SUBORBITAL RESEARCH PROGRAM PLAN

It is the responsibility of each of the signing parties to notify the other in the event that a commitment cannot be met and to initiate the timely renegotiations of the terms of this agreement.

/Mark A. Allen/

Program Lead, Science Mission Directorate — Date: 4/21/14

/Charles Kay/

Associate Administrator, Science Mission Directorate — Date: 4/21/14

Suborbital Research Program Plan

Concurrence:

David Chenette
Director, Heliophysics Division

21 January 2014
Date

Paul Hertz
Director, Astrophysics Division

8/21/13
Date

Michael H. Freilich
Director, Earth Science Division

Date

James Green
Director, Planetary Science Division

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Tupper Hyde
Chief Engineer, Science Mission Directorate

Date

Geoffrey L. Yoder
Deputy Associate Administrator for Programs
Science Mission Directorate

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Suborbital Research Program Plan

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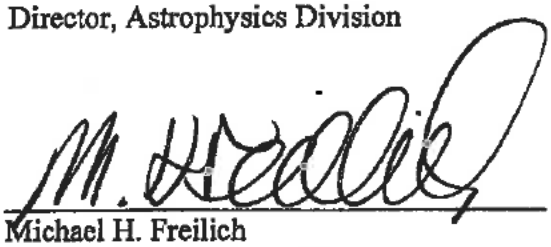

Michael H. Freilich
Director, Earth Science Division

23 Aug 2013
Date

James Green
Director, Planetary Science Division

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Science Mission Directorate

Date

SUBORBITAL RESEARCH PROGRAM PLAN
CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	April 21, 2014	**Baseline**

CONTENTS

1.0 PROGRAM OVERVIEW

1.1 INTRODUCTION

The Suborbital Research Program (SRP) enables fundamental scientific, technological, and educational investigations, and is characterized by frequent flight opportunities utilizing aircraft, balloons, sounding rockets, cubesats, suborbital reusable launch vehicles, and small International Space Station (ISS) payloads. These platforms support a wide variety of scientific objectives related to Earth science, heliophysics, planetary science, and astrophysics. Suborbital platforms can often provide data on much finer spatial and temporal scales than those achievable by on-orbit instruments, and they enable in-situ measurements and active experiments that require waiting for appropriate geophysical conditions.

The Suborbital Research Program is implemented as part of the NASA Headquarters (HQ) Program Commitment Agreement (PCA) for the Suborbital Research Program, and consists of a set of uncoupled Research and Technology (R&T) projects (which are referred to as programs for historical reasons), each with a separate funding and management structure. Each project conforms to the NASA project management processes detailed in NASA Procedural Requirements (NPR) 7120.8, *NASA Research and Technology Program and Project Management Requirements.*

1.2 GOALS AND OBJECTIVES

The primary goal of the Suborbital Research Program is to provide frequent flight opportunities for science, technology, and educational investigations in support of the Science Mission Directorate (SMD). The Suborbital Research Program will execute these investigations in support of the user's requirements utilizing streamlined and efficient management approaches. The Program seeks to provide safe, low-cost, access to near space through a commitment to developing enabling technologies that are intended to extend the performance capabilities of the research carriers to support investigation requirements, as well as increase the Technology Readiness Level (TRL) of science instruments. The Program will also provide opportunities to train the next generation of scientists and engineers, and to promote science, technology, engineering and mathematics (STEM) through providing hands-on educational training activities.

The goals and objectives of the Suborbital Research Program flow down from the NASA Strategic Plan, as follows:

- *Earth Science:* Advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet.
- *Heliophysics:* Understand the Sun and its interactions with Earth and the solar system, including space weather.
- *Planetary Science:* Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.

- *Astrophysics:* Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars. .

- *Technology:* Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit.

- *Workforce and Education:* Attract and advance a highly skilled, competent, and diverse workforce, cultivate an innovative work environment, and provide the facilities, tools, and services needed to conduct NASA's missions.

Suborbital platforms often can provide data on much finer spatial and temporal scales than those achievable by on-orbit instruments, and enable in-situ measurements and active experiments that require waiting for appropriate geophysical conditions. Suborbital platforms also provide an inexpensive and low-risk way to develop and test new space flight instrument concepts, as well as to calibrate and validate the on-orbit spacecraft instrument.

1.3 PROGRAM ARCHITECTURE

The Suborbital Research Program is organized as Cross-Program Research, and the budget lines associated with each project will remain in the SMD research division where they are managed. The Astrophysics Division (APD) manages the scientific Balloon Project for all of SMD. The Earth Sciences Division (ESD) manages the Airborne Science Project for all of SMD. The Heliophysics Division (HPD) manages the Sounding Rockets Project for all of SMD. SMD sponsored investigations utilizing cubesats, small ISS payloads, and suborbital reusable launch vehicles will be managed on an ad-hoc basis through the sponsoring SMD research division.

Each project has a portfolio of R&T investigations, each with unique science and platform requirements. The annual flight manifest of these R&T investigations is, in general, competitively selected via the NASA Research Opportunities in Space and Earth Sciences (ROSES) solicitations. Occasionally, reimbursable investigations from other NASA mission directorates, branches of the Department of Defense (DoD), other government agencies, and commercial and foreign entities are supported by the Suborbital Research Program.

Suborbital R&T investigations are characterized as low cost, level of effort activities, with less than Class D mission assurance requirements. Per the PCA, aggregate mission success (launch vehicle and experiment success) is expected to be on the order of 85 percent during a 12 month period of time. Suborbital investigations must comply with all agency safety policies, including but not limited to NPR 8715.3, *NASA General Safety Program Requirements* and NPR 8715.5, *Range Flight Safety Program*. Other key aspects of the Suborbital Research Program involve tailoring of NPR 7120.8 processes or requirements, and program-wide requirements on suborbital class research investigations.

