-style seating in the viewing room. All historic fabric on these seats should be cleaned and repaired rather than replaced.

NASA worked with the National Gallery of Art on a program that sent artists to NASA facilities to create works based on whatever interested them. The collection is now in the National Air and Space Museum. This 1969 pencil-on-paper sketch by Franklin McMahon depicts the control room during Apollo 11 from a vantage point in the viewing room (perhaps the standing desk). A freestanding metal ashtray is depicted at the end of the rear seating row and some Standing Room Only visitors are sitting on the stairs. From http://airandspace.si.edu/collections/artifact.cfm?object=nasm_A19760535000
The woven-style, adhesive-applied paper covering on top of the standing desk in the rear of the viewing room requires repair and better protection from high traffic in this room. Visitors should be prohibited from touching the desk or placing items on it. The plywood and metal surfaces should be cleaned and maintained.

The walls of the viewing room are covered with non-historic photo murals that should be removed to restore the historic appearance of the room during the Apollo era. The ramp entrance should be inspected for ADA compliance and any necessary fixtures for that purpose retained or improved without removal of or damage to historic fabric. The carpet on the ramp and throughout the room should be cleaned and maintained.
J. Summary Display Projection Room (the “Bat Cave”) in the Apollo Era
The projection room immediately west of the control room housed equipment for the Projector Plotter Display (PPD) subsystem in the Apollo era. The PPD produced large-format summary (group) displays on the glass screens that the rows of controllers and visitors faced and could see from any vantage point. Other launch and landing graphics were also displayed using this subsystem, which was active into the Space Shuttle era. Each of the two original MOCRs had a PPD that consisted of a set of seven projectors: one background; two spotting; four scribes. The background projector displayed the world map from a 1-inch square slide, while the spotting projectors imposed symbols representing the spacecraft or a target on the map and moved the symbols based on trajectory data from the Mission Operations Computer. The computer also controlled the scribing projectors, which used diamond-tipped styli to scratch alphanumeric characters or an X-Y plot through the metalized coating on a glass slide. Through these etched slides light was projected on the screen with 2500 watt xenon lamps and color filters. All of the equipment was carefully aligned together to allow a collection of several slides from multiple projectors to superimpose on each other and form a complete display. This display was reflected onto the viewing screen via an optical display mirror, which optically folded the projected images to achieve the required optical throw distance that would allow the images to display properly on the group display screens.45

To project large-scale television images onto the large group display screens, the projection room also contained an Eidophor projector, an early type of light-valve projector type that provided a brighter image than cathode ray tube (CRT) projectors. Eidophor, based on the Greek eido for image and phor for bearer, used a thin, oil-film control layer spread on the surface of a conductive and reflecting spherical substrate that rotated and was addressed by a rastered electron beam. The beam deposited a charge pattern on the oil surface, and the pattern was electrostatically attracted to the conducting substrate, which caused a deformation pattern in the oil. The result acted as a phase diffraction grating.47

The projection room is roughly 65 feet long on the north-west orientation and 36 feet wide, with a 15-foot ceiling. Access to the room is through the double set of solid metal swing doors in the northwest corner of the control room. The walls are gypsum board, the ceiling is acoustical tile, and the floor is XX. The walls, ceiling, and floor are painted black.48

K. Summary Display Projection Room: Post-Apollo Era
In the early 1980s, JSC replaced the original Eidophor projectors in the two projection rooms with GE light-valve type projectors.49 After the third-floor control room was retired in 1992, the projection room was also retired. The projector plotting equipment was transferred to the JSC’s historical artifacts storage facility.50 In 2004, JSC installed two racks of equipment but made no

49 MCCU, 1; Minutes of July 11, 1990 Historic Preservation Committee Status Meeting, July 17, 1990, NASA.gov.
50 Temporary storage records, JSC Historic Preservation files.
modifications to the room. The SHPO found no adverse effect from the installation. Minor additions of modern equipment to the room in 2003 allowed Space Center Houston tram tour guides to use the group display screens during their interpretive activities. The JSC worked with Space Center Houston to add temporary projectors on stands to project Apollo-era graphs and images on the display screens. Tram tour guides could control the projectors via remote control from the Visitors Viewing Gallery.

L. **Recommended Treatment for the Summary Display Projection Room: Restoration**

Although it is not visible to the public, the summary display projection room is a functional extension of the control room and should be treated with the same approach. The functional purpose of the projection room and its spatial relationship to the large group display screens in the control room is an important link in the physical space and any proposed changes to this room should be in service to overall historic site preservation and interpretation rather than current JSC operations.

**Immediate Needs**

1. This room is used for storage and has not been inventoried. The first priority should be to establish which historic materials and furnishings are still in the room.
2. Because this area is not visible to visitors, the JSC should consider other means and locations for interpretive display in the building to reveal its function and original contents to the public.
3. The room should be protected from competing uses while the restoration is underway and consultation with interpretive specialists is ongoing. The possibility of renewing rear projection group displays should be explored during this process.

**Long-term Recommendations**

1. Revive the rear projection group display technology with historically accurate display choices to enhance the restoration activity in the MOCR.
2. Inventory and store all historic furnishings and objects that are not in use for this purpose in JSC storage.

---

M. Detailed Guidelines for Summary Display Projection Room Furnishings

These images of a group display mirror and Eidophor projector are from the original Philco configuration manual for the control rooms in Building 36. The feasibility of restoration of the rear-projection technology should be considered along with more modern projection options for restoring the original Apollo-era control room environment.
N. Staff Support Rooms
The original space allocations for each of the two identical mission operations facilities in Building 30 included nine associated functional rooms on each floor. Additionally, the Closed-Circuit Television Equipment and Control Room on the first floor and the Meteorological Center on the second floor served both of the mission operations facilities.

The Visitors Viewing Areas, while associated with the control rooms, were not part of the functional association of operational rooms. This historic furnishings report treats in detail only the third-floor Mission Operations Control Room (MOCR), and its adjacent Visitors Viewing Area and Display Projection Area. However, two support rooms, the Simulation Control Room (328) and the Recovery Control Room (327) were visible from the control room through the glass windows and should also be included in the restoration and visitor interpretation plans for the Apollo Mission Control Center NHL.

Other associated Staff Support Rooms on the third floor have been converted to other uses. They are not included in this treatment plan but should be mentioned in the interpretive tours of the NHL to give a fuller picture of how the control room functioned. They include:

- Flight Dynamics Staff Room
- Trajectory Data Monitoring Room
- Life Support Systems Data Monitoring Room
- Vehicle Systems Data Monitoring Room
- Operations and Procedures Staff Room
- Network Support Staff Room

O. Simulation Control Room in the Apollo and Post-Apollo Eras
The Simulation Control Room (328) was visible through the interior window along the north corridor inside the Mission Operations Control Room. In the late Apollo era, the room contained four consoles (62-65) for simulation activities. The controller positions active in this room included the simulations supervisor at console 62, the simulation LM/SLV at console 63, the simulation telcomm/network position at console 64, and the simulation CIM at console 65. At some point this room was converted to storage, presumably after the MOCR was inactivated and repopulated with Apollo-era consoles. The consoles and P-tube station in this room convey Shuttle-era configurations and technology.

P. Recommended Treatment for the Simulation Control Room: Restoration
Restoration of this room would greatly improve the array of Apollo-era historic resources that are being preserved and interpreted for the public. Without at least one well-restored Staff Support Room, the representation of a functional matrix of physical spaces in Building 30 is lost. The MOCR, its projection room, and the Visitors Viewing Area were only the “front rooms” of mission control and the majority of personnel worked at consoles distributed through the Staff Support Rooms. The Simulation Control Room should be preserved to emphasize the importance

53 Philco Western Development Laboratories, “Facility Requirements and Building Specifications,” July 1, 1962, Box 7, MCC and RTCC Subseries, Center Series, JSC History Collection, University of Houston-Clear Lake Archives, 4.2.3-1 to 4.2.3-2.
of preparatory simulations for successful flight missions, and also because it should be visible from both the MOCR and the viewing area through its glass windows. Opening up this room will provide a more complete historic scene and preserve a more complete array of related historic resources for the future.

Immediate Needs
1. Remove curtains covering the glass window panes that allow visual access between the Simulation Control Room and the main control room.
2. Use the floor plan included here to arrange the consoles that remain in this room in a configuration that reflects the Apollo-era use of the room.
3. The JSC uses this room for storage. All non-historic objects should be removed from this space and stored elsewhere.
4. Clean the room thoroughly, including all objects that will be displayed there.
5. Any consoles found in this room that cannot be used for the restoration of the MOCR or the Simulation Control Room should be retained and stored properly in the JSC storage facility.
6. During active tours of the NHL, the lighting in this room should replicate historic operating levels during active use, which will allow visitors to see the consoles and understand their spatial and functional relationship to the MOCR.
7. Retain the wall-mounted P-tube station and the aluminum canisters in place.
8. Add console chairs to the consoles to complete the basic configuration of the room.

Long-Term Recommendations:
1. Restore the Apollo-era panels as shown in the following diagrams for each of the four consoles to create a more accurate historic scene and preserve those components in a protected environment for the future.
2. Adjust room lighting for appropriate levels.
3. Include consoles in this room in the long-term plan for reactivation of lights on the event indicators.
Q. Detailed Guidelines for Simulation Control Room Furnishings

Configuration of the Simulation Control Room (328) as shown in the MCC Operational Configuration document for Apollo 15 (PHO-TR155, 03-26-71). Although not shown, the windows allowing visual access between the control room and this room are along the left wall in front of controller positions 1, 2, and 3.

Controller positions for Simulation Control Room 328, Apollo 15 operational configuration (PHO-TR155, 03-26—71)
## Apollo Mission Control Center — Historic Furnishings Report and Visitor Experience Plan

### Historic Furnishings Report and Visitor Experience Plan

<table>
<thead>
<tr>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
<td>08</td>
<td>VOICE COMM POSITION-3313</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>EVENT INDICATOR</td>
<td>09/16</td>
<td></td>
<td>09</td>
<td>COUNCIL ROOM STATUS CTRL 09/36</td>
<td>09/16</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>EVENT INDICATOR</td>
<td>09/16</td>
<td></td>
<td>10</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>TV MONITOR SELECT</td>
<td>09/16</td>
<td></td>
<td>11</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
<td>12</td>
<td>MANUAL SELECT KEYBOARD 01/16</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>TV MONITOR 14&quot; PRECISION C/1</td>
<td>01/16</td>
<td></td>
<td>13</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>TV MONITOR 14&quot; PRECISION C/1</td>
<td>01/16</td>
<td></td>
<td>14</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
</tr>
</tbody>
</table>

### Diagrams

![Diagram of Apollo Mission Control Center](image1)

**TRI55 1-02-64-01**

**SIM TELECOM NETWORK**

**CONSOLE NO. 64**

**ROOM NO. 328**

---

### Another Section

<table>
<thead>
<tr>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
<th>LOC</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
<td>09</td>
<td>COUNCIL ROOM STATUS CTRL 01/16</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>EVENT INDICATOR</td>
<td>09/16</td>
<td></td>
<td>10</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>EVENT INDICATOR</td>
<td>09/16</td>
<td></td>
<td>11</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
<td>12</td>
<td>MANUAL SELECT KEYBOARD 01/16</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
<td>13</td>
<td>BLANK PANEL</td>
<td>01/16</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>TV MONITOR 14&quot; PRECISION C/1</td>
<td>01/16</td>
<td></td>
<td>14</td>
<td>TV MONITOR SELECT</td>
<td>01/16</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of Apollo Mission Control Center](image2)

**TRI55 1-02-65-01**

**SIM CIN**

**CONSOLE NO. 65**

**ROOM NO. 328**

---

### Footnotes

- 93
Apollo-era consoles containing both Shuttle-era and Apollo-era modules are still in place in Room 328. They should be used to create accurate Apollo-era configurations in this room as well as supplemental materials for the restoration of the control room, as appropriate. All extraneous stored items in this room should be removed.

A “Selectomatic Transibes” station is still present in its original location in Room 328, the Simulation Control Room. It should be preserved as is and ultimately be visible from the control room through the window glass.
R. Recovery Control Room in the Apollo and Post-Apollo Eras
In this room NASA and Navy officials coordinated recovery after splash down. The complexity of these recovery activities increased significantly during the Apollo era and required improved methods and hardware. Former Landing and Recovery Division Chief Jerome Hammack called this room “the little known nerve center of recovery operations.” As shown in the floor plan from 1967 and the diagram below from the Apollo 15 MCC Operational Configuration handbook, the room was similar in layout and structure to the mission control room, with its own group display screen and associated projection room behind the wall opposite the consoles. The room was immediately adjacent to the control room on the third floor and was used for recovery operations during the Gemini and Apollo eras until deactivation in 1973. It was converted in 1977 into the primary Approach and Landing Test (ALT) operations support room in preparation for the Space Transportation System (STS) flights. ALT furnishings included standard consoles, strip chart recorders, and X-Y plotboards; it was used for that purpose for less than a year, until November 9, 1977.

S. Recommended Treatment for the Recovery Control Room: Restoration
The Recovery Control and Communications Room (327) was set up in a similar configuration to the main control room and used by the DOD for recovering operations. The room contained group display screens and a projection room as well. The DOD console in the MOCR was directly related to the activities in Room 327. This support room is not visible from the Visitors Viewing Area but could be seen through the windows from the front of the MOCR, if the opaque covering on the windows is removed.

Immediate Actions
1. If the room will be restored, at least minimally, to represent a configuration for recovery operations, the JSC should evaluate the opaque window coverings for removal and/or replacement with window glass.
2. The diagrams included here are from TR155, which also includes console diagrams for the Apollo 15 configuration of the room and its equipment. The general recommendations that apply to the other rooms in the NHL would apply here if a restoration effort of the Recovery Control Room is feasible. A minimal approach would include placing consoles in proper configuration in the room so that its appearance from a vantage point in the hallway would convey its general function during the Apollo era.

