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MEMORANDUM OF AGREEMENT

BETWEEN

THE USAF SPACE AND MISSILE TEST AND EVALUATION DIRECTORATE

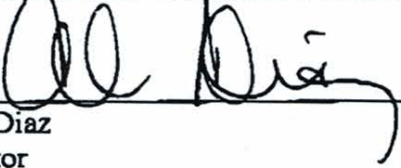
AND

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
GODDARD SPACEFLIGHT CENTER (GSFC)

FOR

THE GROUND SUPPORT/MISSION OPERATIONS OF
P99-1 CLOUDSAT

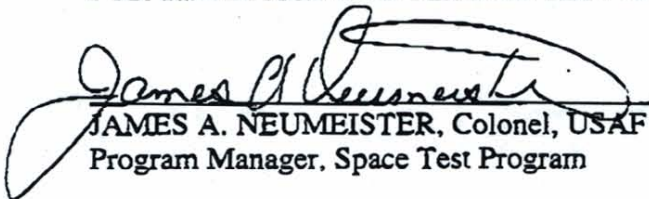
FOR THE NASA GODDARD SPACEFLIGHT CENTER:



A.V. Diaz
Director

Date: 9/7/00

FOR THE SPACE AND MISSILE TEST AND EVALUATION DIRECTORATE:



JAMES A. NEUMEISTER, Colonel, USAF
Program Manager, Space Test Program

Date: 18 July 2000

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MEMORANDUM OF AGREEMENT

1.0 PURPOSE:

The purpose of this Memorandum of Agreement (MOA) is to define the relationship, terms and conditions, and responsibilities of the USAF Space and Missile Systems Center, Space

and Missile Test and Evaluation Directorate, Space Test Program (SMC/TEL) and NASA Goddard Space Flight Center (GSFC), for the ground support/mission operations of SMC-801, CloudSat. CloudSat is designated as STP mission P99-1. The basic guidance for this document is AFI 10 1202(I) "Space Test Program Management", 1 April 1998.

2.0 SCOPE:

- 2.1 This MOA shall establish the basic working agreements between SMC/TEL and NASA for the ground support/mission operations of the CloudSat Mission.
- 2.2 The MOA shall be effective upon the date of the final signatures of both parties.
- 2.3 This MOA will be reviewed annually and amended as required. It will automatically terminate upon program completion or six (6) years from the date of origination, whichever occurs first.
- 2.4 Termination in advance of this agreed expiration date can be made by either party but shall require 180 days advance written notification by the withdrawing party.
- 2.5 Each Party shall bear the costs of discharging its respective responsibilities under this MOA, including travel and subsistence of each agency's personnel and transportation of its own equipment and associated documentation. It is understood that the ability of the Parties to carry out their respective responsibilities is subject to their respective funding procedures and the availability of appropriated funds.
- 2.7 The Parties will use reasonable efforts to carry out their respective responsibilities in accordance with the schedules to be defined in the CloudSat Project Implementation Plan, and to avoid changes that will have a negative effect on the other Party with regard to scientific return, implementation approach, cost, or schedule. Where changes cannot be avoided, the Parties agree to minimize these negative effects. To the extent that changes to the CloudSat Project Plan, proposed by GSFC or the Air Force, cause schedule, cost or other problems that go beyond either Party's program constraints, the signatories of this MOA agree to meet and define a reasonable resolution.
- 2.8 CloudSat ground support/mission operations requirements will be defined by the following documents, that are deliverables from GSFC to SMC/TEL:
 - a. CloudSat Ground Mission Requirements Document (GMRD)
 - b. CloudSat Ground Specification Document (GSD)
 - c. CloudSat Orbital Operations Handbook (OOH)
 - d. CloudSat Space Vehicle Handbook (SVH)
- 2.9 The response to CloudSat ground support/mission operations requirements will be defined in the following documents, that are deliverables from SMC/TEL to GSFC:
 - a. Mission Operations System (MOS) Description and Implementation Plan