The Suborbital Research Program consists of these component projects:

Airborne Science – Conducts Earth science investigations utilizing both NASA and non-NASA aircraft, including both piloted and remotely piloted aircraft, provides payload integration and flight operations at altitudes up to 21 km. The NASA Airborne Science Program (ASP) conducts approximately 1,500 to 2,500 flight hours annually in support of the NASA scientific and technology community, from locations around the world. The ASP operates a suite of airborne science platforms to meet NASA Earth science requirements. ASP activities are managed by a core of civil servants located at NASA field centers, including ARC, DFRC, GRC, GSFC/WFF, JSC, and LaRC.

Balloons – Conducts Earth and space science investigations characterized by payload integration, test, and launch on scientific balloons, with near space access for payloads up to altitudes of 38 km. The Balloon Program Office (BPO) typically conducts between 10 to 16 balloon launches per year in support of the NASA scientific and technology community. Balloon activities are managed by a core of civil servants located at GSFC/WFF, and through the contract of the Columbia Scientific Balloon Facility (CSBF) located at Palestine, Texas. Balloon flights are conducted from U.S. and foreign launch sites throughout the world, driven by science requirements.

Sounding Rockets – Conducts Earth and space science investigations characterized by payload integration, test, field operations support and launch on sounding rockets at altitudes up to 1500 km. The Sounding Rockets Program Office (SRPO) typically conducts between 15 to 20 sounding rockets launches per year in support of the NASA scientific and technology community, and supports a wide spectrum of scientific and technical experiments. Sounding rocket activities are managed by a core of civil servants and through the NASA Sounding Rocket Operations Contract (NSROC) located at GSFC/WFF. Rocket launches are conducted from U.S. and foreign launch sites throughout the world, driven by science requirements.

Special Orbital Projects - Conducts Earth and space science investigations characterized by small orbital science investigations, including CubeSats, small ISS payloads, and university-class investigations that offer lower-cost opportunities to advance science and train the next generation of scientists and engineers. These investigations are a coordinated set of uncoupled missions wherein each investigation has unique science and carrier requirements.

1.4 Customer and Stakeholder Definition and Advocacy

The customer is defined as the investigator, or other user, of the Suborbital Research Program platform and its services. The U.S. science community, representing SMD's four Science Divisions, is the principal user of the suborbital platforms and the data resulting from the suborbital missions and provides the intellectual guidance and rationale for the suborbital platforms. It should be noted that the Suborbital Research Program is also used extensively for technology and educational missions. Project teams may include academia, industry, government, Federally Funded Research and Development Centers (FFRDC), and international partners.

The Suborbital Research Program is composed of a variety of suborbital and special orbital platforms that are available to support the unique science, technology, and educational characteristics that any customer may demand.

The NASA HQ SMD and the science community are the immediate stakeholders for the Suborbital Research Program. The SMD provides the Suborbital Research Program, through its constituent suborbital projects, their operating budgets, programmatic guidelines, and identification of goals and objectives.

Stakeholder advocacy is achieved through interactions with the science, technology, and educational communities and with the general public. These interactions involve the NASA HQ SMD Science Divisions (Heliophysics, Astrophysics, Planetary and Earth Science), NASA Advisory Committee (NAC), Project Scientists, Principal Investigators (PIs), Science Advisory Committees, and scientific user working groups. The programmatic advocacy comes from the Science Division Directors, the NASA HQ Science Mission Directorate (SMD) Associate Administrator (AA) and the NASA Administrator in their budgetary submittals to Congress and by the Congress via its appropriation of the funding necessary to implement the Suborbital Research Program.

1.5 Program Authority and Management Approach

1.5.1 Program Authority

The Suborbital Research Program is a multi-project program, and is implemented through SMD's Science Divisions. Program authority is delegated from the NASA-HQ SMD AA to the Science Division Directors to the Project Manager for the assigned suborbital Project.

The Airborne Science Project is administered by the Earth Science Division. Program authority and oversight/insight for all airborne science missions are delegated from the NASA-HQ SMD AA through the Earth Science Division Director, Earth Science Associate Director for Research, to the Airborne Science Program Director within SMD.

The Balloon Project is administered by the Astrophysics Division. Program authority and oversight/insight of all Balloon missions are delegated from the NASA-HQ SMD AA through the Astrophysics Division Director to the Balloon Program Office Chief at Goddard Space Flight Center's Wallops Flight Facility.

The Sounding Rockets Project is administered by the Heliophysics Division. Program authority and oversight/insight of all Sounding Rocket missions are delegated from the NASA-HQ SMD AA through the Heliophysics Division Director to the Sounding Rockets Program Office Chief at Goddard Space Flight Center's Wallops Flight Facility.

Program management for the Suborbital Research Program is delegated to the following NASA field centers and their implementing project offices, as shown in Table 1.

SRP Element	Field Center	Project Office
Airborne Science	ARC	Earth Science Project Office
	DFRC	Aircraft Office
	GRC	Aircraft Office
	GSFC/WFF	Aircraft Office
	JSC	Aircraft Office
	LaRC	Aircraft Office
Balloons	GSFC/WFF	Balloon Program Office
Sounding Rockets	GSFC/WFF	Sounding Rockets Program Office

Table 1: Suborbital Research Program (SRP) Implementing Project Offices

The governing Program Management Council (PMC) for the Suborbital Research Program is the SMD Program Management Council (PMC). Oversight of the Suborbital Research Program activities is performed by the Center Management Council at the host Center, which evaluates all suborbital project investigations for safety, technical content, cost and schedule, to ensure compliance with the PCA, this Program Plan, Center procedures and processes, and applicable NASA technical standards. Details of performing Centers supplying missions, suborbital carriers, services, etc. to the Suborbital Research Program and its Projects are contained in the individual Project Plans.