Controller positions for Recovery room 327, Apollo 15 operational configuration (PHO-TR155, 03-26-71)
Configuration of the Recovery room (327) as shown in the MCC Operational Configuration document for Apollo 15 (PHO-TR155, 03-26-71). Note the display screens with associated projection room.
The glass windows that provided visual access between the Recovery Control Room and the MOCR have been blocked with an opaque, white covering. Removal of this covering or replacement of the glass as a facsimile of the original would be an appropriate step in a restoration plan.
T. Floor Plans
Scale model of third-floor Mission Operations Wing – which includes the MOCR, Summary Display Projection Room (“Bat Cave”), Recovery Control Room, Simulation Control Room, and Visitors Viewing Area – by Philco. Note the detail includes the upholstery seating color in the Visitors Viewing Area, and the proper configuration of projectors and mirrors in the “Bat Cave”. The Visitors Viewing Area was entered only via the north and south stairs climbing to the communications booths before the addition of the Visitors Lobby elevator and new entrance and wheelchair ramp along the back wall.
## LIST OF RECOMMENDED FURNISHINGS

<table>
<thead>
<tr>
<th>Furnishings Type</th>
<th>Location</th>
<th>Description</th>
<th>Recommendation</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio speakers</td>
<td>Ceiling</td>
<td>Brushed metal cover plates; flush-mounted in ceiling</td>
<td>Preserve in place.</td>
<td>![Image]</td>
</tr>
<tr>
<td>Acoustical tiles</td>
<td>Ceiling</td>
<td>Appear to match original photos</td>
<td>Preserve in place.</td>
<td>![Image]</td>
</tr>
<tr>
<td>HVAC Diffusers</td>
<td>Ceiling</td>
<td>Nine square, white, aluminum, flush-mounted in ceiling alternating with lighting fixtures</td>
<td>Preserve in place.</td>
<td>![Image]</td>
</tr>
<tr>
<td>Lighting, overhead, fluorescent</td>
<td>Ceiling</td>
<td>Four rows of eleven narrow, rectangular fluorescent lighting fixtures with standard plastic lenses. At construction, special lenses to prevent radiated radio-frequency were considered and rejected.</td>
<td>Preserve in place. Install filtering sleeves to reduce UV radiation.</td>
<td>![Image]</td>
</tr>
<tr>
<td>Lighting, overhead, incandescent</td>
<td>Ceiling</td>
<td>28 recessed, dimmable, square, ceiling mounted fixtures</td>
<td>Preserve in place. Mitigate to reduce UV radiation.</td>
<td>![Image]</td>
</tr>
<tr>
<td>Group display cameras</td>
<td>Ceiling</td>
<td>Three brackets on the east wall (center an SE corner) and one on northwest corner; camera sizes differed; different function?; also on tripods in NW and SE corners</td>
<td>Reinstall three cameras with original or replacement technology.</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Console Status Report Module | Console area | Preserve and restore as appropriate. |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Area</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chairs, Steno style</td>
<td>Console</td>
<td>Steel frame with padded gray upholstery with piped edges and black, padded arms; rolling</td>
<td>Retain; Not original models but a similar style.</td>
</tr>
<tr>
<td>Console Analog Meters</td>
<td>Console</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
<td></td>
</tr>
<tr>
<td>Console communication panels</td>
<td>Console</td>
<td>Philco WDL; included PABX rotary dial</td>
<td>Most of the consoles contain these Apollo-era modules. Inspect, preserve, and restore as appropriate.</td>
</tr>
<tr>
<td>Console Display Request Keyboard (DSK)</td>
<td>Console</td>
<td>Philco WDL</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td>Console Event Module</td>
<td>Console</td>
<td>Philco WDL</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td>Console Manual Select Keyboard (MSK)</td>
<td>Console</td>
<td>Philco WDL</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td>Apollo Mission Control Center — Historic Furnishings Report and Visitor Experience Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Console Monitor</strong></td>
<td><strong>Console area</strong></td>
<td>Aeronautics Corporation of America; Lockheed Martin (formerly Loral). Cathode Ray Tube (CRT); two per console; 14&quot; monitors in rack-mounted drawers with handles on both sides</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td><strong>Console shells</strong></td>
<td><strong>Console area</strong></td>
<td>Lockheed Martin (formerly Loral); sage-green, number of bays varied from one to four; panel space was divided into two modular areas (7&quot;x19&quot; and 14&quot;x19&quot;) that could be further subdivided. Panels could be mounted either vertically or horizontally.</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td><strong>Console Summary Message Keyboard (SMEK)</strong></td>
<td><strong>Console area</strong></td>
<td>Philco WDL</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td><strong>Flight Controllers Abort Command Module</strong></td>
<td><strong>Console area</strong></td>
<td>Philco WDL</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td>Item</td>
<td>Location</td>
<td>Description</td>
<td>Instructions</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Group time and data display units</td>
<td>West end</td>
<td>Mounted over the display screens on west side of room; large-scale alphanumeric readout assemblies and display drivers</td>
<td>Retain; reactivate if possible to show GMT, etc.</td>
</tr>
<tr>
<td>Headsets</td>
<td>Console area</td>
<td>Two types: Plantronics and &quot;earmuff,&quot; headsets individually assigned and stored in lockers between shifts. Extras kept for observing guests for duration of mission periods.</td>
<td>Display originals or replacements at consoles</td>
</tr>
<tr>
<td>Log, Console Discrepancy</td>
<td>Console area</td>
<td></td>
<td>Restore facsimiles</td>
</tr>
<tr>
<td>Log, Flight Director's</td>
<td>Console area</td>
<td></td>
<td>Restore facsimiles</td>
</tr>
<tr>
<td>Flight Mission Rules</td>
<td>Console area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maps of Earth</td>
<td>Console area</td>
<td>paper, long, rectangular, color, taped to back of console</td>
<td>Restore facsimiles</td>
</tr>
<tr>
<td>Item Description</td>
<td>Location</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-----------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Pneumatic tube carriers (canisters)</td>
<td>Console area</td>
<td>Cylindrical; metal; spring-loaded-closed doors. For delivery of hard copy printouts of displays.</td>
<td>Preserve and restore. Display originals in P-tube stations.</td>
</tr>
<tr>
<td>Pneumatic tube delivery system</td>
<td>Console area</td>
<td>Philco, under NASA contract NAS 9-1261. Conduit, hangers, deflector valves, and wiring removed in 1998</td>
<td>No action</td>
</tr>
<tr>
<td>Pneumatic tube stations (aka &quot;receivers&quot;)</td>
<td>Console area</td>
<td>Mark Controls Corp. See station directory and photos for locations</td>
<td>Restore in individual consoles, according to plan diagrams.</td>
</tr>
<tr>
<td>Television monitors, freestanding</td>
<td>Console area</td>
<td></td>
<td>Restore.</td>
</tr>
<tr>
<td>3-hole punch</td>
<td>Console area</td>
<td>Vintage 3 Hole Punch Master Products Series #1000 Industrial Office Products</td>
<td>Restore.</td>
</tr>
<tr>
<td>Item</td>
<td>Area</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>3-hole Ring Binders</td>
<td>Console area and book-cases</td>
<td>3-ring. Later missions had binders with photos of lunar service that controllers consulted during lunar landing.</td>
<td>Restore.</td>
</tr>
<tr>
<td>Bookshelves, short</td>
<td>Console area</td>
<td>Two shelves; gray metal government issue; positioned as end caps to console rows</td>
<td>Preserve and restore as appropriate.</td>
</tr>
<tr>
<td>Bookshelves, tall</td>
<td>South wall</td>
<td>Gray metal government issue; tall ones near coat racks; short ones near consoles</td>
<td>Preserve and restore as appropriate.</td>
</tr>
<tr>
<td>Clipboards</td>
<td>Console area</td>
<td>Hung on back of consoles or on desks</td>
<td>Restore.</td>
</tr>
<tr>
<td>Desktop computer</td>
<td>Console area</td>
<td>The &quot;Programma 101&quot; (P101), by Olivetti, used in MOCR as early as 1969, during missions for rapid calculations the mainframe couldn't handle quickly, such as the descent fuel computation for the lunar landing</td>
<td>Restore.</td>
</tr>
<tr>
<td>Flight controller assignment signs</td>
<td>Console area</td>
<td>Not historic--added for interpretive assistance.</td>
<td>Retain as exhibit signage.</td>
</tr>
<tr>
<td>Hardcopy prints</td>
<td>Console area</td>
<td>Monitor displays requested and sent through p-tubes</td>
<td>Restore.</td>
</tr>
<tr>
<td>Legal pads—yellow</td>
<td>Console area</td>
<td></td>
<td>Restore.</td>
</tr>
<tr>
<td>Item</td>
<td>Location</td>
<td>Details</td>
<td>Action</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Pencil sharpeners</td>
<td>Console area</td>
<td>Desk-edge mounted; rotary, manual, steel. Manufactured by Apsco.</td>
<td>Restore</td>
</tr>
<tr>
<td>Pencils</td>
<td>Console area</td>
<td>Venus yellow pencils in cardboard box; manufactured by Venus-Esterbrook of NYC; used also for punching the console buttons</td>
<td>Restore</td>
</tr>
<tr>
<td>Rotary Dial Telephones; desktop style</td>
<td>Console area</td>
<td>Red DOD phone is historically accurate; other phones mounted on backs of consoles</td>
<td>Preserve and restore as appropriate.</td>
</tr>
<tr>
<td>Ruler</td>
<td>Console area</td>
<td>wooden</td>
<td>Restore</td>
</tr>
<tr>
<td>Speaker, portable desktop</td>
<td>Console area</td>
<td>aka &quot;the squawk box&quot;</td>
<td>Preserve</td>
</tr>
<tr>
<td>Stop Clock</td>
<td>Console area</td>
<td>Philco-Ford. On only two consoles.</td>
<td>Preserve and restore as appropriate.</td>
</tr>
<tr>
<td>Item</td>
<td>Location</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Tape dispenser</td>
<td>Console area</td>
<td>Metal, industrial style</td>
<td>Restore</td>
</tr>
<tr>
<td>Tape recorder, reel-to-reel</td>
<td>Console area</td>
<td>Desktop size</td>
<td>Restore</td>
</tr>
<tr>
<td>Tapes, reel-to-reel</td>
<td>Console area</td>
<td>Scotch brand, in cardboard cases</td>
<td>Restore</td>
</tr>
<tr>
<td>Trash can</td>
<td>Console area</td>
<td>Freestanding, at ends of console rows. Rectangular steel refuse receptacles with self-closing, pyramidal top; Solar Sturges Mfg.</td>
<td>Restore</td>
</tr>
<tr>
<td>Ashtrays, beanbag style</td>
<td>Console area</td>
<td>Beanbag cloth base in white, cream, or gray; metal top; 3&quot; to 4&quot;</td>
<td>Restore</td>
</tr>
<tr>
<td>Ashtrays, glass</td>
<td>Console area</td>
<td>Amber/brown glass, round; approx. 6&quot; to 8&quot; diam.; possibly Anchor Hocking?</td>
<td>Restore</td>
</tr>
<tr>
<td>Item</td>
<td>Location</td>
<td>Description</td>
<td>Restoration Status</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Briefcases</td>
<td>Console area</td>
<td>brown leather</td>
<td>Restore</td>
</tr>
<tr>
<td>Cigarettes</td>
<td>Console area</td>
<td>Winston, Kent</td>
<td>Restore</td>
</tr>
<tr>
<td>Cigars</td>
<td>Console area</td>
<td>R.G. Dun Palma Deluxe, 50 ct. box, Kraft desk (he passed them out)</td>
<td>Restore</td>
</tr>
<tr>
<td>Coffee cups, disposable</td>
<td>Console area</td>
<td>Styrofoam</td>
<td>Restore</td>
</tr>
<tr>
<td>Coffee mugs, reusable</td>
<td>Console area</td>
<td>ceramic</td>
<td>Restore</td>
</tr>
<tr>
<td>Coffee pot</td>
<td>Console area</td>
<td>Ed Fendell said that this was kept in the control room. Where was it set up? Do any of the controllers remember the type/style?</td>
<td>Restore, if verified</td>
</tr>
<tr>
<td>Flags--small, on sticks</td>
<td>Console area</td>
<td>Wooden stick with spear tip; nylon flag; 8&quot; x 12&quot;?</td>
<td>Restore</td>
</tr>
<tr>
<td>Lighter, cigarette</td>
<td>Console area</td>
<td></td>
<td>Restore</td>
</tr>
<tr>
<td>Pipe and pouch</td>
<td>Console area</td>
<td></td>
<td>Restore</td>
</tr>
<tr>
<td>Item Description</td>
<td>Location</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Roses, bouquet</td>
<td>Console area</td>
<td>Bouquet arrived before each Apollo mission from “Cindy,” an admirer. Controllers considered it a talisman of public support and positioned it on a table to make it visible on television.</td>
<td>Restore (artificial bouquet). Need to consult with Kranz to find out where they were typically placed.</td>
</tr>
<tr>
<td>Models, spacecraft</td>
<td>Console area</td>
<td>Desktop size</td>
<td>Restore.</td>
</tr>
<tr>
<td>Windows, viewing room</td>
<td>East end</td>
<td>A ribbon of five glass viewing windows arranged along the center line of the vertical wall at roughly waist height. The two smaller windows on each end provide views from the communications booths.</td>
<td>Preserve.</td>
</tr>
<tr>
<td>Carpeted tile flooring</td>
<td>Flooring</td>
<td>A modular system of carpeted tiles removable for cable access. Carpet replaced in at least some areas (around consoles) in 1998 with p-tube station removal.</td>
<td>Replacement with light-gray carpeted tiles is best options. At minimum, remove safety tape, clean throughout and replace most damaged sections.</td>
</tr>
</tbody>
</table>

56 Kranz, 278. He writes that the vase of flowers was placed on a small table in a location where it could be seen on television as cameras picked up controllers congregating to celebrate a mission success. Location of that table still needs to be determined.
### Apollo Mission Control Center — Historic Furnishings Report and Visitor Experience Plan