1.5.2 Management Approach

The Suborbital Research Program is organized as Cross-Program Research. The program management responsibility for each project element will remain within the SMD science division where they are administered. The SMD AA delegates authority and responsibility for Suborbital Research Program activities to the Science Division Directors. The Science Division Directors delegate authority and responsibility for Suborbital Research Program activities to the assigned Suborbital Project Managers. The Suborbital Project Managers at the implementing field centers report programmatically to the Science Division Program Executives/Program Directors who are responsible for oversight of the assigned suborbital Project.

The SMD Senior Program Executive for Suborbital Research is a member of the SMD front office, and provides overall monitoring of the Suborbital Research Program and reports to the SMD AA through the SMD Deputy Associate Administrator for Research. The Science Division Program Scientists and Discipline Scientists are responsible for the funding of the science investigations, and for representing the Science Division to the assigned Project Office on all science issues, and for providing advice on maintaining carrier science requirements.

The Suborbital Research Program is responsible for the safe execution of the carrier and the investigation, including flight and mission operations. Suborbital research investigations must comply with all agency safety policies, including but not limited to NPR 8715.3 and NPR 8715.5. Suborbital Research Projects are typically low cost, level of effort activities, with less than Class D mission assurance requirements.

The Project Offices at the field centers establish operational policies, assure appropriate review of project elements, monitor the progress of each investigation, report project status to SMD, recommend necessary corrective and preventative actions, and provide engineering support to the investigation teams, as required. The Project Offices are responsible for ensuring the carrier is capable of supporting the customer's committed science requirements, and promote efficiencies through the application of innovative management practices, the identification of, the capture and application of lessons learned, and supports SMD in the preparation of NASA Research Announcements (NRAs). Oversight to support program management and Technical Authority (TA) responsibilities will include the conduct of telecommunications with the Project Manager (PM) and the Project Office staff. Monthly Status Reviews (MSRs) will be presented to SMD and the Center Management Council (CMC).

1.6 Implementation Approach

SMD implements the Suborbital Research Program through its research divisions and assigned field centers to provide a portfolio of highly effective suborbital and special orbital research platforms and operational support services. The annual flight manifest of these R&T investigations is, in general, comprised of investigations competitively selected via the NASA Research Opportunities in Space and Earth Sciences (ROSES) solicitations, or directed by the Science Division. Occasionally, the AO process is used to solicit and select projects. Since the Suborbital Research Program is a coordinated set of uncoupled R&T Projects, the execution of the investigations embodies the implementation of the Program. Based on the risk posture of the Suborbital Research Program, these investigations are conducted while specifically accepting many risks that an orbital mission may not accept.

The Suborbital Research Program (SRP) is responsible for conducting the investigation to meet the user's requirements, at a level of rigor commensurate with the cost, complexity, and risk of the investigation. Suborbital Projects will be implemented as low cost, level of effort activities, with less than Category 3, Class D, mission assurance requirements (per NPR 7120.5, *NASA Space Flight Program and Project Management Requirements*). The applicable elements of the Suborbital Research Program mission assurance are as follows:

- SRP missions must comply with all agency safety policies, including but not limited to NPR 8715.3 and NPR 8715.5.
- While complying with all agency safety policies, SMD accepts a higher level of mission risk for the SRP. Failure of the mission/investigation prior to the scheduled completion of

the planned primary mission (failure to meet threshold requirements) does not constitute a mishap.

- The SRP operates under a risk posture that tolerates an 85% long-term mission success rate, but has historically achieved greater than 90% mission success.
- In order to keep mission cost and timelines reasonable, the Program utilizes commercial off-the-shelf components as much as practical, and relies on system standardization, robust designs, and when required, rigorous environmental testing to ensure mission success.
- Launch constraints are flexible. Suborbital operations typically attempt to meet the scheduled launch dates for the investigation, while designed to allow for changes in the field and to allow the investigator the decision when to launch in order to optimize the mission return by waiting for appropriate geophysical conditions.

2.0 PROGRAM BASELINE

2.1 Baseline Requirements

The Suborbital Research Program shall provide frequent flight opportunities to SMD science divisions for NASA science and technology investigations that are competitively selected via the NASA ROSES solicitation process. The following flight rate is directed, commensurate with the availability of adequate funding and payloads projected to be ready for launch.

- Sounding Rockets will launch 15-20 investigations each year
- Balloons will launch 10-16 investigations each year
- Aircraft will fly 1,500-2,500 investigation flight hours each year
- Special projects will launch 1-2 investigations each year

The investigations level performance requirements for each science investigations shall be detailed in a NPR 7120.8 compliant Portfolio Investigations Project Plan, as required by the Project, or by the investigator's proposal. The requirements shall define both the baseline and the threshold science requirements based on the selected proposal and according to the following definitions:

- Baseline Science Requirements – An investigation which, if fully implemented, will accomplish the entire set of scientific objectives identified.
- Threshold Science Requirements – The minimum science component for the proposed investigation.

Suborbital Research Program science investigations shall be complete activities, where the Project Office provides the suborbital carrier, launch vehicle integration, launch, mission operations, tracking support, and payload recovery. The Project Office shall be responsible for providing the mission assurance for the carrier platform. The aggregate mission success (launch vehicle and experiment success) is expected to be on the order of 85 percent in a given year.

The full investigation performance will be validated using the customer's provided performance requirements, with test procedures used to validate that the system meets all the functional and performance requirements. In cases of a Suborbital Research Program carrier's system development, the verification and validation for the development will consist of a Test Flight that will demonstrate full system performance under actual flight conditions.

Mission assurance requirements will be tailored to each investigation. Instrument development is specifically intended to be higher than normal risk to allow for experimentation with new instrument designs. The customer or other investigation lead shall provide the instrument to be integrated and flown on the platform. The customer or other investigation lead shall be responsible for the mission assurance of the science payload and for data analysis, publication, and training of students. The customer shall ensure the science payload is operating nominally during integration, and prior to launch.

All Suborbital Research Program investigations shall be operated within the framework of the NPR 7120.8. Projects shall ensure that relevant Safety and Mission Assurance elements are identified for those investigations, with appropriate ground and flight safety documentation approved by NASA Safety. Suborbital Research systems, have limited workmanship inspection. The parts selection, design, buildup, integration and testing requirements for each investigation payload are guided by less than Class D type payloads, with use of commercial off-the-shelf components as much as practical, limited workmanship inspection, but mitigated by robust integration and system level testing prior to launch.

NPR-8621.1, *NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping*, will govern the process to be used for investigating and reporting of any safety-related mishaps, or close calls. Any flight mission success related-anomalies or failures of the payload or the suborbital carrier will be investigated by a locally appointed team and reported to the appropriate level as stated in the project documentation. Review of the Suborbital Research Program's anomalies will be conducted annually by the Program with SMD, Office of the Chief Engineer, Office of Safety and Mission Assurance (OSMA), and the appropriate Center SMA organization. The applicable definitions for mishaps, close calls, and anomalies are provided in Appendix C.

2.2 Schedule Baseline

The Suborbital Research Program flight/launch schedules are customer driven, within the bounds of an in guide funding mission model. Each fiscal year, SMD approves a prioritized flight list, that is based on peer reviewed and competitively selected, or directed, investigations that are ready to fly that year. Detailed integrated investigation schedules are included, as required, in each Investigation Project Plan.

Project	Airborne Science	Sounding Rockets	Balloons	Special Projects
Annual Flights	1,500 – 2,500 hours flown annually	15-20 launches annually	10-16 launches annually	1-2 Investigations annually
Acquisition	Selected via NRA(ROSES)	Selected via NRA (ROSES)	Selected via NRA (ROSES)	Selected via NRA (ROSES)
Divisions Supported	Earth	Astrophysics, Heliophysics, and Planetary	Astrophysics, Earth, Heliophysics, and Planetary	Astrophysics, Earth, Heliophysics, and Planetary
Investigation Life Cycle	life cycle <36 months	life cycle <48 months	life cycle <36 months	life cycle <48 months
Locations	World-wide	Polar, Mid-latitude, Southern Hemisphere	Polar, Mid-latitude, Southern Hemisphere	Polar, Mid-latitude, Southern Hemisphere

Table 2: Suborbital Research Program Scope

The Suborbital Research Program attempts to meet the scheduled launch dates for the various experiment types. The program is flexible enough to allow for changes induced by the experimenter in the field, as well as, allowing the customer the decision as to when to launch, to optimize the scientific return. SMD funding and science demands drive the flight rate, campaign selection, and the launch schedule.

The schedule is based on the science instrument selection process. Dozens of individual suborbital missions are in various stages of development at any given time. Launch schedules and locations are completely under the control of the program within the limits of available funding and demand for flight opportunities. Launch and reflight schedule flexibility is a feature of the program designed to accommodate the experimental nature of the technology used in many of the payloads. In addition, the timing of new scientific targets of opportunity, such as a volcanic eruption, hurricane, a new supernova or a comet, cannot be planned in advance. Launch campaigns are scheduled as required by the science investigations selected.

The Sounding Rockets Project typical annual mission model is shown as follows:

- ~ 8-10 flights at White Sands Missile Range (WSMR)
- ~ 2-6 flights at Wallops Flight Facility (WFF)
- ~ 2-4 flights at the Poker Flat Research Range (PFRR)
- ~ 1-2 flights at Andoya Rocket range in Norway
- ~ 2-4 flights launched from the Wallops Mobile Range at locations dictated by the science of interest (e.g., Australia, Kwajalein/Reagan Test Range)

The Balloon Project typical annual mission model has a baseline program of launches, including:

- ~ 2-3 flights from McMurdo, Antarctica
- ~ 2-3 flights from Sweden (alternating years)
- ~ 2-3 flights from Australia (alternating years)
- ~ 0-1 flights from CSBF (Palestine, Texas)
- ~ 5-9 flights from Ft. Sumner (Spring and Fall)

The Airborne Science Project typical annual mission model is shown as follows:

- ~ 300 - 600 flight hours using the DC-8 (NASA 817)
- ~ 300 - 600 flight hours using the ER-2 (NASA 806, NASA 809)
- ~ 300 - 600 flight hours using the Global Hawk (NASA 871; NASA 872)
- ~ 500 - 900 flight hours on the GIII (NASA 502, 992)
- ~ 300 - 600 flight hours using the P-3B (NASA 426)
- ~ 200 - 300 flight hours using the C-23 (NASA 430)
- ~ 200 - 300 flight hours using the C-130 (NASA 439)

2.3 Resource Baseline

Suborbital Research Program activities are managed in a "level of effort" approach intended to maximize the flight/launch output of the project's mission model within fixed budgets, and without prescribed budget reserves, while maintaining schedule flexibility for the customer. Table 3 displays the Suborbital Research Program NOA requirements as contained in the FY 2014

President's budget. Updates, if any, to these NOA requirements and cost plans, are included in the PPBE process.

Element - NOA	FY2014 ($M)	FY2015 ($M)	FY2016 ($M)	FY2017 ($M)	FY2018 ($M)
Airborne	49.2	50.0	51.1	51.7	36.8
Sounding Rockets	53.2	65.6	48.0	53.0	53.0
Balloons	32.9	38.3	34.2	34.3	37.3

Table 3: Suborbital Research Program NOA Summary

3.0 PROGRAM CONTROL PLANS

3.1 Technical, Schedule, and Cost Control Plan

The Project Management for each investigation is determined by the customer's requirements, and will provide the basis of the NPR 7120.8 compliant project plan, as required by the Project, that the investigation will be executed. The project plan is intended to be the explicit agreement between NASA and the customer on the terms and conditions of the investigation.