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Location</th>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door, northeast entry</td>
<td>North end</td>
<td>Metal swing doors (2); open out into corridor with push bar handles</td>
<td>Preserve</td>
</tr>
<tr>
<td>Door, northwest entry</td>
<td>North end</td>
<td>Metal swing doors (2)</td>
<td>Preserve</td>
</tr>
<tr>
<td>Hand Rail, entry ramp</td>
<td>North end</td>
<td>Original; solid oiled walnut (1-3/8&quot; thick, 5-5/8&quot; wide), steel brackets painted black, aluminum tube frame and caps; its counterpart was removed in second floor MOCR</td>
<td>Preserve. Repair damaged areas.</td>
</tr>
<tr>
<td>Windows, Staff Support Rooms</td>
<td>North end</td>
<td>Square windows; groups of four, two, and two along north wall.</td>
<td>Preserve. Remove non-historic curtains and opaque coverings.</td>
</tr>
<tr>
<td>Utility cabinets, lighting switches</td>
<td>North end</td>
<td>House the control switches for incandescent and florescent lights in control room and viewing room</td>
<td>Preserve. Operating plan should consider that spare parts are in short supply.</td>
</tr>
<tr>
<td>Item</td>
<td>Location</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Storage cabinet</td>
<td>North end</td>
<td>Metal, vertical steel. Contains console event modules (18 and 32 events); MSKs, status report modules.</td>
<td>Inventory contents for historic value and store items not used in secure location.</td>
</tr>
<tr>
<td>Mission Plaques (wall)</td>
<td>North end; South end</td>
<td>Full color, mounted on north wall for Gemini and early Apollo missions by 1969, if not earlier. Includes Mission Control patch recognizing controllers in 1973. Those positioned directly under lights are UV-faded.</td>
<td>Preserve in place and repair, as needed.</td>
</tr>
<tr>
<td>Door, south entry</td>
<td>South end</td>
<td>Metal swing door (1); opens inward</td>
<td>Preserve</td>
</tr>
<tr>
<td>Calendar, wall-mounted</td>
<td>South end</td>
<td>White board style calendar mounted over the water fountain on the south wall</td>
<td>Restore.</td>
</tr>
<tr>
<td>Drinking water fountain</td>
<td>South end</td>
<td>Manufacturer is Cordley; water fountain was removed in 2nd floor MOCR in 1996.</td>
<td>Preserve.</td>
</tr>
<tr>
<td>Fire Extinguisher</td>
<td>South end</td>
<td>Location between drinking fountain and south door.</td>
<td>Preserve location for modern equipment, if possible.</td>
</tr>
<tr>
<td>Electrical panel</td>
<td>South end</td>
<td>Electrical, security, fire, A/C systems had multiple upgrades.</td>
<td>Preserve location for modern equipment, if possible.</td>
</tr>
<tr>
<td>Item</td>
<td>Location</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Fire Control Box</td>
<td>South end</td>
<td>Electrical, security, fire, A/C systems had multiple upgrades.</td>
<td>Preserve location for modern equipment, if possible.</td>
</tr>
<tr>
<td>Apollo 13 lunar module mirror</td>
<td>South end</td>
<td>Presented to Mission Control by flight crew in recognition of role they played in successful return</td>
<td>Preserve</td>
</tr>
<tr>
<td>Flight Director Retirement Proclamations</td>
<td>South end</td>
<td>Framed paper certificates in two rows of 9 each; recognized and retired signature color for each Flight Director</td>
<td>Preserve 2013-11-18 11.21.13.jpg</td>
</tr>
<tr>
<td>Coat racks</td>
<td>South wall</td>
<td>Gray metal, freestanding, 3 shelves w/ matching metal hangers; both sides of room. Only one small rack remains; pictures show two racks lining the wall. Lyon Metal Products?</td>
<td>Preserve and restore as appropriate.</td>
</tr>
<tr>
<td>Wallcovering/wallboard</td>
<td>Walls</td>
<td>Gypsum board with woven-style covering</td>
<td>Preserve</td>
</tr>
<tr>
<td>Screens, rear projection viewing, 10 x 10 feet</td>
<td>West end</td>
<td>Polacoat lenticular screens; quantity: 4. Data on the left screens; live feed on the right.</td>
<td>Preserve</td>
</tr>
<tr>
<td>Item Description</td>
<td>Location</td>
<td>Details</td>
<td>Action</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Screens, rear projection viewing, 10 x 20 feet</td>
<td>West end</td>
<td>Original was Polacoat LS-60; quantity 1; glass in aluminum frame; 1200 pounds. Replaced and stored in Dec. 1989 due to deterioration and changing optical needs; new screens are washable, with better off-angle properties and clarity.</td>
<td>Retain replacement screen</td>
</tr>
<tr>
<td>X-Y Plotboard, Manual</td>
<td>West end</td>
<td>Possibly made by Milgo; Five in the front of the room during Gemini; holdover as they were learning to trust projection plotting system</td>
<td>No action required. Gemini-era only.</td>
</tr>
<tr>
<td>Microphone stand</td>
<td>West end</td>
<td>Not historic; used for ceremonial functions today</td>
<td>Remove and store out of sight when not in use</td>
</tr>
<tr>
<td>Podium</td>
<td>West end</td>
<td>Not historic; used for ceremonial functions today</td>
<td>Remove and store out of sight when not in use</td>
</tr>
<tr>
<td>Speakers, stand-mounted</td>
<td>West end</td>
<td>Two in front of room; Not historic; used for ceremonial functions today</td>
<td>Remove and store out of sight when not in use</td>
</tr>
<tr>
<td>Description</td>
<td>Location</td>
<td>Details</td>
<td>Action</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>----------</td>
<td>------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Flag--lunar type example</td>
<td>West end</td>
<td>in NW corner; 3-foot-by-5-foot nylon flag hemmed on the top edge; hung on a pole of gold, anodized aluminum, 1-inch diameter tubing with a horizontal, telescoping curtain rod to make the flag appear to &quot;fly;&quot; mounted on gold wall bracket; Developed by Jack Kinzler, Chief of the Technical Services Division during Apollo 11.</td>
<td>Preserve</td>
</tr>
<tr>
<td>Moon landing replica plaque</td>
<td>West end</td>
<td>Replica of plaque mounted on Apollo 11 lunar module descent stage; stainless steel plaque mounted on wood. &quot;Here men from the Planet Earth first set foot upon the moon. July 1969 AD. We came in peace for all mankind.&quot; Signatures of Armstrong, Aldrin, Collins, and President Nixon. Designed by Jack Kinzler and his assistant chief, David McCraw</td>
<td>Preserve</td>
</tr>
<tr>
<td>Plotting boards (X-Y Recorders)</td>
<td>West end</td>
<td>Mfr: Milgo, Model 3010</td>
<td>No action required--Gemini-era only.</td>
</tr>
<tr>
<td>Sign, to keep hands off screen</td>
<td>West end</td>
<td>see photos</td>
<td>?</td>
</tr>
<tr>
<td>Furnishings Type</td>
<td>Location</td>
<td>Description</td>
<td>Recommendation</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Audio speakers</td>
<td>Ceiling</td>
<td>Brushed metal cover plates; flush-mounted in ceiling</td>
<td>Preserve</td>
</tr>
<tr>
<td>Acoustical tiles</td>
<td>Ceiling</td>
<td>Appear to match original photos</td>
<td>Preserve</td>
</tr>
<tr>
<td>HVAC Diffusers</td>
<td>Ceiling</td>
<td>Nine, square, white, aluminum, flush-mounted in ceiling alternating with lighting fixtures</td>
<td>Preserve</td>
</tr>
<tr>
<td>Lighting, overhead, fluorescent</td>
<td>Ceiling</td>
<td>Rows of narrow, rectangular fluorescent lighting fixtures with standard plastic lenses.</td>
<td>Preserve. Install filtering sleeves to reduce UV radiation.</td>
</tr>
<tr>
<td>Lighting, overhead, incandescent</td>
<td>Ceiling</td>
<td>8 recessed, dimmable, square, ceiling mounted fixtures alternating with air diffusers. In March 1990, work order for “material to install lighting” in this room (Doc #J-24292).</td>
<td>Preserve and mitigate UV radiation.</td>
</tr>
<tr>
<td>Doors, entry</td>
<td>East end</td>
<td>two sets at each end of rear (east) wall</td>
<td>Retain</td>
</tr>
<tr>
<td>Apollo Mission Control Center — Historic Furnishings Report and Visitor Experience Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Telephone booths</td>
<td>East end</td>
<td>Four (two in each back corner). Contain original counters and doors.</td>
<td>Retain and consider restoring rotary phone units.</td>
</tr>
<tr>
<td>Wheelchair ramp and railing</td>
<td>East end</td>
<td>Includes metal safety railing</td>
<td>Retain</td>
</tr>
<tr>
<td>Standing desk</td>
<td>East end</td>
<td>In back of room behind and adjacent to tiered seating rows. Woven-style covering on the plywood surface, which is the same as the wallcovering in this room and control room, is peeling up at the edges.</td>
<td>Retain, clean, and repair.</td>
</tr>
<tr>
<td>Carpet</td>
<td>Flooring</td>
<td>Carpet with padding throughout the viewing area and the adjacent communications booths</td>
<td>Retain, clean, and repair.</td>
</tr>
<tr>
<td>Stairs</td>
<td>Seating area</td>
<td>On north and south ends of seating rows. Carpeted; lit; safety strips.</td>
<td>Retain and restore as appropriate.</td>
</tr>
</tbody>
</table>
| Seating   | Seating area | AMSECO? 74 seats in five tiers; upholstered seats, backs, and arm rests in red/orange heavy-duty or commercial fabric and piped edging; theater-style with folding seats; steel frame and steel bucket seat pans; plywood end caps and wood backing with metal flip-lid ashtrays (Lawrence Metal Products) on every other seat back. | Preserve, clean, and repair. Wooden endcaps are scuffed and dented and cushions are stained. Check frames and hardware, repair missing parts including ashtray lids.

"1710" and "175683(?)" below the seats on the frame. A number "18" is stamped on the bottom of metal seat pan. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashtrays, freestanding</td>
<td>Seating Area</td>
<td>Artist drawing of Apollo 11 shows freestanding metal ashtray</td>
<td>No action required. Installation may not be practical due to heavy visitor traffic on stairs.</td>
</tr>
<tr>
<td>Wallcovering</td>
<td>Walls</td>
<td>Gypsum wallboard with woven-style covering</td>
<td>Retain; clean and repair where needed</td>
</tr>
<tr>
<td>Photomurals on walls</td>
<td>Walls</td>
<td>Enlarged EVA photos</td>
<td>Remove</td>
</tr>
<tr>
<td>332A--JSC Director's Office (Communications Booth)</td>
<td>West end</td>
<td>north end of room; roughly 8' x 7'; three windows; wood swing door on east wall</td>
<td>Retain and restore, as appropriate. Remove blinds and furnish appropriately.</td>
</tr>
<tr>
<td>Location</td>
<td>Description</td>
<td>Recommendation</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Audio speakers</td>
<td>Brushed metal cover plates; flush-mounted in ceiling</td>
<td>Preserve</td>
<td></td>
</tr>
<tr>
<td>Ceiling tiles</td>
<td>Acoustical tiles, painted black</td>
<td>Preserve</td>
<td></td>
</tr>
<tr>
<td>HVAC Diffusers</td>
<td>13 square, white, aluminum, flush-mounted in ceiling alternating with lighting fixtures</td>
<td>Preserve</td>
<td></td>
</tr>
<tr>
<td>Lighting, incandescent</td>
<td>5 recessed, dimmable incandescent, square, ceiling mounted fixtures</td>
<td>Preserve</td>
<td></td>
</tr>
<tr>
<td>Doors, entry</td>
<td>East end</td>
<td>Metal swing doors from northwest corner of control room; also a door from the room beyond?</td>
<td>Preserve</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Projection Television Display Equipment</td>
<td>East end</td>
<td>875-line Eidophor Projectors (EP-2 Model) purchased from Theater Network TV, New York, NY; used a 2kW xenon lamp; Quantity 2. Replaced with GE light valve projector in 1989.</td>
<td>Replace with cost-effective alternative</td>
</tr>
<tr>
<td>Projector Plotting Display Equipment</td>
<td>East end</td>
<td>Mfg. by E-Systems, Inc. The rear projection subsystem of 7 projectors: one Xenon background projector, four Xenon scribing projectors, and two Xenon spotting projectors</td>
<td>Restore if possible, or replace with cost-effective alternative.</td>
</tr>
<tr>
<td>Floor</td>
<td>Floor</td>
<td>Not carpeted; painted black</td>
<td>Preserve</td>
</tr>
<tr>
<td>Wallboard</td>
<td>Walls</td>
<td>Gypsum board; painted black</td>
<td>Preserve</td>
</tr>
<tr>
<td>Optical Fold Mirrors</td>
<td>West end</td>
<td>Used in conjunction with the PPD system to reflect the produced image onto the viewing screen. In storage.</td>
<td>Preserve and restore, as needed.</td>
</tr>
<tr>
<td>Slides</td>
<td></td>
<td>Used with historic projectors.</td>
<td>If projectors re-installed, select slides could be displayed</td>
</tr>
</tbody>
</table>
ADMINISTRATIVE HISTORY

A. National Historic Landmark Management Summary
The Apollo Mission Control Center National Historic Landmark (NHL) at Johnson Space Center is an excellent example of the challenges associated with historic preservation in an active operational setting operating under budgetary constraints and with multiple competing priorities. The NHL was designated on October 3, 1985, just 21 years after the date of construction. The designation recognized the importance of the entire Mission Control Center to the history of manned spaceflight, particularly in the Apollo era, but the historic site management and preservation has concentrated almost solely on the third-floor MOCR and Visitors Viewing Area. In the thirty years since designation, the Johnson Space Center has managed the site based on multiple priorities: ongoing mission operations, preservation compliance, and visitor education and interpretation. The JSC’s management policy statement applies to all civil service and contractor undertakings and measures the success of preservation efforts against the 1989 national Programmatic Agreement between NASA, the National Conference of State Historic Preservation Officers, and the Advisory Council on Historic Preservation (ACHP). The difficulties of preserving nationally significant historic resources in this setting have led to deteriorated physical integrity that can be addressed with greater attention to accurate restoration of the space and better preservation and maintenance standards.

National Historic Landmark Designation
The boundary of the Apollo Mission Control Center NHL is the perimeter of the original three-story structure known as Building 30. The Johnson Space Center constructed a substantial five-story addition to the original building footprint in 1991 as its programs expanded to include the Space Shuttle and the International Space Station. Harry Butowsky, author of the National Historic Landmark nomination form as well as the “Man in Space” theme study that supported it, argued that the significance of the original Mission Control Center building was due to “its close association with the manned spacecraft program of the United States.” While he noted that the achievement of the lunar landing during Apollo 11 was particularly important, he named each of the sequential manned spaceflight programs controlled from Building 30, including nine Gemini flights, all of the Apollo flights, and the Skylab, Apollo-Soyuz, and Space Shuttle flights to date, as evidence for the building’s significance in U.S. history. Butowsky also highlighted public recognition of the building in his argument. The use of television and print media coverage of the missions to promote support for NASA’s endeavors familiarized the general public with the mission control activities in the building. Along with Launch Complex 39 at the Kennedy Space Center in Florida, this particular NASA site is noted as one of “two resources that symbolize for most Americans the achievements of the manned space program leading to the successful first moon landing during the flight of Apollo 11 in July 1969.”

Challenge of Preservation at Active NASA Sites
The Apollo Mission Control Center NHL, along with its companion NHL at the JSC—the Space Environment Simulation Laboratory (SESL)—and the other 19 landmarks at NASA sites were

57 National Register of Historic Places, Apollo Mission Control Center, Harris County, Texas, National Register #85002815.
less than fifty years old and all part of active complexes when designated in October 1985. For this reason, some historic preservation officials believed that some of the sites would receive only Historic American Buildings Survey (HABS) and/or Historic American Engineering Record (HAER) documentation before demolition or reconfiguration to meet the needs of NASA’s ongoing mission priorities. Prior to the NHL designations, Thomas King, Director of the Office of Cultural Resource Preservation for the ACHP, pragmatically noted, “The mission of the agency [NASA] is paramount; we do not expect it to be sacrificed in favor of historic preservation. We see our job as one of working with agencies to accommodate historic preservation within their mission requirements. . . . It would certainly not be our intent to promote the transformation of active military installations and spaceflight facilities into museums.”

In addition, when the Apollo Mission Control Center NHL was designated in 1985, Building 30 had been the active control center for the newly established Space Shuttle program for only four years. The control room on the third floor of the Mission Operations Wing, known then as Flight Control Room 2 (FCR-2) rather than the original term, Mission Operations Control Room (MOCR), contained reconfigured and new equipment to support Shuttle missions, including classified DOD missions.

King correctly predicted that NASA’s response to the agency-wide designations that emerged from the theme study would be lukewarm at best, all things considered. NASA Headquarters opposed the designations because of concerns about how they would affect operations and began to advise staff at NASA installations on how to respond. Discussions about the NHLs at Johnson Space Center were interrupted immediately by the tragic explosion of the Space Shuttle Challenger orbiter (STS-51L) on January 28, 1986, in which all seven crew members were lost. The third-floor control room in Building 30 had served as the control room for the mission, and all JSC employees and contractors felt the loss acutely. NASA grounded the Shuttle program for two years, and the agency endured an unprecedented period of leadership turnover. The news of NASA’s newly designated landmarks thus coincided with a period of mourning, distraction, and anxiety about the future of NASA’s goals. Despite the awkward timing, the resulting hiatus from active mission control operations did not alter the agency’s long-term plans for building updates to serve the Shuttle program, nor did it remove the need to address the implications of a new directive to preserve Apollo-era history as a result of Building 30’s landmark status.

**Developing a Preservation Plan**

In response to the designation of the Apollo Mission Control Center NHL, JSC officials began to negotiate agreements with the Texas State Historic Preservation Office (SHPO) regarding preservation of the NHL. The Texas SHPO recommended preservation of Flight Control Room 2 (the third-floor MOCR) as well as its original furnishing and components. If this proved infeasible, the SHPO advocated for creating a replica of the control room at the JSC Visitor Center, using many of the original consoles and hardware. NASA initially balked at the request, arguing that they needed both control rooms to conduct Shuttle flights and simulations.

---

58 Thomas King, Advisory Council on Historic Preservation, letter to Dr. Ed Bearss, NPS, April 9, 1985, JSC History Office.
60 “Chronological Summary” document from National Historic Landmark files, JSC.
Construction of a new $16.8 million, five-story addition to Building 30 in 1992 dramatically changed the dynamics of these negotiations. The new wing provided new flight control rooms and allowed NASA to begin plans for the restoration and interpretation of the third-floor MOCR.

**Third Floor Apollo-Era Restoration**

General interest in historic control room activities grew with the production and release of the 1995 film *Apollo 13*, spurring further interest in preserving the third-floor MOCR. By early 1996, NASA was developing plans to restructure the use of the second-floor MOCR and use it for International Space Station and Shuttle simulations and operations by the end of the year. This reinforced the interest in using the third-floor MOCR as the place to interpret the history of the Apollo era. This plan would require an extension of the elevator from the Visitors Lobby to the third floor so that the control room could be used for visitor interpretation.\(^{61}\)

The JSC also had to coordinate with Space Center Houston, which had opened in October 1992, to create tours reflecting the new building configuration and to provide appropriate visitor access to the third floor.\(^{62}\) Plans called for outfitting the third-floor MOCR with Apollo-era furnishings and power to light up the panels, as well as reactivation of monochromatic displays on the old CRT monitors. The display screens at the front of the room would display videos of Apollo mission launches, lunar surface activities, and Earth/lunar ground track, and reactivated mission clocks. New access from the Visitors Lobby would allow for “a permanent, accessible, interpretive National Historic Landmark with an authentic setting.”\(^{63}\)

Descriptions of the changes made to the second-floor MOCR at that time reveal furnishings present in each control room in 1996 and provide a benchmark for historic furnishings that remained in place in the third-floor MOCR. In the second-floor MOCR, the JSC removed the water fountain and pneumatic tube send/receive stations, re-carpeted, painted, removed unused wiring, installed an underfloor grounding grid, and removed and stored “items of historical importance.”\(^{64}\) The SHPO letter of September 21, 1996, indicates provisional approval of this plan.\(^{65}\) Although the JSC did not commit the full funding to carry out the entire restoration of the third-floor MOCR, a modified version of the plan with installation of Apollo-era sage-green consoles was in place by 1998.

In April of 1999, at a time when the JSC considered and then dismissed a plan for extensive modifications to the “Bat Cave” to support active control center functions, the record indicates that Melody Nation and other JSC officials were still hoping to get the third-floor MOCR “back on line to display for tourism” but lacked the funding to implement the plan.\(^{66}\) Despite these hopes, not much happened until 2003 when the JSC made some additional changes to the

---

61 Melody Nation email to Rhea Saylor and Perri Fox, May 2, 1996, JSC Historic Preservation files.
64 John O’Neill, Director, Mission Operations, to JA/Director, Center Operations, July 31, 1996, NASA.gov.
65 Gerron Hite, Texas Historical Commission, to Melody Nation, Historic Preservation Officer, September 1, 1996, JSC Historic Preservation files.
Visitors Viewing Area and the projection room ("Bat Cave") to improve the visitor experience for the Space Center Houston tours. These changes were part of a larger effort that included modifications to the first-floor Visitors Lobby exhibits, installation of the Bob McCall artwork exhibit in the third-floor foyer outside of the Visitors Viewing Area, and the addition of photographs in the tourist-access stairwell. Inside the Visitors Viewing Area, the television units mounted in the front corners of the viewing area were replaced with flat-screen, speaker-enhanced models using the existing mounting bracket system; adding photomurals on each sidewall and six moon landing photos on the back wall with a mounting system that would not mark the walls; and adding temporary projectors on stands to the “Bat Cave” to project Apollo-era graphs and images on the display screens. The new televisions and projector would be controlled via infrared remote control from the Visitors Viewing Area by the Space Center Houston tram tour guides. Although the plan proposal called again for control room improvements, including the addition of “console identifier placards,” lights to the consoles, CRT images, dimming the lights in the MOCR and Visitors Viewing Area, a spotlight for the flight director console, and various options for maps and charts on the group displays, only the console placards were added. The 2003 plan also called for installation of small signs on the exterior doors of the MOCR to restrict use of the space as an “employee passageway” while visitors were in the Viewing Area.  

Ongoing considerations for restoring the third-floor control room, projection room, and viewing area included both practical requirements and the needs of historic tour operations. In 2007, the JSC consulted with the SHPO on replacing the carpet and wallcoverings in the Visitors Viewing Area with similar materials, with the goal of improving the room for visitors and correcting potential safety hazards, but that work was not implemented.

Film Productions in the NHL
Management of the NHL has also included ongoing requests from television and film production crews who want to film inside the historic control room. In 1994 interest in the historic configuration of the control room renewed with production of the feature film Apollo 13. Producers Ron Howard and Brian Grazer asked NASA to cooperate on the project as they considered shooting it on location in Building 30 in the MOCR on the third floor. After some consideration of logistics, the production team determined it would be simpler to re-create the Apollo-era MOCR on Stage 27 at Universal Studios in Los Angeles with the assistance of cinematic architect Michael Corenblith. To prepare for the construction project, he and his team shot more than 500 rolls of film inside Building 30 and created more than 30 pages of blueprints. The location of the rolls of film and blueprints is unknown today. For the

---

production and set design, JSC loaned Universal Studios multiple historic objects, including the MCC floor plan model and nineteen vertical and horizontal keysets.  

In fall 2010, Paramount Pictures shot footage for *Transformers: Dark of the Moon*, using JSC team members from the Mission Operations Directorate (MOD) as paid extras who played non-speaking roles as flight controllers. The scene depicted an Apollo moon landing and cast males over twenty-five years of age who were willing to wear period costumes and haircuts from the late 1960s. JSC notified the SHPO that the film company would install a temporary platform in the Visitors Viewing Area for cameras, which required temporary removal of two rows of seating. JSC also allowed Paramount Pictures to change out the light bulbs to accommodate their lighting requirements and replace the original bulbs after filming, and to cover the Shuttle plaques on the walls of the control room with fabric so the room would reflect only Apollo-era artifacts. The production company also installed a camera track on the carpeted floor in front of the consoles, which held a 1,300-pound, 15-foot crane. A JSC Facility Engineer approved the weight and load limit. Finally, JSC allowed Paramount Pictures to use “Special Effects Smoke” to simulate cigarette smoke in the room.

**Current Access to the Apollo-Era Preserved/Restored Areas in the NHL**

In addition to occasional interest from television and film production companies, Space Center Houston brings 700,000 visitors to the Visitors Viewing Area each year. JSC staff use the control room as a training site for co-op interns, as sites to conduct oral history interviews with former flight controllers, to educate and entertain VIP visitor groups on private tours with the External Relations staff, and to conduct recognition ceremonies. These multiple uses continue to impact the historic fabric of the NHL, which has few protective safeguards in place to prevent excessive wear, fading, and other damage. Thus, the NHL space in Building 30 has deteriorated and would benefit from a review of access policies and procedures, as well as a plan for preservation and restoration.

**B. Prior Planning Documents and Documentation Reports**

Prior reports that pertain to the documentation and/or preservation of the Apollo Mission Control Center NHL include the following:


Archaeological Consultants, Inc. “Survey and Evaluation of NASA-owned Historic Facilities

---

70 Melody Nation, Facility Development Division, memorandum and draft loan agreement, to Stan Graves of the Texas Historical Commission, June 23, 1994, JSC-Historic Preservation files.
72 Sandra Tetley, JSC Historic Preservation Officer, to Mark Wolfe, State Historic Preservation Office, September 13, 2010; JSC Historic Preservation files.
73 NASA staff presented this rough figure in the August 25-26, 2014 preservation and interpretation workshop for the NHL in Building 20.


Johnson, Michael Peter. “‘This is Ground Control’: The Invention of Mission Control Centers in the United States and Europe,” unpublished dissertation submitted to the Graduate Faculty of Auburn University, May 7, 2012.


Programmatic Agreement among the National Aeronautics and Space Administration, National Conference of State Historic Preservation Officers, and the Advisory Council on History Preservation, 1989
HISTORICAL INFORMATION AND DETAILED EVIDENCE OF ROOM USE

A. History of the Structure
The original purpose of the 1964 Mission Control Center (MCC, aka Building 30) at NASA’s Manned Spacecraft Center in Houston was to centralize control of manned spacecraft missions in a single building that was linked to a support system of globally dispersed stations in the Manned Spaceflight Network (MSFN). Together, the MCC and the MSFN were known as the Ground Operations Support Systems (GOSS), which made possible the achievements of the Gemini and Apollo spaceflight programs in the center’s first decade of operations. Construction of the MCC was concurrent with the initial development of the Manned Spacecraft Center campus in Clear Lake, Texas, approximately 25 miles from downtown Houston in an undeveloped area.

The process to develop the 1,260-acre facility began in the fall of 1961 in response to President John F. Kennedy’s challenge in May of that year to achieve a lunar landing by the end of the decade. On September 19, NASA Administrator James Webb announced that Houston would be the site for a new manned spaceflight center that would be essential to meet that goal. Under the direction of Robert Gilruth, members of the Manned Spacecraft Center group (formerly known as the Space Task Group) moved to Houston and consulted with the U.S. Army Corps of Engineers in its oversight role as the construction agency for the project.

A long chain of contractors and subcontractors contributed to the design and construction of the Manned Spacecraft Center. The Corps selected the firm Brown and Root Engineering to develop the site. Brown and Root engaged Austin-based architectural firm Charles Luckman Associates to develop the campus Master Plan and also hired Houston-based firms Harvin C. Moore, MacKie & Kamrath, and Wirtz, Calhoun, Tungate & Jackson as additional subcontractors. Charles Luckman Associates developed the simple design vocabulary and elements that allowed for rapid construction. The basic architectural concept for many of the buildings was a steel-frame structure on a poured concrete foundation with exterior walls of precast exposed aggregate facing (PEAF) panels.74

The design for Building 30 followed this basic scheme but its size and windowless operations wing made it stand out from the other structures on the campus. Located between 2nd Street and 4th Street and south of Avenue C on the campus, the Mission Control Center was known in its development phase as the Integrated Mission Control Center (IMCC). The idea of integration was the major innovation represented by this new facility, which allowed NASA to centralize, consolidate, and direct all of the activities required for a successful spaceflight mission, from planning to flight control. Manned Spaceflight Network personnel worked in the building’s control rooms and staff support rooms alongside the Houston-based teams to coordinate communications associated with ground network activity. Other primary activities in the building included simulation checkout and training system exercises, flight control, and the computer complex. The building’s design considered the ideal spatial and technical relationships between

these activities and allowed NASA to bring all computer programming efforts to one site as well as conduct simulations in the same facilities used for actual flights.\footnote{Jerolimov, “NASA Johnson Space Center: Apollo Mission Control,” 14.}

The original MCC (Building 30) structure was 252,390 square feet—the largest building on the campus at the time. Kaiser Engineers of Oakland, California, designed the building in 1962, and a joint effort between W.S. Bellows Construction Corporation and Peter Kiewit and Sons allowed work on the foundation and structural steel frame to begin in April 1962 and reach completion by May 1963. As contractor Ets-Holkin & Galvin finished the structure in November 1964, construction costs totaled $8,050,072. The actual cost for the building’s 112,896-square-foot Mission Operations Wing alone, including the control rooms, computer complex, and staff support rooms, was many times the modest original budget of $492,192 for that wing. The construction of the building was right on schedule, however, and NASA employees began moving into Building 30 in the spring of 1964, although the full installation of the computers and equipment required nearly another full year of effort.\footnote{Ibid., “Manned Spacecraft Center Inventory Detail List,” (Folder 1), Box 7, Series IV, Construction of MSC, 1963-1982, Jack McCaine NASA Papers, Woodson Research Center, Rice University, Houston, Texas; Jerolimov, 8-9; Kraft, Flight, 204.}

The construction of the building was fairly straightforward compared to the sophisticated technical systems required for the mission control operations. In retrospect, we now understand the Apollo-era activities as Earth-based mission command at its apex before on-board computer systems evolved for spacecraft and changed the role of flight controllers on the ground. The knowledge gained in Project Mercury (1959-1963) and some of its early systems did provide the basis for the increasingly complex and sophisticated goals and programs associated with the Gemini and Apollo projects. The manned space flight program was in a period of rapid evolution to work out the requirements for successful Earth-based command for lunar orbit and landing when Building 30 was planned and constructed, and thus the Houston control center was far more complex than its predecessor, Mercury Control on Cape Canaveral, Florida. The changing physical infrastructure and number of buildings at all NASA sites in that era as well as the specialized variety of equipment, furnishings, and technology found inside reflect that evolution in complexity.

On January 28, 1963, while the foundation and steel building frame were being constructed, the Philco Corporation earned the $33.8 million contract [NAS 9-1261] to design the equipment and integration plan for the building. In a news release, NASA underscored the importance of its contribution to the control center, stating, “Philco will provide the ‘pulse’ of the Integrated Mission Control Center.” In the Request for Proposal (RFP) process, the company bested six qualified competitors—ITT, RCA, Lockheed, IBM, Hughes, and Bendix.\footnote{Report of the Source Evaluation Board, n.d., Box 7B, Center Series, JSC History Collection, University of Houston-Clear Lake Archives; NASA News Releases NR63-66 and NR 63-14, NASA.gov.} Philco was a Ford Motor Company subsidiary with fifty years of experience as a government contractor in electronics and communications, including the Mercury Control Center in Florida. Philco’s Western Development Laboratories Division in Palo Alto, California, directed the design and development of the systems for the MCC in cooperation with Philco Houston Operations, which employed about 250 people. Other Philco divisions involved in the development of the MCC
included its Communications and Electronics Division, the TechRep Division, and the Philco Scientific Laboratory—all in the Philadelphia area—and the Aeronutronic Division in Newport Beach, California.

IBM’s Federal Systems Division, which had provided the computer for the Mercury Control Center, was selected to outfit the Real Time Computing Complex (RTCC) that would provide the system to support the mission control operations throughout the control center. The RTCC’s original system included five IBM 7094 mainframe computers that drove all of the displays that appeared on the consoles in the control rooms. While it was the most powerful computer complex in the world in 1965, the system would require numerous upgrades to keep up with the rapidly evolving goals and needs of the Apollo program.  

The original footprint of the IMCC included two wings of similar size connected by a smaller, central, three-story lobby. The Operations Support Wing was a three-story structure with windows that housed the Mission Planning and Analysis Division, the Flight Control Division, and the Flight Support Division. The Mission Operations Wing was also three stories, but windowless to make it less vulnerable to weather and radio wave disruptions. Most notably, it housed the two Mission Operations Control Rooms (known at NASA as the MOCRs, pronounced mo-kers), twelve Staff Support Rooms (six for each MOCR), and the Real Time Computer Complex. Entrance to the Mission Operations Wing was gained through the central lobby. The rectangular corridor on the perimeter of the second and third floors provided access to the Staff Support Rooms, also known as the “back rooms,” the recovery operations room occupied by Navy officials who coordinated astronaut recovery after splash down, and the meteorological room. In the center of the second and third floors were the Mission Operations Control Rooms and their adjacent Visitors Viewing Areas and Group Display Areas.  

Although internal room configurations and uses shifted, the building remained unchanged until the 1980s. In the fall of 1982, the Visitors Lobby was the first addition to Building 30. Because the Lyndon B. Johnson Space Center (designated as such in 1973 in honor of the late President) was preparing to operate secure Department of Defense missions as a core activity for the new Space Shuttle program, the new lobby provided a separate entrance for visitors to access an elevator and stairs that led only to the second-floor Visitor Viewing Room. The second addition to the building, in 1987, was a 3,472-foot extension on the north end of the Mission Operations Wing, which added mechanical rooms and storage.  

As the decade continued, Space Shuttle activities and the development of the International Space Station program demanded additional space in the Mission Control Center. Construction on a five-story, 60,000-square-foot addition to Building 30 began in April 1990 and opened for use in 1992. The Dallas-based firm Haldeman Powell Johns designed the structure and J.W. Bateson Company served as the builder. The addition was built around the southwest corner of the Mission Operations Wing. It was also constructed of a steel skeleton framed with PEAF panels. The JSC expected that the new control center would handle all of the International Space Station  

flights while the original MCC would support the Space Shuttle. But as the federal funding and support for the Space Station program faded as the building project developed, which forced the JSC to use the new addition as a dual-use Control Center Complex that would also handle shuttle flights. The first use for shuttle programs of the new flight control room (the White FCR) in the addition was in December 1994. Space Shuttle operations shifted entirely to the new control room in May 1996, and the second-floor control room in the original Mission Operations Wing became dedicated to support for the International Space Station. At that time, the JSC began taking steps to restore the third-floor control room, deactivated in 1992, to the historic Apollo-era configuration for preservation and tour access.

In 1998, another three-story mechanical room addition was added to Building 30 along the west elevation of the Mission Operations Wing. A new Mission Evaluation Room was configured on the third floor of the Mission Operations Wing in 2004, and the following year a new Mission Management Team area was constructed on the first floor of the Mission Operations Wing. Building 30 is now 383,417 gross square feet.

It is important to note that the physical plant for the Mission Control Center is composed of two separate buildings. Building 48 was constructed as a companion structure for Building 30 as its emergency power building. An underground utility tunnel, an extension of the space center’s central tunnel system, connects the two buildings. There were two classes of power designated in the MCC: Class “A” for uninterruptable systems and Class “B” uses, which could be interrupted for a maximum of 25 seconds. All critical subsystems were on “A” power and their supply was supported by the generators in Building 48. If “B” power needs experienced a failure the operations in the control center would be affected. If the console monitors would fail, 80 percent of the lighting would disappear, and the MSKs, SMEKs, ESPs, FDKs, ROs, P-tube stations, voice communication panels, and event panels would not function. The intercom system would continue to operate because it was protected by wet cell batteries for up to eight hours.