Monthly technical, schedule, and cost information is collected analyzed, acted upon, and status reported to the center's CMC and SMD to assure that all program and project requirements are being met. Annual Flight Manifest schedules shall be generated for each project, and as required, investigations, using appropriate scheduling tools and methodology. In addition, each Project Office electronically transmits copies of weekly and monthly reports to the designated SMD Program Executives and Program Scientists. Cost controls for the Suborbital Research Program shall incorporate monthly tracking of resources (plan vs. actual forecast), and labor (plan vs. actual forecast).

3.2 Safety and Mission Assurance Plan

Individual Suborbital Research Projects will be managed according to NPR 7120.8, and will detail science and investigation success requirements, support systems, key milestone dates for the investigation, and supporting safety and mission assurance documentation. For mishap classification, the total value of the investigation includes the value of the scientific payload. Investigation expendables (e.g., balloon, rocket, consumables) along with the associated pro-rata campaign sunk costs are funded as part of each project's annual mission model and thus are not considered in calculating the mishap value for the investigation. Each Suborbital Research Program project shall develop a NPR 8621.1, *NASA Procedural Requirement for Mishap and Close Call Reporting, Investigating and Recordkeeping*, compliant response Mishap Preparedness and Contingency Plan (MPCP) to describe the pre-planned actions to be taken in response to a mishap or close call.

Safety of people (public, project and support personnel) is the paramount requirement for the Suborbital Research Program, its Projects and investigations. Safety requirements and compliance will not be compromised in trade-offs against other project considerations. Safety planning documentation is included in each of the Portfolio Investigation Project Plans.

Mission and Quality Assurance requirements for individual Suborbital Projects will be developed and tailored specifically for the project taking into consideration the available level of effort funding and the project's accepted risk posture so as to maximize the science return versus project cost ratio. Individual projects will develop a Project Quality Assurance Plan (PQAP) and Safety and Mission Assurance Plan (SMAP) that document these project specific quality/mission assurance requirements and is approved at the Suborbital and Special Orbital Projects Directorate level. The rigor of these project specific quality/mission assurance requirements is expected to be no greater than that typically required for a non-flight project that is neither critical nor complex.

Per NPD 8700.1, *NASA Policy for Safety and Mission Success*, the Suborbital Research Program will establish safety and mission success requirements within their projects, in conjunction with the designated Center Safety Technical Authority at a level of rigor commensurate with the cost and complexity of the investigation. Suborbital Project Offices will work with the host Center SMA organization to coordinate/execute SMA efforts within the project/element, as required.

The Suborbital Research Program uses problem tracking and anomaly reporting systems that are consistent with Agency and Center practices and procedures for mission assurance. Each project office develops a Mishap Preparedness and Contingency Plan (MPCP) to inform management of the occurrence of anomalies or incidents based on their mission criticality. NASA and Center Guidelines/Procedures are applied for the reporting, root cause determination, mitigation, and recurrence control of problems, failures, incidents, and anomalies. The Project Offices, in conjunction with the Center SMA representative, reviews past performance to determine the incidence of identical or related anomalies, evaluate and disposition Government-Industry Data Exchange Program (GIDEP) Alerts, Safe-Alerts, Problem Advisories, Agency Action Notices and NASA Advisories.

Review of the Suborbital Research Program's anomalies will be conducted annually by SMD, Office of the Chief Engineer, and the NASA Office of Safety and Mission Assurance (OSMA). In accordance with the requirements of NPR 7900.3, *Aircraft Operations Management Manual,* Airborne Science Project anomalies are reviewed as part of the NASA's Inter-Center Aircraft Operations Panel.

The Suborbital Research Program does not provide mission assurance functions for science payloads that are funded by the NASA SMD/ROSES grant process, and rely on the customer to ensure that the science payload meets proposed science requirements.

3.3 Risk Management Plan

Risks in the Suborbital Research Program associated with the suborbital platform will be managed via the risk management plan associated with the suborbital platform. Project specific risks are documented in the project office's Risk Management Plan, in accordance with the requirements of NPR 7120.8. The flow down of NPR 8000.4, *Agency Risk Management Procedural Requirements*, for the Projects shall also be documented in Risk Management Plans and implemented at a level commensurate with the cost, complexity, and risk of the suborbital investigation.

The Suborbital Research Program actively focuses efforts to integrate both programmatic and technical risk assessment activities as part of its continuous risk and overall management process. The first effort, establishing Mission Success Criteria, is necessary to determine what risks are acceptable and what risks require additional mitigation or contingency activities are required.

The Suborbital Research Program is excluded from NPR 8705.4, *Risk Classification for NASA Payloads.* However, accepted risks associated with the project or science investigations are

documented in the investigation portfolio project plan to ensure that the risk is understood and agreed to by the customer and the project, such that no further specific mitigating action is required. The flow down of NPR 8000.4 requirements for the Suborbital Research Projects shall be documented in project Risk Management Plans and implemented at a level commensurate with the cost, complexity, and risk of the suborbital investigation. The Project Offices report risks at the MSR using the standard 5X5 matrix format.

In accordance with baseline programmatic implementation and in agreement with the stakeholders, accepted risks for the Suborbital Research Program shall include, but are not limited to: launch abort; failure of the science mission or carrier; failure of flight support equipment or instrumentation; failure of science equipment or instrumentation; damage to, or loss of the science payload, provided no safety violations were experienced.

Risk management strategies shall be applied following the guidelines of NPR 8000.4, *Agency Risk Management Procedural Requirements*. Per NPD 8700.1, the Suborbital Research Program will establish safety and mission success requirements per the SMA Plan within their projects, and elements in conjunction with the designated Center Technical Authority at a level of rigor commensurate with the cost and complexity of the project. Project Offices will work with the Center SMA organization to coordinate/execute SMA efforts within the project.