B. Analysis of Historical Occupancy
The idea for a Control Center emerged as the necessary physical environment to support changing roles and activities of ground-based personnel. NASA’s earlier Mercury missions (1958-1963) operated more like aircraft flight tests in which the astronauts were in control of systems during the actual flights. The defined roles for ground-based flight controllers became more ambitious as the Space Task Group began to understand all of the support activities that would be required to process the mission-generated data and information required to fulfill the goals of the Gemini and Apollo programs. Murray and Cox note the emergence of “the concept of a room on the ground with not just a man talking to the astronaut, but many people analyzing tracking data and telemetry data on the status of the launch vehicle and the space craft.” This was the general purpose of a control center.

82 Archaeological Consultants, “MCC/Building 30,” 17.
84 Murray and Cox, Apollo: The Race to the Moon, 254.
The design concept for the mission control facilities gave special consideration to several structural and interior design factors that determined how the building was finished and furnished. NASA’s Request for Proposals guidelines issued the following instructions for potential contractors to consider: “The operating positions in the MOCR and SSRs should not be constrained by the aesthetic features in such a manner that they would not be habitable for long periods of time. Room lighting, coloring, sound, and conditioning should be considered . . . or at least indicated as significant.” Based on these guidelines, the Philco WDL plan for Building 30 gave special attention to air-conditioning and ventilation needs required to offset heat production from equipment and ensure human comfort in the windowless rooms. The number of room air changes and air filtration needs were based on the number of occupants planned for each room, assuming that they would be smoking while they worked. Acoustical needs also received particular attention—the acceptable, average overall noise level in an unoccupied room was not to exceed 35 decibels. The architectural plans called for acoustical treatment for walls, floors, and ceilings. Illumination was another concern as the building required a balance between appropriate task lighting and the reduction of room light on the large display screens in the control rooms.

Built-in flexibility was another critical issue in the design of the Mission Control Center. For the individuals who participated in the conceptualization and execution of the design for Building 30, the Mercury Control Center in Florida provided an example of difficulties that could result without designing with flexibility in mind. The new Integrated Mission Control Center in Houston would be designed with expansion in mind as well as a dual mission support concept that would allow overlap between simulations and real missions to coexist in time and maintain a pace of activity that would help the agency meet its aggressive goals. Several key features reflected the idea of flexibility. The floor space in the control rooms and the data monitoring and terminal equipment rooms was equipped with a modular system that would facilitate ongoing rewiring and reworking of connections of cables between equipment in different rooms. Additionally, the developers of the Mission Control Center understood that the evolution of the spaceflight programs would drive a need for room configurations to adjust to changing practices and conditions. For this reason, the Mission Operations Wing included moveable metal partitions that would meet the basic requirement for flexibility of the building design.

85 NASA, “MCC Request for Proposals,” 1962, Box 7B, CC Kraft MCC RFP Info folder, MCC and RTCC Subseries, Center Series, JSC History Collection, University of Houston-Clear Lake Archives, 3.5.6.
86 Smoking was banned in common work areas at the JSC in March 1987 and from all JSC buildings and government vehicles on September 5, 1990. See JSC Announcement 90-139, September 5, 1990, Box 1019A, Folder 1990 JSC Announcements, Center Series, JSC History Collection, University of Houston-Clear Lake Archives; For smoking-related design considerations, see “Comments and suggestions to Kaiser Engineers,” October 22, 1962, Box 823, Philco NAS 9-366 General Info Folder, NASA Johnson Space Center Contract Administration Files, Record Group 255, National Archives Fort Worth.
87 Philco Western Development Laboratories, “Facility Requirements and Building Specifications,” July 1, 1962, Box 7, MCC and RTCC Subseries, Center Series, JSC History Collection, University of Houston-Clear Lake Archives, 4.2.3-4 to 4.2.3-5.
88 Ibid.
Flexibility was important but redundancy for the dual mission support concept was perhaps the most important overall consideration that drove the development of a system for flight monitoring and control. The original space allocations for each of the two identical mission operations facilities in Building 30 included two duplicate configurations of nine associated functional rooms on each floor. Additionally, the Closed-Circuit Television Equipment and Control Room on the first floor and the Meteorological Center on the second floor served both of the mission operations facilities. The Visitors Viewing Areas, while associated with the control rooms, were not part of the functional association of rooms. As a reflection of current management of the NHL in Building 30, this historic furnishings report documents only the third-floor Mission Operations Control Room (MOCR) and its adjacent Visitors Viewing Area, Summary Display Projection Room, Recovery Control Room, and Simulation Control Room.\(^90\)

Once both control rooms were configured for Apollo missions, the redundancy scheme was in place but the need for ongoing reconfigurations never stopped. Each mission in the Apollo program added new goals—a trans lunar trajectory for Apollo 8, a landing-module trajectory for Apollo 9, a command-module trajectory for Apollo 10, final-descent software for Apollo 11, and precision landing requirements for Apollo 12. This rapid evolution pushed the limits of the original equipment of the control center as they required new parameters, new lines of code, upgrades to the mainframe computers, the re-wiring of the consoles in the control rooms and staff support rooms, and the retrofitting and addition of new equipment such as small Olivetti Programma 101 computers positioned next to the consoles to allow the controllers to perform rapid calculations that the mainframe computers in the RTCC could not handle in a timely fashion.\(^91\)

The Mission Control Center at the Manned Spacecraft Center in Houston embodied the current working standard of Flight Operations in U.S. manned spaceflight activities when it opened in 1964, but the definition and range of those operations was always evolving as the Apollo missions and related technological requirements developed in the late 1960s. The physical space and equipment of Building 30 manifested the two main characteristics of that evolutionary process. First, the original design and systems in the building had to be robust, well-tested, and reliable to meet the demands of the agency’s high-profile, high-risk activities that had little to no margin for error. The basis system of mainframe computers and hard-wired consoles in the control center continued well beyond the development of more efficient computer systems for that reason. At the same time, the Mission Control Center contained and executed a rapidly evolving manned spaceflight program that—at least during the Gemini and Apollo eras—set highly ambitious goals to meet President Kennedy’s directive to achieve a lunar landing by 1970 and thus demanded flexibility and innovation. The MCC’s first flight control activities were as backup control for the Gemini III flight on March 23, 1965. With Gemini IV on June 3 of that same year, the Houston center completed the transition to serving as the lead control for all of NASA’s manned spaceflights. The third-floor control room was used for this flight and the remaining nine Gemini flights, while the second-floor control room was being configured for the

\(^{90}\) Philco Western Development Laboratories, “Facility Requirements and Building Specifications,” July 1, 1962, Box 7, MCC and RTCC Subseries, Center Series, JSC History Collection, University of Houston-Clear Lake Archives, 4.2.3-1 to 4.2.3-2.

\(^{91}\) Gene Kranz describes the purpose and use of the Olivetti computers in Testa, “Mission Control,” 17.
needs of the early Apollo test flights. After the Gemini program concluded in November 1966, reconfigurations to the third-floor MOCR began and were completed by November 1967.92

The three major functional systems that worked together in the Apollo-era Mission Control Center in Houston included the Communications Interface System (CIS) for internal communications and linking to the larger NASA Communications (NASCOM) network and the mission simulator; the Data Computation Complex (DCC) that provided the mainframe computational and display processing, and the Display and Control System (DCS), which provided the human interface for the controllers and staff.93 Each of these functional categories had associated designated rooms in Building 30 that connected physically by corridors, stairways, and elevators and also by complex wiring and pneumatic tube delivery systems with central exchangers, air-tight tubing, and send/receive stations for transporting hard copy documents. Similarly, phone and data lines connected the engineering personnel to the wider network of personnel at other NASA sites and contractor facilities. The systems in Building 30 connected directly with the power and air-conditioning systems in Building 48 via a utility tunnel between the buildings.

The complexity of these national and global efforts required tight communications and reliable technology. At the Mission Control Center, each room, each system, each piece of technology, and each NASA employee and contractor played a critical and sharply defined role, and yet several of those physical spaces and human roles were more prominent, and in some cases more visible, to the general public. Due to television coverage of the room during space flight missions, the flight controllers in the Mission Operations Control Room (MOCR) and, to a lesser extent, its adjoining Visitors Viewing Area, became as much a part of what the public understood about NASA’s inner workings and endeavors as the astronauts and the rockets and modular space vehicles that carried them into orbit and to the lunar surface. Despite its familiarity, the small number of consoles in the room and the active team of twenty or so controllers represented only a small percentage of the related personnel and equipment active inside the building.

Beyond this central command room, a network of six Staff Support Rooms supported the activity inside the MOCR, along with the Real Time Computer Complex, the Summary Display Projection Room, the Simulation Control Room, the Recovery Control Room, and others. Many of these rooms contained Philco-Ford designed consoles, IBM computers, and other specialized equipment operated by highly trained civil servants and contractors, “upward of 250,” according to a NASA press release, who played critical technical and administrative support roles for each mission.94 The boundary of the National Historic Landmark, which is the perimeter of Building 30, recognized the importance of all of these rooms and people working in a matrix of interdependent functions under one roof. As much as possible, this report has considered this larger context of how people interacted with, used, redesigned, modified, and moved around in the wider physical environment of the Mission Control Center, but has emphasized in particular the occupancy, use, and historic furnishings of the third-floor MOCR, its associated functional space known as the Summary Display Projection Room (aka “Bat Cave”), the Visitors Viewing

Area that was connected by a window wall on the east side, or rear, of the MOCR, and the Recovery Control Room and the Simulation Control Room. From this third-floor MOCR, known today as the Apollo Mission Control Room, flight controllers oversaw nine Gemini flights; 12 Apollo flights; and 22 Space Shuttle flights, including classified Shuttle operations that required adaptations to carry out secure systems and operations.95

Inside the hub of the MOCR, flight controllers carried out activities that served mission operations goals using human-adapted equipment, functionally designed interior spaces and furnishings that supported their work in two broad categories: tracking, navigation, and monitoring flight position and receiving, processing, and analyzing on-board spacecraft data conveyed via telemetry. To prepare for the missions, flight controllers and astronauts participated in many hours of simulations using the same equipment and consoles in the MOCR. These rehearsals were critical to the success of each mission and in number of hours represented the bulk of activity at the Mission Control Center. In addition to simulations, redundancy was an organizing principle that provided proper backup systems, personnel, and physical space in Building 30 for missions as a critical component for mission safety and success. For this reason, the floor plans for the Mission Operations Wing contained nearly identical MOCRs with attached “Bat Caves” and Viewing Galleries. With growth and immediate pressure to add to the building and make the most of its equipment and space, the Mission Control Center was a dynamic environment that changed rapidly during the Apollo era to accommodate the expanding agency personnel.

Occupants and Roles
In general, most of the brotherhood of flight controllers who worked in the mission control room were veterans of the military test-flight community, air-traffic control, or some other aspect of aviation. These pilots, engineers, and other technical experts had some years of experience working for the agency and for its predecessors. As NASA created the first flight controller positions for Project Mercury, it drew on the pool of individuals who worked on the first U.S. satellite launches in 1958 (Vanguard, Explorer, and Pioneer) and those who worked on pilotless aircraft research. Some flight controllers came from the National Advisory Committee for Aeronautics (NACA).96 Despite NASA’s reputation as an agency that hired based on merit rather than race, religion, or gender, the highly specialized world that produced the first flight controllers meant that the controllers and high-level NASA personnel during the Apollo program were white males from similar cultural backgrounds. To supplement the contributions from space program veterans and round out the expertise necessary to meet President Kennedy’s challenge to get to the moon by the end of the decade, NASA space centers relied on regional recruitment of recent college graduates through the National Defense Student Loan Program. Many of those individuals were first-generation college graduates from rural backgrounds who had a strong work ethic and “could fix anything,” according to former flight director Gene Kranz.97 The influx of these younger controllers reduced the average age from twenty-nine in 1965 to twenty-six in 1969.98 The men who worked together on the teams that fulfilled the goals

95 Loree, “MCC Development History,” 17.
96 Jerolimov, “NASA Johnson Space Center: Apollo Mission Control,” 5; Johnson, “This is Ground Control,” 111.
97 Testa, “Mission Control,” 17.
98 Michael Peter Johnson, “This is Ground Control: The Invention of Mission Control Centers in the United States and Europe,” unpublished dissertation submitted to the Graduate Faculty of Auburn University (May 7, 2012), 110.
of the Apollo missions thus operated comfortably together in a close working environment. The uniformity of the physical space inside the MOCR reflected the efficient, highly specialized activities of mission control for early space flight exploration, and it also reflected the similarity of the habits and social interactions of these men who operated in a chain-of-command protocol that owed its character to the experimental and dangerous endeavors they supported. Women entered the space of the control room only rarely, but were more frequently found as visitors in the viewing room or administrative support areas at the Manned Spacecraft Center. Three women worked in the Mission Planning and Analysis Division at that time—a sign of greater diversity to come. The merit-based hiring approach at NASA meant that the first female flight controllers joined mission control in 1971. In 2005, NASA hired the first African-American flight controller, Kwatsi Alibaru, and the first two Hispanic flight controllers, Ginger Kerrick and Richard Jones. By 2012, approximately 40 percent of flight controllers were women.99

The control room was the hub of the Mission Control Center’s centralized authority within the larger Manned Space Flight Network. As participants in the Apollo program, the flight controllers who inhabited the room were the decision makers who had to translate their experience as systems engineers who understood how the systems worked together to an environment where quick decisions may be needed to accomplish a mission successfully. In addition to taking on this responsibility, they had to exert some authority over astronauts who, as former test pilots, were accustomed to making autonomous decisions during flight missions. They relied on their “back room” staff in the support rooms to evaluate, analyze, and recommend contingency solutions and there was a strong culture of giving credit to those individuals for their role in each mission.100 There were fewer than twenty people in an operating control room at any given time during a mission, but beyond that highly visible command center there were approximately 250 additional people making it possible for them to do their jobs effectively.

Although designed with human use in mind, the MOCR was a room that challenged the stamina of the controllers. Flight controllers worked in nine-hour shifts that required them to report one hour early to a briefing room where they received a report from one of the on-duty controllers. Arriving at their console, the outgoing controller provided additional briefing information. Accounts of working conditions by former flight controllers emphasize the grueling nature of the long, stressful shifts. Former INCO Ed Fendell remembered that the crisis hours in the control room after the oxygen tank explosion on Apollo 13 created a particularly pungent combination of sweat, stale cigarette smoke, and meals eaten hastily at the consoles.101 Controllers developed red eyes and headaches from staring at the monochromatic console monitors through the haze. Repetitive use injuries such as “Controller’s elbow,” a form of bursitis, and hearing loss from long-term exposure to multiple audio channels via the headphones were also common problems.102 Former EECOM Sy Liebergot remembered that flight controllers referred to the metal handles on either side of the console monitors as "security handles" and gripped them when stressed.103

99 Kranz, Failure is Not An Option, 13; Johnson, “This is Ground Control,” 111.
101 Author’s personal conversation with Ed Fendell at Johnson Space Center, August 25, 2014.
102 Murray and Cox, 271-273; Johnson, “This is Ground Control,” 120.
Each of the four rows of consoles arranged by functional areas in the original configuration of the Mission Control Room contained 18 designated positions, some that were known by various formal and slang terminology. Each console was numbered but their relative positions in the MOCR did not follow a linear numeric pattern. There were three positions at Console 8 and no Console 13.

The back row in the early MOCR configuration included consoles for representatives from the mission command and control and public affairs information control functional areas. The higher ranking NASA and DOD officials in this row provided official oversight but had less to do with the flight control operations.

- The Public Affairs Officer, aka “the voice of Mission Control,” sat on the far left at Console 3. This position handled publicity and interacted with the media.
- On the far right of the back row, at Console 17, was a Department of Defense representative (for landing and recovery operation and some of the communications support).
- In between sat “The Hummers,” a slang moniker that referred to their propensity to nod their heads upon receiving information and say, “Hmmm.” These included the Mission Director from Washington at Console 2, and the Flight Operations Director at Console 1. In the Apollo era, this was Christopher Kraft, aka “The Teacher.” This position was renamed Mission Operations Director (MOD) in the Shuttle era.
- In later missions also included in the back row were consoles for the head of ASPO and the MSC Director.

The third row of consoles in the early MOCR configuration was the home of the mission command and control positions associated directly with flight command and operations.

- The Operations and Procedures Officer (O&P) sat on the far left at Console 7. This position checked flight activities against mission rules and techniques and also performed some peripheral duties such as overseeing the display projections in front of room. In later Apollo missions, a new position was added on the far left, to the left of the O&P, the communication systems officer in charge of monitoring the instrumentation and communications systems on board the spacecraft known as INCO for instrumentation and communications systems officer. The position of consolidated all communications responsibilities formerly spread out among several positions.
- The Assistant Flight Director sat on the right of the O&P at Console 5. The position was known to some as the “least popular job in the MOCR ..” The position was eliminated at the end of the lunar program.
- The Flight Director sat to his right at Console 4, in a central position relative to other controllers. Known simply as “Flight” in the control room’s mission lingo, the flight director’s job was to run all activities in the MOCR and direct the mission. The four flight directors for Apollo 11 were Cliff Charlesworth, Gene Kranz, Glynn Lunney, and Gerry Griffin.

---

105 Murray and Cox, 274; Liebergot and Harland, Apollo EECOM: Journey of a Lifetime, 113.
The controller for Experiments and Flight Planning sat at Console 6 to the right of the Flight Director. Later renamed the Flight Activities Officer, this representative from Flight Crew Operations compared astronaut preparation for the mission to the actual activities required during the flight.

The Network Controller occupied Console 16 on the far right of the third row and coordinated with global MSFN ground stations that acquired the telemetry and tracking data for transmission to MCC.

The second row of controllers in the early MOCR configuration included the following consoles related to the systems operations functional area.

- The Flight Surgeon was positioned at Console 9 on the far left of the second row. A physician who monitored astronaut health in flight, he also tended to the medical needs of controllers.
- To his right at Console 10 was the Spacecraft Communicator, also known as “CapCom,” for Capsule Communicator, a holdover from the Mercury program. This position was always filled by an astronaut, often from the backup crew for the flight in progress. Other than CapCom, only flight director or Chris Kraft could speak directly to crew. The CapCom console included a stop clock module connected to the control center’s timing component.\(^\text{106}\)
- To the right of the CapCom at three consoles labeled as Console 8 sat the Vehicle Systems Engineers, aka “The Systems Guys.” The group started with EECOM (electrical, environmental, and communications) on the left, the controller who knew the whole spacecraft and oversaw all life-support, electrical, instrumentation, and mechanical systems.\(^\text{107}\) To his right, the GNC (Guidance, Navigation, and Control Officer) monitored guidance hardware to make sure it was working, as well as hardware for in-flight propulsion systems and the engine in the service module. In the lunar missions period of the Apollo program, new positions were added. First was “Control,” a GNC position specifically for the lunar module, and to his right TELMU, formerly TELCOM.

The front row of controllers held positions related to the flight dynamics functional area. Known as the “Trench,” it included “The Trajectory Guys” for the mission. As a group, they had a reputation as clannish and proud, because they knew the most of all the controllers about actually flying the spacecraft.\(^\text{108}\)

- At Console 14 on the far left sat the Booster Systems Engineer who monitored the propellant tank pressurization systems for abnormalities. Additional Booster positions were added eventually and these controllers, who were from Marshall Space Center, left the MOCR after the Saturn V was fully expended.

\(^{106}\) Phlco WDL, “Manned Spacecraft Control Center Maintenance and Operations Activity Indoctrination Booklet,” July 1964, Box 5, MCC and RTCC Subseries, Center Series, JSC History Collection, University of Houston-Clear Lake Archives, 29.

\(^{107}\) See Murray and Cox 274-275 for more on EECOM importance from John Aaron’s perspective.

\(^{108}\) See Murray and Cox, 278-279, for more on legendary character of the Trench.
- The Retrofire Officer known as “RETRO” sat to the right of the Boosters at Console 12, the first of the Flight Dynamics Branch consoles in the row. This position was eliminated for the Shuttle program.\textsuperscript{109}

- The Flight Dynamics Officer, or FIDO, sat to his right in the second of the Flight Dynamics Branch positions at Console 11. He was the lead man in the Trench and determined where the spacecraft was going and when, giving “Go” or “Abort” recommendations to the Flight Director. John Llewellyn, a well-known FIDO with a reputation as a maverick, is often credited with giving the Trench its nickname based on a comparison to his military combat experience.

- The Guidance Officer (GUIDO) sat to his right, on the far right of the Trench at Console 15. Also from the Flight Dynamics branch, this position was the ground navigator for the spacecraft who monitored the accuracy of its position. Men who served as GUIDO in the Apollo era included Glen Lunney and Jerry Bostick, who was promoted to head of Flight Dynamics by August 1968.\textsuperscript{110}

In addition to the flight controllers and their support staff, the critical simulation activities for the Apollo program, known as Apollo Simulation Checkout and Training System (ASCATS), included dedicated personnel. One the flight rules for a mission were in place, simulations for all phases from launch to reentry and recovery could begin. The purpose was to test human response to system problems and emergencies, sometimes occurring simultaneously or as cascading failures, as well as the efficacy of the flight rules. The original simulation system, configured in Building 422, was a UNIVAC 494 computer, an IBM 360-75 computer, a set of custom telemetry decommutation equipment, and data interfaces to the command and service module simulators at JSC and KSC. About the time of the Apollo 11 mission in 1969, the ASCATS system at JSC was moved to the MCC.\textsuperscript{111} The Simulation Supervisor, or “SimSup,” oversaw the exercises and the tracking and recording of each controller’s performance. While it was difficult to anticipate and simulate multidimensional problems that might occur on an actual flight, these exercises required many hours of work for the controllers and gave them insight into possible scenarios that might occur, as well as their responses to those situations.\textsuperscript{112}

During a flight, the occupants of the attached Visitors Viewing Area for the MOCR included family members, VIPs, and the press—all issued access badges that allowed them to enter the room during an active mission, watch the controllers at work at the consoles beyond the glass window wall, and take in the group displays projected at the front of the room. For this audience seated in the viewing area’s theater-style seating, the activities of the control room framed in the glass partition took on an element of staged performance during active missions and simulations. Visitors watched the controllers interacting with each other and periodically with the astronauts in flight, who appeared via video feed (frequency) on the large display screens. The action was limited most of the time, but several moments of much greater interest punctuated the missions, particularly lunar surface landings and activity and splashdown. Intense coverage of the Apollo missions peaked during Apollo 11, and the NBC News team won an Emmy for their work. The

\textsuperscript{109} Johnson, “This is Ground Control,” 114.

\textsuperscript{110} All early Apollo era controller positions and functions taken from the early Apollo era NASA brochure, “MCC-H: Mission Control Center, Manned Spacecraft Center—Houston, Texas,” n.d..

\textsuperscript{111} Loree, “MCC Development History,” 7.

viewing room represents the transparency that the agency actively cultivated to build support for NASA activities and present successful missions to audiences around the globe. At the same time, access to this space was highly controlled, mediated, and removed from the main action on the floor of the MOCR and its support rooms elsewhere in Building 30.
HISTORIC FURNISHINGS PLAN SOURCES AND BIBLIOGRAPHY

**Primary sources** that proved particularly useful for establishing the descriptions and purpose of the original furnishings include both online and archival sources. The 1967 Philco-Ford “Familiarization Manual: MCC Houston” is available online at https://www.hq.nasa.gov/alsj/MCCFamManual.pdf, as is NASA’s “MCC Operational Configuration: Mission J1, Apollo 15” (PHO-TR155), at http://klabs.org/history/history_docs/jsc_t/mcc_operational_configuration_as15.pdf. PHO-TR155 was an invaluable, essential guide for this historic furnishings plan. Sandra Tetley, Historic Preservation Officer of the Johnson Space Center, provided JSC records and correspondence related to the management of the Apollo Mission Control NHL since the 1980s.

Archival collections that proved useful include:

- The Jack McCaine NASA Papers Collection at Rice University’s Woodson Research Center
- The JSC History Collection at University of Houston-Clear Lake Archives
- NASA RG255.4.7, Records of the Lyndon B. Johnson Space Center, Houston, TX, at the National Archives at Fort Worth, TX (finding aid online at http://www.archives.gov/research/guide-fed-records/groups/255.html)

**Sources on the technical requirements of mission control and building history**

Douglas Jerolimov’s Historic American Engineering Report is excellent and provides important historical and historiographical context for the Apollo program not addressed in this report. The Mercury Control Artifact Inventory serves as a source for comparison and evolution of control center design and technology.


Prior planning documents and documentation reports


Johnson, Michael Peter. “‘This is Ground Control’: The Invention of Mission Control Centers in the United States and Europe,” unpublished dissertation submitted to the Graduate Faculty of Auburn University, May 7, 2012.


Programmatic Agreement among the National Aeronautics and Space Administration, National Conference of State Historic Preservation Officers, and the Advisory Council on History Preservation, 1989
Sources on the History of the Apollo program
Charles A. Murray and Catherine Bly Cox provide an overview of the Apollo program through the lens of personal stories, and thus present a rich source for understanding the life histories and personal philosophies of some of the controllers and other associated engineers and scientists. Personal memoirs, particularly Gene Kranz’s *Failure is Not an Option* and Chris Kraft’s *Flight*, provided authoritative first-hand accounts of the development of the MCC and mission activity in the MOCR.


*For All Mankind*. Criterion, 2000.


Sources on historic furnishings and historic preservation:


———. “NASA History and the Challenge of Keeping the Contemporary Past.” The Public Historian 21, no. 3 (July 1, 1999): 63–81.


Appendices

APPENDIX A
Control Room Assignments for Gemini, Apollo, and Shuttle Missions

APPENDIX B
Historic Furnishings at Johnson Space Center Storage and Other Sites

APPENDIX C
List of Acronyms
APPENDIX A

CONTROL ROOM ASSIGNMENTS FOR GEMINI, APOLLO, & SHUTTLE MISSIONS

Flights controlled from the third floor:
- Gemini IV (June 3-7, 1965)
- Gemini V (August 21-29, 1965)
- Gemini VI (December 15-16, 1965)
- Gemini VII (December 4-18, 1965)
- Gemini VIII (March 16, 1966)
- Gemini IX (June 3-6, 1966)
- Gemini X (July 18-21, 1966)
- Gemini XI (Sept 12-15, 1966)
- Gemini XII (November 11-15, 1966)
- Apollo 4 (November 9, 1967)
- Apollo 6 (April 4, 1968)
- Apollo 8 (December 21-27, 1968)
- Apollo 9 (March 3-13, 1969)
- Apollo 10 (May 18-26, 1969)
- Apollo 11 (July 16-24, 1969)
- Apollo 12 (November 14-24, 1969)
- Apollo 13 (April 11-17, 1970)
- Apollo 14 (January 31-February 9, 1971)
- Apollo 15 (July 26-August 7, 1971)
- Apollo 16 (April 16-27, 1972)
- Apollo 17 (December 6-19, 1972)
- STS-5 (November 11-16, 1982)
- STS-6 (April 4-9, 1983)
- STS-7 (June 18-24, 1983)
- STS-8 (August 30-September 5, 1983)
- STS-9 (November 28-December 8, 1983)
- 41-B (February 3-11, 1984)
- 41-C (April 6-13, 1984)
- 41-G (October 5-14, 1984)
- 51-C DOD (January 24-25, 1985)
- 51-D (April 12-19, 1985)
- 51-G (June 17-24, 1985)
- 51-I (August 27-September 4, 1985)
- 51-J (October 3-7, 1985)
- 61-B (November 26-December 3, 1985)
- 51-L (January 28, 1986)
- STS-27 (first post-Challenger DOD mission, December 1988)
- Six DOD Shuttle missions (January 1989-December 1992)

Flights controlled from the second floor:
- AS-201 (February 26, 1966)
- AS-203 (July 5, 1966)
- Apollo 5 (January 22, 1968)
- Apollo 7 (October 11-22, 1968)
- Skylab 1 and 2 (May 4-June 22, 1973)
- Skylab 3 (July 28-September 25, 1973)
- Skylab 4 (November 16-February 8, 1974)
- Apollo-Soyuz (July 15-24, 1975)
- STS-1 (April 12-14, 1981)
- STS-2 (November 1981)
- STS-3 (March 1982)
- STS-4 (June-July 1982)
- Six STS flights through Jan 1986
- STS-26 (September 29-October 3, 1988)
- 40 STS missions through STS-71 (June 1995)
- ISS support since 1996

113 Archaeological Consultants, “MCC/Building 30.”
APPENDIX B

HISTORIC FURNISHINGS AT JOHNSON SPACE CENTER STORAGE
AND OTHER SITES

The furnishings listed below are potentially appropriate for a late Apollo era (Apollo 11-Apollo 17) restoration of the third-floor control room and associated projection room and viewing room, all associated with the Apollo Mission Control Center NHL. Knowledgeable agency personnel, current and former, should verify that the storage holdings match these records and evaluate these items for inclusion in the restoration.

JSC Storage (Building 425)

Projection System (E-Systems, Inc)
- Plotter Projector: Qty 3
- Reference High Speed Projector: Qty: 1
- Spotting Projector: Qty: 2
- Illuminator Color Changer: Qty: 7
- Projector Assembly: Qty: 1
- Projector Illuminator Assembly: Qty: 6
- Projector Panel: Qty: 1
- Projector Control System: Qty: 3
- Symbol Generator: Qty: 1
- Signal Generator: Qty: 1
- Monitor Projector Control: Qty: 1
- Control Indicator: Qty: 1
- Control Panel Assembly: Qty: 6
- Conditioned Air Assy: Qty: 4
- Cabinet Power Supply Unit: Qty: 8
- Control Unit Cabinet: Qty: 1
- Power Supply Assembly Cabinet: Qty: 3

Consoles (Lockheed Martin, formerly Loral)
- 1-bay: Qty 1
- 3-bay: Qty 1
- 4-bay: Qty 2
- 5-bay: Qty 6

Console Assembly (Lockheed): Qty 1
- Auxiliary Projection Control (Lockheed Martin): Qty: 1
- Control Panel Assembly (Ford Aerospace): Qty: 2

Hardcopy Output Recorder (Lockheed Martin): Qty: 1
- Keybox Assembly (Lockheed Martin): Qty: 1
- Coordinate Assembly Display (Lockheed Martin): Qty: 2
- Digital Data Transmitter (Lockheed): Qty: 1
- Input-Output Console (Lockheed Martin): Qty: 2
- Power Supply (Lockheed): Qty 7
- Power Supply Assembly (Lockheed Martin): Qty: 3
- Electrical Logic Drawer (Lockheed Martin): Qty: 6
- Selection Panel Assy Control, Lockheed Martin): Qty: 2
- Indicator Control Panel (Lockheed Martin): Qty: 11
- Indicator/MSK Control (Lockheed Martin): Qty: 1
- Television Monitor (Lockheed Martin) Qty: 8
- Television Receiving Set (Lockheed Martin): Qty: 1
- Auxiliary Projection Control (Ford Aerospace): Qty: 1
- Plotting Display Control (Ford Aerospace.): Qty: 1
- Still Picture Projector (LTV Corp): Qty: 1
- Microfiche Viewer: Qty: 2
Pneumatic Tube Station (Mark Controls Corp): Qty: 1
Power Supply (Hughes): Qty: 2
Recording Instrument Chart (Brush Instruments): Qty: 1
Television Set (Dotronix Inc): Qty: 9
Television Monitor (Astronautics): Qty: 1
Television Set (Ball Brothers): Qty: 1
Chairs, gray: Qty: 10
Chairs, other: Qty: 2
Screens: Qty: 2
Mirror and stands: Qty: 2
Headsets: Qty: 12

**JSC Building 30 (Simulation Control Room 328)**

Consoles and installed components (need to be surveyed)
Wall-mounted P-tube station and aluminum canisters

**JSC Building 30 (MOCR)**

In addition to the Apollo-era materials on display, the MOCR contains two locked cabinets in the northeast corridor that contain a large quantity of console components. JSC staff should verify where these items have been inventoried and evaluate them for use in the restoration. Some items are Apollo-era.