3.4 Acquisition Plan

Major acquisitions fall into the following five categories: Scientific investigations (missions) shall be procured through the NASA Research Announcement (NRA) process for competitively selected and separately funded science investigations to be conducted; competitive industrial contracts for aircraft, sounding rockets, and scientific balloon operations; commercial suborbital reusable launch vehicles and flight support services will be procured from the Space Technology Mission Directorate (STMD) to conduct the investigation; range and launch services as required by the science investigations; and sophisticated scientific investigations (missions) using suborbital carriers to be competitively selected and funded through the Announcement of Opportunity (AO) process.

Competitively selected industrial contractors provide aircraft, sounding rockets, and scientific balloon flight operations to NASA. Sounding Rockets missions are designed and implemented via the NASA Sounding Rockets Operations Contract. The support contractor chosen to operate aircraft at designated Field Centers conducts aircraft maintenance and operations. The support contractor chosen to operate the Columbia Scientific Balloon Facility (CSBF) conducts scientific balloon flights.

3.4.1 Relationships to Other Programs and Organizations

The Suborbital Research Program will enter into formal agreements with organizations within and outside of NASA through its Project Offices to support the objectives and requirements of the Projects. Examples of other NASA organizations with which Suborbital Projects may engage include: NASA Launch Services Program for the CubeSat Launch Initiative (CSLI), Space

Communications and Navigation (SCaN), STMD, the WFF Research Range Program, and the International Space Station Program.

The Suborbital Research Program may facilitate the interaction between the Suborbital Projects and the responsible NASA organization to ensure timely implementation of the agreements. Projects that require external agreements with respect to other U.S. Agencies, industry, and academia will also make direct contact to reach agreement for support. Projects involved with international non-NASA partner will work with SMD and the NASA Office of International and Interagency Relations (OIIR) to generate the appropriate agreement and approvals.

3.5 Technology Development Plan

Technology developments envisioned to extend the capabilities of suborbital and special orbital carriers in support of the science investigations will be managed by the Project Office, according to policies under NPR 7120.8. The technology thrusts of the Project Offices are generally carrier and investigation enabling (e.g., advanced pointing, high data rate telemetry) related, and occasionally investigation-unique. The Suborbital Research Program provides technology maturization information to SMD to include capabilities in upcoming NRAs, and to customers that could be beneficial to their investigations. The Suborbital Research Program routinely employs novel applications of technologies to enable science investigation requirements. For instance, a prototype flight support system may be used by a scientist for their investigation, with the eventual benefit of providing this enabling technology to the entire suborbital research community. Therefore, close interaction with users is maintained throughout the investigation life cycle, as a low-cost way to promote technology applicability.

3.5.1 Cooperation and Commercialization

The potential for technology transfer of suborbital carriers, subsystems, and investigation support systems, is somewhat limited due to the nature of the activities and the relatively small budgets. The Suborbital Research Program's strategy will be to examine all implementation approaches, including direct use or leveraging of commercial assets and capabilities, and strategic partnerships with industry, which enable achievement of mission requirements and objectives.

3.6 Review Plan

Program and Project reviews will be conducted in accordance with the terms of reference and consistent with NPR 7120.8. Independent reviews of Suborbital Research Program elements and activities are conducted, as required, to evaluate the project's performance against science, technical, education and programmatic performance requirements.

Review of the Suborbital Research Program's anomalies will be conducted annually by SMD, Office of the Chief Engineer, and the NASA Office of Safety and Mission Assurance (OSMA). In accordance with the requirements of NPR 7900.3, *Aircraft Operations Management Manual,* Airborne Science Project anomalies are reviewed as part of the NASA's Inter-Center Aircraft Operations Panel.

Because of the low cost nature of Suborbital Research Program Investigations, design reviews are not required for science payloads. Design reviews are generally limited to the project's carrier and enabling technology, and flight support systems.

Each of the Suborbital Research Program projects report to their Center's CMC monthly as part of the Monthly Status Review. At the project level, there are several levels of status reviews at each phase of development that are conducted. Prior to launch, a Mission Readiness Review/Flight Readiness Review are conducted as non-advocate reviews.

The key requirements on each investigation are the science requirements, launch/campaign date, as documented in the investigation project plan. The Suborbital Research Program regularly reviews investigation status and projected ability to meet its requirements.

The Mission Readiness Review (MRR) occurs prior to the shipment of the system to the launch site. The purpose of the MRR is to assure the campaign is ready to commence, that the science payload has been validated through the environmental qualification, that all deviations, waivers and open items have reached a satisfactorily disposition and that the system, along with all the required documentation, operating procedures, etc., is ready for shipment. The results of system testing, alignment, calibration and end item performance are to be demonstrated and documented. The solutions to all problems encountered during the environmental test and validation phase and the solution rationale are to be presented. This review will be conducted at the project level.

The Flight Readiness Review (FRR) assesses the overall readiness to proceed with flight and is normally held one to three days prior to a scheduled launch. It is a review of the total system to support the flight objectives of the investigations. It is a review of the status of the payload, the status of all the ground support systems and the launch and flight operations for their readiness to support the launch. The review is to cover all the activity since the MRR, the closure of any actions from that review, and a summation of all the testing and launch operations planning and rehearsals to the present. Any open items and residual risks are to be presented at this time. Closure of this review and any actions generated from the review indicate the system is ready for launch.

3.7 Mission Operations Plan

Mission operations associated with aircraft, balloons, sounding rockets, cubesats, ISS payloads, and other Suborbital Research Projects will be addressed within their individual investigation Project Plans.

3.8 Environmental Management Plan

All Suborbital Research Project Offices shall conform to NASA and US environmental requirements for mishaps, radiation sources, and other environmental concerns. Project Offices shall maintain the appropriate level of environmental documentation, such as the Sounding Rocket Programmatic Environmental Assessment, and the Scientific Balloon Programmatic Environmental Assessment.