**Kansas Cosmosphere and Space Center, Hutchinson, Kansas**

Max Ary started this collection as the Apollo lunar program ended and the contractors who built the hardware for the missions wondered what would happen to the equipment they created. NASA referred the Apollo 13 movie production crew to Ary as they set out to build replicas for filming. This is reportedly the largest collection other than Smithsonian. \(^{114}\)

**Niagara Aerospace Museum, Niagara Falls**

EECOM Console

---

\(^{114}\) Kluger, *The Apollo Adventure*, 94-95.
Museum of Flight, Seattle, Washington

**Donation from JSC in March 2004**\(^{115}\)
SPAN Manager Console Input-Output Digital, Equipment Control Number (ECN) 295567
Two built in TV monitors (ECN235151 and ECN294367) and panel indicator (ECN 295572)
Key panel desk (ECN 842152)
6-bay console shell (ECN G018865)
TV monitors (ECN234530 and ECN 233395)

**On loan from JSC as of June 2007**\(^{116}\)
Voice Keysets: Qty: 4
MSK: Qty: 1
DRK: Qty: 1
72-Event Indicator Panels: Qty: 3
36-Event Indicator Panel: Qty: 1
Status Switch: Qty: 1
Status Report Module: Qty: 1
Analog Meter: Qty: 1
Stop Clock: Qty: 1
Display Coordinate: Qty: 1

**UHCL Archives, JSC History Collection**
The Center Series of the JSC History Collection at UHCL includes a subseries, “MCC Display/Control System Slides,” that contains special slides made to commemorate successful completions of missions or programs. The slides are single symbol or color slides that create a multi-colored image when projected together. The collection also contains a few ground tracking slides that show orbital paths and satellite coverage zones.

---

\(^{115}\) Perri Fox, JSC Federal Preservation Officer to Jeffrey Harris, Texas Historical Commission, March 18, 2004, JSC Real Property-Historic Preservation files.

\(^{116}\) Perri Fox, JSC Federal Preservation Officer to Derek Satchell, Texas Historical Commission, June 22, 2007, Subject: Loan of Historic Apollo Mission Control Room Items, Real Property-Historic Preservation files, JSC.
### APPENDIX C
**LIST OF ACRONYMS**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACHP</td>
<td>Advisory Council on Historic Preservation</td>
</tr>
<tr>
<td>CONIS</td>
<td>Console Input System</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
</tr>
<tr>
<td>DSK</td>
<td>Display Request Keyboard</td>
</tr>
<tr>
<td>EECOM</td>
<td>Electrical, Environmental, and Communications Officer</td>
</tr>
<tr>
<td>FCR</td>
<td>Flight Control Room (Shuttle era)</td>
</tr>
<tr>
<td>FIDO</td>
<td>Flight Dynamics Officer</td>
</tr>
<tr>
<td>FOD</td>
<td>Flight Operations Director</td>
</tr>
<tr>
<td>GNC</td>
<td>Guidance, Navigation, and Control Officer</td>
</tr>
<tr>
<td>HABS/HAER</td>
<td>Historic American Buildings Survey/Historic American Engineering Record</td>
</tr>
<tr>
<td>HPO</td>
<td>Historic Preservation Officer at the JSC</td>
</tr>
<tr>
<td>INCO</td>
<td>Integrated Communications Officer</td>
</tr>
<tr>
<td>JSC</td>
<td>Johnson Space Center</td>
</tr>
<tr>
<td>MCC</td>
<td>Mission Control Center (or MCC-H to distinguish from MCC-K at Kennedy Space Center)</td>
</tr>
<tr>
<td>MOCR</td>
<td>Mission Operations Control Room (Gemini and Apollo era)</td>
</tr>
<tr>
<td>MOD</td>
<td>Mission Operations Director (post-Apollo era)</td>
</tr>
<tr>
<td>MSC</td>
<td>Manned Spacecraft Center</td>
</tr>
<tr>
<td>MSK</td>
<td>Manual Selection Keyboard</td>
</tr>
<tr>
<td>MSFN</td>
<td>Manned Spaceflight Network</td>
</tr>
<tr>
<td>NARA</td>
<td>National Archives and Records Administration</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NHL</td>
<td>National Historic Landmark</td>
</tr>
<tr>
<td>NPS</td>
<td>National Park Service</td>
</tr>
<tr>
<td>O&amp;P</td>
<td>Operations and Procedures Officer</td>
</tr>
<tr>
<td>PAO</td>
<td>Public Affairs Officer</td>
</tr>
<tr>
<td>PPD</td>
<td>Projector Plotter Display System</td>
</tr>
<tr>
<td>SHPO</td>
<td>State Historic Preservation Officer</td>
</tr>
<tr>
<td>SMEK</td>
<td>Summary Message Enabled Keyboard</td>
</tr>
<tr>
<td>SSR</td>
<td>Staff Support Room</td>
</tr>
<tr>
<td>STS</td>
<td>Space Transportation System (aka Space Shuttle)</td>
</tr>
<tr>
<td>RTCC</td>
<td>Real-Time Computer Complex</td>
</tr>
<tr>
<td>THC</td>
<td>Texas Historical Commission</td>
</tr>
<tr>
<td>UHCL</td>
<td>University of Houston-Clear Lake</td>
</tr>
<tr>
<td>WDL</td>
<td>Philco Western Development Laboratories</td>
</tr>
</tbody>
</table>
Visitor Experience Plan for the Apollo Mission Control Center

Primary Interpretive Themes for Apollo Mission Control Center

*Story* is the communication tool most effective for facilitating an exploration of resource meanings. Societies depend on the power of story to explore, clarify, and share ideas, meanings, beliefs, and values that collectively constitute culture. Story is at the heart of human interaction and, consequently, at the heart of heritage interpretation.

Sites develop a set of overarching stories to organize the largest-scale ideas and meanings related to the site’s resources. These stories are called primary interpretive themes. The set of themes is developed to fully capture, and express in story format, the content of the site’s entire set of significance statements. The set is complete when it provides opportunities for people to explore and relate to all of the significance statements.

The set is usually comprised of a handful of primary interpretive themes (commonly three to five).
Primary interpretive themes provide the foundation for the development of visitor experiences at Apollo Mission Control Center. The following interpretive themes for the Apollo Mission Control Center were developed by the joint NASA-NPS visitor experience workshop team:

A — NASA and the Apollo Missions powerfully exemplify the innate human driven to explore new frontiers.

B — NASA's Apollo team met the challenge laid down by President John F. Kennedy in 1961 and, despite adversity and tragedy, safely landed Americans on the moon eight years later – and inspired generations of scientists, engineers, and astronauts.

C — The Apollo program demonstrated that, with the commitment and support of the American people, a young, dedicated, and enthusiastic team can accomplish what is initially considered impossible.

D — The creativity and inventiveness of the Apollo team produced enormous advances in a wide range of technologies and sciences that not only took us to the Moon but changed our lives forever.

**Audiences for the Apollo Mission Control Center**

A set of audiences must be defined so that the site’s interpretive and informational services can most effectively enhance the experiences of visitors. When comprehensively planning an interpretation and education program, audiences are best defined by considering two central questions, the responses to which ultimately determine the set of audiences for which the site will plan interpretive and informational services.

1. **On what basis do we interpret to some people differently than we do to others?**

   Factors to consider include the life experiences of the individual or group, level of education, learning styles, language, cultural traditions, time available for interaction, etc.

2. **At what point does a particular segment of the visiting public become so large, so important, or so distinct from general site visitors as to warrant interpretive or informational services targeted specifically to their needs?**

   Such targeted services are, by definition, less effective for the general public. What criteria do we use to formulate answers? Consideration of this question includes a review of current and future visitor profiles and their categorization for strategic interpretive planning purposes.

   The basis for categorizing audiences (for the interpretation and education program) lies in whether or not a particular audience requires communication in a way distinct from that of the general site audience. A subjective balance must be struck between communicating effectively with a greater number of specific audiences, and the limited resources available to the site’s program.

The Apollo Mission Control Center has three audiences:

1 — **General Audience.**

2 — **Curriculum-based Groups.** *(Primarily grades K-12 curriculum-focused educational groups.)*

3 — **Special Audiences.** *(A number of different categories of “VIPs” including Members of Congress, high-ranking members of the executive and the judiciary branches of government, foreign and domestic dignitaries and officials, celebrities, business leaders, military leaders and groups, special needs groups, etc.)*
Desired Visitor Experiences

Statements of desired visitor experiences describe how the site’s interpretation and education program facilitates physical, intellectual, inspirational, and emotional experiences for visitors. These statements describe the experiences visitors would like to have when visiting the site (either in person or remotely).

With regard to visitors who experience the site via curriculum-based educational programs, these statements can also describe what educators, teachers, and students desire to experience from their site visit. These desired experiences are frequently derived from specific educational objectives due to the inherent needs of this subset of visitors.

Visitor experience considerations are synthesized from statements of desired visitor experiences gathered through research of the many different histories and historical studies of the Apollo Mission Control Center, including the Historic American Engineering Record and National Historic Landmark nomination, a review of the NASA Office of Communications Apollo Mission Statements and the efforts of the Joint NASA-NPS Visitor Experience Workshop. Visitor experience considerations guide the interpretation and education program in developing interpretive and informational services that facilitate the connections visitors want to make with the resources of the site. Specifically, visitor experience considerations will be useful in determining what services might be most appropriate, why, where, and to what extent.

During the August 25-26, 2014, NASA-NPS workshop, the statements were ranked by the NPS-NASA workshop participants to indicate relative value to the interpretive planning process — What do the workshop participants think visitors would want to tell the core planning team as they develop the future interpretation and education program?

Space Center Houston and the Apollo Mission Control Center provide an opportunity for visitors to experience two different types of visitor experience:

- Visitors want active, fun, hands-on experiences as well as the opportunity to see some of the “sacred sites” of America’s Apollo era accomplishments and the larger Manned Space Flight Program. Balancing active, hands-on experiences at Space Center Houston with the more meditative and thoughtful experience of the hallowed spaces of the National Historic Landmarks at Johnson Space Center (JSC) along the tram tour can make for both an informally fun and secularly uplifting overall site visit.

- Visitors want to see and experience the real thing regarding people, places, and objects related to Apollo and the Manned Space Flight Program. At the same time, they want to explore and question the bounds of their experience and understanding of the subject, including the opportunity to converse with knowledgeable visitor services staff who can answer questions and put events and objects into context and perspective. This includes an appreciation of the current and future work of NASA and how they can become “part of the mission team.”
Analysis of Existing Visitor Service Operations at Apollo Mission Control Center

In some instances, one or a few key issues need to be resolved in a holistic way and incorporated into a site’s strategic approach to planning its interpretation and education program. Often, the challenges to be resolved are intimately interrelated: Most options for addressing each one have fundamental ramifications regarding the others. Resolution of these issues can occur at any stage of the process, but issues that will significantly affect the development of the future interpretation and education program are best resolved before the program is drafted. Summarizing the most prominent of these issues can be useful in documenting their interconnection and evolution, prompting the development of successful strategies for addressing them.

Johnson Space Center and Space Center Houston are working together to attempt a difficult feat: providing visitor access to and education about the JSC campus and Apollo Mission Control Center, while balancing consideration for the ongoing protection and preservation of the historic places and resources visitors are clamoring to see. As of fall 2014, visitors may experience the Apollo Mission Control Center NHL in several ways. Space Center Houston brings approximately 700,000 visitors to the building annually on its tram tour of the Johnson Space Center. Their more exclusive “Level 9” tour brings approximately 3,000 annual visitors, ages 14 and older, to the Mission Operations Control Room in once-daily groups of no more than 12 people. All Space Center Houston tour participants enter the building with a guide through the official Visitors Lobby where some interpretive exhibit information is displayed.

At present, the majority of visitors to the Apollo Mission Control Center NHL are restricted to the Visitors Viewing Area. Over 90% of visitors to the NHL fall into this category since this is the primary experience of the large population that participates in the tram tours from Space Center Houston. The experience consists of being led into and through the lobby of Building 30 to the Visitors Viewing Area (332) and adjacent private Communications Booths (332a, 332b). Visitors are then seated in the historic theatre-style seating and receive a 10-12 minute talk describing the Mission Operations Control Room (331) and the Visitors Viewing Area, with anecdotal reference to the Simulation Control Room, Recovery Control Room, and the Summary Display Projection Room (330), the so-called “Bat Cave, as well as information about the continuing missions of NASA. At the end of the presentation, there is time for the critically important question-and-answer interaction between the interpreter guide and the audience. Based on information provided at the NASA-NPS workshop, it is estimated that about 700,000 visitors pass through the Visitors Viewing Area on such tours each year.

This is a particularly advantageous vantage point from which to learn about the control room complex and the Apollo Program since the room was specifically designed to give an outstanding view of the Mission Operations Control Room and all that is happening within. Currently, the Simulation Room is not visible due to curtains, which should be removed to restore the historic appearance and function of the windows and expose the interior of the room. Although the Recovery Control Room is not visible from the Visitors Viewing Area, this is also an advantageous point from which to tell the significance of the room.

Aside from the fact that more visitors are currently allowed on each tour than can be seated in the Visitors Viewing Area, this is a comfortable place to learn about the Apollo Program and there is little historic fabric beyond the seats themselves and the wall covering that is subject to impact due to high traffic. It was noted that some of the lids on the ashtrays mounted on the backs of the seats have been removed, apparently for souvenirs, but the room seems designed to be able to withstand high traffic without much damage and, in the future, items such as the ashtrays can be
hardened to prevent further abuse. The seating, although deteriorated, is uniform with steel framing and seat pans and can be cleaned, repaired, and reupholstered as needed when the cumulative impacts of high use demand maintenance.

The situation is quite different, however, in the Mission Operations Control Room (331), the other room where the Johnson Space Center traditionally has given staff and visitors access. The JSC offers its own free version of a “Level 9” tour for VIPs through the Office of External Relations. The JSC’s External Relations group works with the Center Directorate and NASA Headquarters to provide customized, three-hour tours for VIP visitors to multiple buildings on the campus, including Building 30. On average, VIP groups spend about 45 minutes inside the control room, where visitors are asked to refrain from opening console drawers or removing objects from the room, but are otherwise allowed to wander freely in the room and touch the consoles. There are six trained employees who conduct these tours and convey highlights from JSC’s key strategic messages while providing behind-the-scenes access to sought-after locations such as the astronaut training facility and the control rooms. Visitors who receive these tours include members of Congress, Department of Defense representatives, contractor employees, celebrities, foreign dignitaries, wounded veterans, and visually impaired individuals. This office also provides tours for the agency’s university partners. These JSC-sponsored visitors number approximately 40,000 annually and fall into the category of “experiential access” to the control room.

It is absolutely essential to reexamine who qualifies as a VIP to be given access to this space, how their experience will be designed, and what behaviors will be permitted or proscribed during such visits. It is recommended that the current access to the room of around 40,000 visitors per year be sharply decreased to perhaps 2,000 or less. Only those truly very important people who cannot practically be excluded from this room should be allowed inside. The cumulative impact of these VIP tours has contributed to a significant loss of historic materials and to the advanced deterioration of the historic furnishings and fabric of the MOCR. When conducted concurrently with the Space Center Houston tram tours, these VIP tours also present a serious distraction for the people in the Visitors Viewing Area.

In addition, other NASA program offices have access to this room and use it for other purposes. Some staffers have office space in close proximity and routinely use the Mission Operations Control Room as a shortcut pass-through to get to their office space even though there are other routes of access to these spaces. At least three different groups also access this space to provide routine maintenance. It was unclear whether these groups coordinate their efforts—or know what sorts of protocols should be in place and observed for maintaining a historic space. Another use, apparently, is to “inspire” new employees, especially interns. When the NASA-NPS workshop team visited the Landmark, we observed a group of 15-20 co-op interns completing work sheets while sitting at the consoles on the original seating. They came with cups of coffee, snack foods, and bags full of lunch materials—all of which they placed on the original Apollo consoles. This behavior sends a mixed message to young people regarding appropriate respect for such a valuable and fragile cultural resource. It was stated that food and drink are prohibited from the space—but also admitted that this prohibition is routinely unenforced. Again, this sends the dissonant message that, “We care about this space—but not really.”

The Johnson Space Center traditionally has given yet one more group of visitors free access to the Mission Operations Control Room: NASA employees and their guests. Since there are no locks on the doors to the Mission Operations Control Room, essentially everyone who has a
keycard to enter Building 30 has unrestricted access to the room. This has routinely included employees, family, friends, and neighbors of employees. Their use of the space has depended wholly on the monitoring, if any, of the employee hosting the group.

This sort of open, unrestrained access is incompatible with the importance and fragility of this National Historic Landmark—it degrades visitor experience and has contributed to the deterioration of historic fabric and loss of valuable objects. While the Johnson Space Center is planning to install keycard access to the Mission Operations Control Room there are no current plans to revise the access plan and change the uses of this space to preserve and protect it.

Allowing such high-volume visitor use in the Mission Operations Control Room is doubly damaging to NASA. Since the tram tours sometimes run concurrently with the VIP tours and employee use, every action down on the control room floor is often witnessed by a large audience up in the Visitors Viewing Area. As this audience observes how casually NASA is treating the MOCR, the message they may get is that this nationally significant historic place is not treated with the same respect as such sites as Monticello, Independence Hall, and the Lyndon B. Johnson National Historical Park. At these National Historic Landmarks, people have an opportunity to visit an authentic historic place—but are not allowed to sit on historic furnishings and handle original objects. These sites are treated as “sacred places” in our American history. By contrast, the existing treatment of the original, irreplaceable historic furnishings and materials in the MOCR may convey a message that Apollo Mission Control is not one of these “sacred places”. This is a message that NASA does not want to send to the public. Also, VIP visitor use of the control room at present regularly overlaps tram tour use of the Visitors Viewing Area, creating an unsettling and confusing experience, at least for the numerous tram tour visitors who witness the use of the room by VIP visitors. It must be very challenging for tram tour guides to keep the attention of the group on the storyline they are presenting with the distraction of a variety of individuals exploring the nooks and crannies of the control room directly in front of them.

This situation is not so surprising since, like its twin control room on the second floor, this Apollo-era control room was converted to an active workspace for the Space Shuttle Program between 1982 and 1992. Nevertheless, the room has been retired from active service for 23 years and is of national—indeed global—historical importance, and thus such haphazard treatment should end. In the interim, the Secretary of the Interior’s Standards for the Treatment of Historic Properties, which all federal agencies are required to follow, should guide the respectful care due this space until specific protocols can be established for access to and activities within this room. Little remains of the personal items, small furnishings, and mission-related objects that were once in this space. The Historic Furnishing Plan’s primary recommendation is to restore the space with appropriate original or reproduction objects and manage use to assure that the room, so richly refurnished, stays that way. The Historic Furnishings Report that accompanies this report focuses on this challenge.

While not venturing here into the details necessary to establish this new management direction, it is important to note that this effort will require an agency-wide paradigm shift in understanding and attitude regarding these historic spaces and resources. For that to be successful, it will absolutely require the clear and unambiguous support of top management. Without that key ingredient, no protocol or prescription will succeed in establishing and maintaining this National Historic Landmark as the priceless national treasure it is.
RECOMMENDED FUTURE CONDITION

The overarching operational consideration for interpreting the Apollo Mission Control Center National Historic Landmark is finding the best formula for balancing access and visitor experience with security and preservation of historic spaces and objects. The following recommendations will help create this desired future condition.

- **Visitors Viewing Area Experience** – There is little improvement needed for the majority of visitors who experience the NHL from the Visitors Viewing Area. With the aid of their interpretive guide, their vantage point mimics the historic experience of visitors during the Apollo mission era and is ideal for understanding and appreciating the use and layout of the control room. Their perspective is much the same as that of the Flight Operations Director and the Flight Director, arguably the two most critical participants on the mission team. They can see the big screens at the front of the Mission Operations Control Room (which can directly lead to discussion of the function of the “Bat Cave” behind), all of the tiers of consoles, and the plaques on the walls (which have important stories to tell in their own right). When the curtains are removed, they will also be able to clearly see into the Simulation Control Room, offering excellent opportunities to talk about flight simulations and the importance of the “back rooms” whose critical support of operations are not immediately obvious without explanation. The blinds on the Communications Booths (332a and 332b) should be removed so that these spaces, too, can be interpreted.

- **Visitor Loading** – The group size in the Visitors Viewing Area should be limited to the number of seats available in that space. Trying to cram in a “standing room only” crowd results in a distracting “musical chairs” effect and implies to visitors that Space Center Houston and JSC managers have not sufficiently considered their comfort and quality of experience. At present, more visitors are assigned to each Space Center Houston tram tour than can be accommodated by the seating available in the Visitors Viewing Area. As a result, people stand against the walls, sit on the floor, lean up against cabinetry, all of which detract significantly from the interpretive experience and increase wear and tear on the room interior. Tram tours should be limited to the number of visitors who can be accommodated by seating in this space.

- **Mission Operations Control Room Experience and Access** – The best place to view and understand the full configuration of the MOCR is from the Visitors Viewing Area, so decreasing the visits to the Mission Operations Control Room will actually enhance visitor experience for VIPs, not degrade it. Visitors standing at the front of the control room are in the least effective location to appreciate the operation of the room during a mission as they are looking back up the set of four tiers of consoles toward the Visitors Viewing Area. From that position, visitors are seeing the blank backsides of the consoles and have a view of the space wholly unlike any of the flight operations staff who manned the control room when it was in operation. From a purely experiential point of view, this is the worst possible perspective for a visitor wanting to understand the operation of the room.

- **When access and experience planning issues for the Mission Operations Control Room are developed, an important consideration will be how many visitors can enter this space at a time. This will be directly proportional to the number of public service staff who can accompany such groups. However, even with abundant staff, small group size should be
imposed to assure that visitors adhere to behavioral guidelines assuring minimal visitor impacts and object security in this space.

• A key recommendation is that the number of visitors allowed to enter the Mission Operations Control Room be sharply reduced—and all those who are permitted to enter this space should be accompanied by a trained representative of the Office of External Relations (either a member of that staff or a trained representative of that staff). The official definition of who is considered a VIP for this sort of access should be revised. It should be restricted to heads of state, governmental representatives, key celebrities, key former NASA staff who worked in this space, and perhaps a few others. The current level of approximately 40,000 visitors entering the Mission Operations Control Room per year should be reduced to about 2,000. Even in these cases, the entourage accompanying such guests should be strictly controlled and limited to a maximum of perhaps 10-15 individuals at a time. The experience of these visitors should be carefully designed and executed as well. Guests should be carefully instructed regarding appropriate behavior before entering the space and carefully monitored when they do. No one should be allowed to sit on the historic furnishing or handle the original objects.

• When the historic mission control room is used for private ceremonial purposes, it is important to provide an appropriate, dignified environment for such ceremonies, and to avoid visitor conflict. This can be accomplished by reserving blocks of time each month for this activity, during which time tours are prohibited. Participants in the ceremonial events should be directed to folding chairs brought into the front of the Mission Operations Control Room for this purpose rather than sitting at, leaning on, or touching the consoles. All equipment associated with ceremonial or official functions, such as stand-mounted speakers and microphones and the extra U.S. flag on a stand, should be removed from the control room immediately following these events and stored nearby to avoid disrupting the historic appearance of the room.

• Access to the room for commercial television and film production is an optional activity that should be eliminated in the future. These productions, although short-lived, place great demand on the historic fabric of the room and introduce potentially damaging activities.

• Restoration and Interpretation—The following rooms should be restored, per the recommendations in the Historic Furnishing Study, and interpreted:
  1. Mission Operations Control Room, aka “MOCR” (331)
  2. Visitors Viewing Area (332, 332a, 332b)
  3. Simulation Control Room (328), a significant example of a critical support “back room”
  4. Recovery Control Room (327), another significant critical support room
  5. Summary Display Projection Room, aka “Bat Cave” (330)
• Visitors should experience:
  ▪ Clean, accurate layout of mission control consoles with Apollo-era hardware modules/devices, headsets, and chairs
  ▪ Software-based displays on monitors to depict black and white, Apollo-era displays for each specific console
  ▪ Projections on the group display screens that depict Apollo-era content
  ▪ Room furniture and features similar to Apollo configuration
  ▪ Examples/facsimiles of Apollo-era flight documentation that is properly secured (mission rules, flight logs, etc.)
  ▪ Recordings of Apollo flight conversation playing as audio loops
  ▪ Appropriate, subdued lighting levels to support console light/monitor display
  ▪ Representative utility objects: pencil sharpeners, 3-hole punches, trashcans, coat racks
  ▪ Representative personal items: ashtrays, coffee cups, cigars, etc.
  ▪ Commemorative, Apollo mission-specific items (flag, plaques, other)

• Following the “working concept” recommendations spearheaded by retired flight controller Ed Fendell, the screens both large and small in the Mission Operations Control Room should be made to recreate a “live feed” look.

• Strategic Messaging — The Office of External Relations has developed a series of strategic messages guiding communications with the public. As various tour outlines and scripts are developed and revised, care should be taken that the information and interpretation provided to touring visitors is consistent with these strategic messages both in content and intent. Since this office is responsible for public affairs and public education throughout JSC, a relationship of close cooperation will be necessary between the various functions of this office and the manager of the NHL.

• Appropriate Maintenance — Treatment of objects and furnishings, environmental conditions, and other factors in the NHL spaces will necessarily be different from those suitable for the general work spaces of Building 30. The Building 30 Facility Engineer is aware of this and shows knowledge of the considerations that will need to form the basis of on-going maintenance. At present, his efforts are overlapped by a contract maintenance firm and Space Center Houston maintenance personnel. This overlapping responsibility is disadvantageous and maintenance responsibility for the NHL should be vested in the Building 30 Facility Engineer under the overall management of the JSC Historic Preservation Officer. In general, the Facility Engineer in the Center Operations Directorate either possesses the knowledge, skills, and abilities or can receive training to develop the necessary knowledge, skills, and abilities to manage the spaces and properties that fall under the auspices of the manager of the NHL.

• Long-Range Interpretive Plan — As the parameters for managing the NHL are developed, the JSC Historic Preservation Officer, in her role of ensuring the preservation of the historic character of the NHL, should work collaboratively with all appropriate divisions, including Facility Management, Communications, and JSC, to implement and refine this Visitor Experience Plan. We recommend that NASA develop a set of Individual Service Plans (ISPs), which outline the various specific services to be offered to the public. ISPs will be very helpful to all service providers to determine and specify the nature, scheduling, costs,
and intent of each type of interpretive service provided—as well as assuring consistency with the set of JSC strategic messages noted above. The NPS can recommend competent interpretive planners who can lead and accomplish such a planning effort.

- **Exhibits and Artifacts** — The JSC Exhibits Manager in the Office of External Relations currently has responsibility for NASA artifacts on site and on-loan offsite, some of which relate directly to the NHL. In addition, the historic Apollo era consoles, which are key elements of the NHL, are property that is under the management authority of the Flight Operations Division. Discussions will need to take place to ensure that the various interpretive exhibits and displays on the JSC campus outside the NHL display consistency from the perspective of visitors. From the visitors’ perspective, all of what they see and experience will, in their minds, be a unified whole, representing NASA’s efforts at helping them understand and appreciate all that has occurred and is occurring at the Johnson Space Center. An appropriate degree of stylistic unity will need to be adhered to in order to maximize visitor comprehension of the stories NASA intends to tell on those portions of the campus accessible by the public.

- **Excess Property Management** — In the past, a considerable amount of equipment and materials associated with the Apollo Program were identified as outdated excess property and disposed of by sale of donation. Now that such items are directly associated with the historic functions and furnishing of the NHL spaces, extreme care will need to be exercised when considering further such property for disposal as excess. Such items as historic Apollo-era consoles and their components will be key for refurnishing the NHL spaces. Also, regardless of the care they receive, such items will eventually degrade and become less appropriate for public display. Therefore, retaining multiples of such items will become critical in maintaining visitor experience over the long term. Such duplicate items should be carefully stored in a secure, environmentally controlled space for long-term preservation and eventual use for display. The JSC Historic Preservation Officer understands these requirements and can provide key assistance in setting up and maintaining such storage.
### Workshop Participants and Contact Information

<table>
<thead>
<tr>
<th>D1</th>
<th>D2</th>
<th>Name</th>
<th>Title</th>
<th>Organization</th>
<th>Telephone</th>
<th>Email address</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>Jeannie Aquino</td>
<td>Assistant Manager, External Relations</td>
<td>Office of External Relations, JSC</td>
<td>281-483-6270</td>
<td><a href="mailto:Jeannie.aquino-1@nasa.gov">Jeannie.aquino-1@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Marilyn Blevins</td>
<td>Real Property Accountant</td>
<td>Office of Planning &amp; Integration, JSC</td>
<td>281-483-3110</td>
<td><a href="mailto:Marilyn.k.blevins@nasa.gov">Marilyn.k.blevins@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Ed Fendell</td>
<td>NASA Flight Controller (retired)</td>
<td>Johnson Space Center</td>
<td>832-474-1476</td>
<td><a href="mailto:edfendell@comcast.net">edfendell@comcast.net</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Dennis Hehir</td>
<td>Building 30 Facility Manager</td>
<td>Flight Operations Division, JSC</td>
<td>281-483-3139</td>
<td><a href="mailto:Dennis.r.hehir@nasa.gov">Dennis.r.hehir@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Elizabeth LeBlanc</td>
<td>Exhibit Manager</td>
<td>Office of External Relations, JSC</td>
<td>281-244-5088</td>
<td><a href="mailto:Elizabeth.s.leblanc@nasa.gov">Elizabeth.s.leblanc@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Charles Noel</td>
<td>Chief, Planning &amp; Integration</td>
<td>Office of Planning &amp; Integration, JSC</td>
<td>281-483-3219</td>
<td><a href="mailto:Charles.a.noel@nasa.gov">Charles.a.noel@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>William Owen</td>
<td>Building 30 Facility Engineer</td>
<td>NASA/Gilbane JMS</td>
<td>281-483-4297</td>
<td><a href="mailto:William.h.owen@nasa.gov">William.h.owen@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Jennifer Ross-Nazzal</td>
<td>Historian</td>
<td>History Office, JSC</td>
<td>281-486-3942</td>
<td><a href="mailto:Jennifer.m.ross-nazzal@nasa.gov">Jennifer.m.ross-nazzal@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Sandra Tetley</td>
<td>Historic Preservation Officer &amp; Real Property Officer</td>
<td>Office of Planning &amp; Integration, JSC</td>
<td>281-483-8113</td>
<td><a href="mailto:Sandra.j.tetley@nasa.gov">Sandra.j.tetley@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Rebecca Wright</td>
<td>History Coordinator</td>
<td>History Office, JSC</td>
<td>281-990-0007</td>
<td><a href="mailto:Rebecca.a.wright@nasa.gov">Rebecca.a.wright@nasa.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Maren Bzdek</td>
<td>Program Manager &amp; Historian</td>
<td>Public Lands History Center, Colo. St. Univ.</td>
<td>970-222-7653</td>
<td><a href="mailto:Maren.bzdek@colostate.edu">Maren.bzdek@colostate.edu</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Christine Whitacre</td>
<td>Manager, National Historic Landmarks Program</td>
<td>National Park Service, Intermountain Region</td>
<td>303-969-2882</td>
<td><a href="mailto:Christine_whitacre@nps.gov">Christine_whitacre@nps.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Greg Kendrick</td>
<td>Assistant Regional Director</td>
<td>National Park Service, Intermountain Region</td>
<td>303-969-2894</td>
<td><a href="mailto:Greg_kendrick@nps.gov">Greg_kendrick@nps.gov</a></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Kim Sikoryak</td>
<td>Interpretive Specialist/Planner</td>
<td>Colorado State University, NPS (retired)</td>
<td>720-236-6317</td>
<td><a href="mailto:sikoryak@comcast.net">sikoryak@comcast.net</a></td>
</tr>
</tbody>
</table>