3.9 Data Management Plan

There is no Suborbital Research Program level Science Data Management Plan as the requirement is flowed down to the customer. In accordance with NASA policy, data are to be released as soon as possible after a brief validation period appropriate for the investigation. The customer shall meet the requirements for data management, as called out in their proposal.

3.10 Information and Configuration Management Plan

The Suborbital Research Program's Project Offices shall maintain a compliant document management system for suborbital carrier and in house development related documents, that it stores and manages the distribution of Project top-level documentation, and provides access to documentation via a Project Office Library in hard copy or electronically. The customer is responsible for maintaining copies for configuration identification, configuration control, interface management, records traceability, and document status related to the science payload.

3.11 Security Plan

The Suborbital Research Program's plan for ensuring security and technology protection shall utilize established Agency procedural documents. The Program's approach to implementing IT security requirements shall be accordance with NPR 2810.1, *Security of Information Technology*.

3.12 Export Control Plan

Individual Export Control Plans shall be prepared and implemented at the Project Office level working with the lead center Export Control Office. The Project Offices shall comply with the export control requirements specified in NPR 2190.1, *NASA Export Control Program.*

3.13 Education and Public Outreach Plan

The Suborbital Research Program and its Project Offices will implement the EPO policy of the Science Mission Directorate.

3.14 Lessons Learned Plan

The project manager shall be responsible for determining lessons learned and entering them into the NASA database in accordance with NPR 7120.6, *Knowledge Policy on Programs and Projects.*

4.0 Waivers Log

The Suborbital Research Program shall maintain a waiver log consistent with the requirements of NPR 7120.8. Waivers currently in the approval process are:

- Earned Value Management System (EVMS) waiver for Suborbital research missions utilizing aircraft, scientific balloons, and sounding rockets and implemented under 7120.8. The decision to do EVM on other projects (such as cubesats or ISS instruments) will be delegated to the director of the sponsoring division.

5.0 Change Log

A change log is included on page ii to incorporate any projects added for implementation, terminated, or for documentation revisions. Changes to this Suborbital Research Program Plan must be approved by the signatories listed in this plan. Changes to the Program Plan will be addressed and logged as they occur. Flight schedules are constantly changing and are documented as part of the MSR packages. Configuration Management of this document will be administered by the Suborbital Research Program Manager.

6.0 Research Plan Appendices

Appendix A - Acronyms

Appendix B - Applicable Documents

Appendix C - Definitions

APPENDIX A
Acronyms

AA	Associate Administrator
AO	Announcement of Opportunity
APD	Astrophysics Division
APRA	Astronomy and Physics Research and Analysis
APT	Approval to Proceed
ASP	Airborne Science Program
BPO	Balloon Program Office
CMC	Center Management Council
CSBF	Columbia Scientific Balloon Facility
DoD	Department of Defense
E&PO	Education and Public Outreach
ESD	Earth Sciences Division
ESSP	Earth System Science Pathfinder
FAR	Federal Acquisition Regulation
FRR	Flight Readiness Review
GIDEP	Government Industry Data Exchange Program
GSFC	Goddard Space Flight Center
HOPE	Hands On Project Experience
HPD	Heliophysics Division
HQ	Headquarters
ISS	International Space Station
MPCP	Mishap Preparedness and Contingency Plan
MRR	Mission Readiness Review
MSR	Monthly Status Review
NASA	National Aeronautics and Space Administration
NPR	NASA Procedural Requirement
NRA	NASA Research Announcements
NSROC	NASA Sounding Rocket Operations Contract
OIIR	Office of International and Interagency Relations
OSMA	Office of Safety and Mission Assurance
PCA	Program Commitment Agreement
PFRR	Poker Flat Research Range
PI	Principal Investigator
PM	Project Manager
R&T	Research and Technology
ROSES	Research Opportunities in Space and Earth Sciences
SMA	Safety and Mission Assurance
SMD	Science Mission Directorate
SPO	Special Projects Office
SRP	Suborbital Research Program
SRPO	Sounding Rockets Program Office

SSOPD	Suborbital and Special Orbital Projects Directorate
STEM	Science, Technology, Engineering and Mathematics
STMD	Space Technology Mission Directorate
TA	Technical Authority
TRL	Technology Readiness Level
UAS	Unmanned Aerial Systems
WFF	Wallops Flight Facility
WSMR	White Sands Missile Range

APPENDIX B

Applicable Documents

NASA Strategic Plan

NPR 2810.1, Security of Information Technology

NPR 2190.1, NASA Export Control Program

NPR 7120.5, NASA Space Flight Program and Project Management Requirements

NPR 7120.8, NASA Research and Technology Program and Project Management Requirements

NPR 8000.4, Agency Risk Management Procedural Requirements

NPR 8621.1, NASA Procedural Requirement for Mishap and Close Call Reporting, Investigating and Recordkeeping

NPD 8700.1, NASA Policy for Safety and Mission Success

NPR 8705.4, Risk Classification for NASA Payloads (*SRP exclusion*)

NPR 8705.6, Safety and Mission Assurance Audits, Reviews and Assessments

NPR 8715.3, NASA General Safety Program Requirements

NPR 8715.5, Range Flight Safety Program

NPD 8730.5, NASA Quality Assurance Program Policy

NPD 8735.2, Management of Government Quality Assurance Functions for NASA Contracts

APPENDIX C
Definitions

Acquisition. The acquiring by contract with appropriated funds of supplies or services (including construction) by and for the use of the Federal Government through purchase or lease, whether the supplies or services are already inexistence or must be created, developed, demonstrated, and evaluated. Acquisition begins at the point when Agency needs are established and includes the description of requirements to satisfy Agency needs, solicitation and selection of sources, award of contracts, contract financing, contract performance, contract administration, and those technical and management functions directly related to the process of fulfilling Agency needs by contract.

Anomaly. An unexpected event that is outside of certified design/performance specification limits. NOTE: Certified design limits are those identified in approved design-level documents.

Approval (for Implementation). The acknowledgment by the Decision Authority that the program/project has met stakeholder expectations and formulation requirements, and is ready to proceed to implementation. By approving a program/project, the Decision Authority commits the budget resources necessary to continue into implementation. Approval (for Implementation) must be documented.

Approval. Authorization by a required management official to proceed with a proposed course of action. Approvals must be documented.

Baseline (Document Context). Implies the expectation of a finished product, though updates may be needed as circumstances warrant. All approvals required by Center policies and procedures have been obtained.

Baseline Science Requirements. The mission performance requirements necessary to achieve the full science objectives of the mission. (Also see Threshold Science Requirements.)

Center Management Council (CMC). The council at a Center that performs oversight of programs and projects by evaluating all program and project work executed at that Center.

Close Call. An event in which there is no injury or only minor injury requiring first aid and/or no equipment/property damage or minor equipment/property damage (less than $1000), but which possesses a potential to cause a mishap.

Concurrence. A documented agreement by a management official that a proposed course of action is acceptable.

Configuration Management. A management discipline applied over the product's life cycle to provide visibility into and to control changes to performance, functional, and physical characteristics.

Contract. A mutually binding legal relationship obligating the seller to furnish the supplies or services (including construction) and the buyer to pay for them. It includes all types of commitments that obligate the Government to an expenditure of appropriated funds and that, except as otherwise authorized, are in writing. In addition to bilateral instruments, contracts include (but are not limited to) awards and notices of awards; job orders or task letters issued under basic ordering agreements; letter contracts; orders, such as purchase orders, under which the contract becomes effective by written acceptance or performance; and bilateral contract modifications. Contracts do not include grants and cooperative agreements.

Decision Authority. The Agency's responsible individual who authorizes the transition of a program/project to the next life-cycle phase.

Environmental Management. The activity of ensuring that program and project actions and decisions that potentially impact or damage the environment are assessed/evaluated during the formulation/planning phase and reevaluated throughout implementation. This activity must be performed according to all NASA policy and Federal, state and local environmental laws and regulations.

Final (Document Context). Implies the expectation of a finished product. All approvals required by Center policies and procedures have been obtained.

Information Technology. Any equipment, or interconnected system(s) of subsystem(s) of equipment, that is used in the automatic acquisition, storage, analysis, evaluation, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the Agency.

Logistics. The management, engineering activities, and analysis associated with design requirements definition, material procurement and distribution, maintenance, supply replacement, transportation, and disposal that are identified by space flight and ground systems supportability objectives.

Management Requirements. Requirements that focus on how NASA does business that are independent of the particular program or project. There are four types: engineering, program/project management, safety and mission assurance, and Mission Support Office functional requirements.

Metric. A measurement taken over a period of time that communicates vital information about the status or performance of a system, process, or activity. A metric should drive appropriate action.

Mishap - An unplanned event resulting in injury to NASA or non-NASA personnel, damage to public, private, or NASA property which was caused by the NASA operations. In the case of the

Suborbital Research Program, failure of the science mission/investigation prior to the scheduled completion of the planned primary mission does not constitute a mishap.

Mission. A major activity required to accomplish an Agency goal or to effectively pursue a scientific, technological, or engineering opportunity directly related to an Agency goal. Mission needs are independent of any particular system or technological solution.

Preliminary (Document Context). Implies that the product has received initial review in accordance with Center best practices. The content is considered correct, though some TBDs may remain. All approvals required by Center policies and procedures have been obtained. Major changes are expected.

Principal Investigator (PI). A person who conceives an investigation and is responsible for carrying it out and reporting its results. In some cases, PIs from industry and academia act as Project Managers for smaller development efforts with NASA personnel providing oversight.

Program. A strategic investment by a Mission Directorate or Mission Support Office that has a defined architecture and/or technical approach, requirements, funding level, and a management structure that initiates and directs one or more projects. A program defines a strategic direction that the Agency has identified as critical.

Program Plan. The document that establishes the Programs' baseline for implementation, signed by the MDAA, Center Director(s), and Program Manager.

Program (Project) Team. All participants in program (project) formulation and implementation. This includes all direct reports and others that support meeting program (project) responsibilities.

Program/Project Management Requirements. Requirements that focus on how NASA and Centers perform program and project management activities.

Project. A specific investment identified in a *Program Plan* having defined requirements, a life-cycle cost, a beginning, and an end. A project yields new or revised products that directly address NASA's strategic needs.

Project Plan. The document that establishes the Project's baseline for implementation, signed by the cognizant Program Manager, Center Director, Project Manager, and the MDAA, if required.

Risk. The combination of the probability that a program or project will experience an undesired event and the consequences, impact, or severity of the undesired event, was it to occur. The undesired event may come from technical or programmatic sources (e.g., a cost overrun, schedule slippage, safety mishap, health problem, malicious activities, environmental impact, failure to achieve a needed scientific or technological objective, or success criterion). Both the probability and consequences may have associated uncertainties.

Risk Assessment. An evaluation of a risk item that determines (1) what can go wrong, (2) how likely is it to occur, (3) what the consequences are, and (4) what are the uncertainties associated with the likelihood and consequences.

Risk Management. An organized, systematic decision-making process that efficiently identifies, analyzes, plans, tracks, and controls, communicates, and documents risk and establishes mitigation approaches and plans to increase the likelihood of achieving program/project goals.

Safety. Freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Safety and Mission Assurance Requirements. Requirements defined by the SMA organization related to safety and mission assurance.

Security. Protection of people, property, and information assets owned by NASA, which covers physical assets, personnel, IT, communications, and operations.

Stakeholder. An individual or organization having an interest (or stake) in the outcome or deliverable of a program or project.

System. The combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose.

Waiver. A documented authorization intentionally releasing a program or project from meeting a requirement.