b. Ground ICD Suite

3.0 ROLES AND SPECIFIC RESPONSIBILITIES:

- 3.1 GSFC responsibilities are carried out through the auspices of the Earth System Science Pathfinder (ESSP) Project Office at Goddard Space Flight Center (GSFC). GSFC is responsible for making arrangements with the Jet Propulsion Laboratory (JPL) for the performance of the specific GSFC responsibilities in this MOA through JPL Task Plan No. 70-5047.
- 3.2 GSFC shall develop and test CloudSat. GSFC shall provide the required technical information and support necessary for SMC/TEL to effectively provide ground support/mission operations for the CloudSat Mission via the RDT&E Support Complex (RSC) located at Kirtland Air Force Base, New Mexico.
- 3.3 SMC/TEL shall provide mission operations, using the SMC/TEO organization, to meet the negotiated experiment requirements of CloudSat identified in the documents in paragraph 2.8 and 2.9. SMC/TEL shall recommend final approval for space flight of CloudSat and shall recommend disapproving the flight of CloudSat if any problem is uncovered that will jeopardize the success of the P99-1 mission.
- 3.4 To support CloudSat ground support/mission operations, SMC/TEL will:
 - a. Develop, maintain, and integrate the RDT&E Support Complex (RSC) to meet all negotiated experiment requirements for operation of the CloudSat spacecraft. Document all interfaces between the spacecraft, the RSC, and all other participating organizations in the Ground ICD Suite. Chair/support appropriate working group meetings and reviews as required to develop the Ground ICD Suite. Provide Ground ICD Suite updates to NASA as required to maintain current interface status.
 - b. Plan, manage, and execute a series of exercises and rehearsals to simulate/practice nominal and contingency procedures in a realistic flight environment. Conduct these exercises and rehearsals with support from GSFC according to the schedule in Section 5 of this MOA.
 - c. Conduct reviews and provide schedule information and status of CloudSat mission operations and RSC development. Provide CloudSat mission and RSC progress and status review information to GSFC upon request. If schedule slips are forecasted, provide notification to GSFC within one week of identification of the slip.
 - d. Provide command generation, telemetry processing and orbit determination capability for the space vehicle. Maintain and provide the capability to update, with any required inputs from GSFC, the command and telemetry databases.
 - e. Conduct factory compatibility and launch site compatibility tests to demonstrate communications compatibility between the RSC and the spacecraft through the Air Force Satellite Control Network (AFSCN) equipment.
 - f. Provide launch and early orbit (LEO) operations support and facilities, to include the capability for immediate experiment checkout/verification after launch.

- g. Operate and provide orbital support for the CloudSat mission spacecraft, including periodic health and status checks and mission/system control for 24 months after launch.
- h. Provide spacecraft trending and analysis services.
- i. Provide GSFC with spacecraft and experiment data in the formats described in the Ground ICD Suite.
- j. Assist GSFC with rapid anomaly resolution for the CloudSat spacecraft bus and assist the CloudSat experimenters in anomaly resolution, as required, during CloudSat on-orbit operations.
- k. Attend reviews and meetings as requested by GSFC.
- l. Participate in the overall Project development, with the intent of meeting the mission objectives, schedule, and cost constraints.

3.5 To support CloudSat ground support/mission operations, GSFC agrees to:

- a. Support the CloudSat mission operations by providing equipment, personnel, and operations and test documentation as required during ground support/mission operations preparations, spacecraft system-level testing, and on-orbit operations. Specific support requirements will be identified in the documents referenced in paragraph 2.8.
- b. Provide the required spacecraft contractor support to the RSC for the CloudSat mission as defined in the documents identified in 2.8 of this agreement. The subject support shall include: spacecraft training, support of mission rehearsals, compatibility testing, launch and early orbit phase, and anomaly resolution.
- c. Provide comprehensive performance and support requirement inputs to SMC/TEL for incorporation into essential mission documents identified in paragraph 2.9 and other documents as needed. Provide thorough review of these documents within 6 weeks of receipt and changes to these documents when requested by SMC/TEL.
- d. Provide monthly schedules and status of the CloudSat mission to SMC/TEL during spacecraft development, space system integration, system level testing, launch, and on-orbit activities. If schedule slips are forecasted, provide notification within one week of identification of the slip. Upon request, provide any additionally required CloudSat funding and schedule status to SMC/TEL upon request.
- e. Support command and telemetry generation and CloudSat system control software development and test verification activities conducted by SMC/TEL, as required.
- f. Provide logistical and operational support of CloudSat-peculiar ground support/mission operations equipment, if any, during test, pre-launch, and on-orbit operations. Specific support requirements will be identified in the documents referenced in paragraphs 2.8 and 2.9.

- g. Provide SMC/TEL with access to CloudSat software, orbital operations procedures, time lines, and associated documentation for the purpose of obtaining status, resolving problems, and/or monitoring tests.
- h. Support appropriate working group meetings and reviews as required.
- i. Support execution of CloudSat on-orbit operations.
- j. Support SMC/TEL in the planning and conducting of mission rehearsals, tests, and other events necessary to the successful development and operation of the CloudSat mission. Support is expected to consist of personnel for test activities and technical information regarding CloudSat. Exercises and rehearsals will be conducted according to the schedule mutually agreed to between SMC/TEL and GSFC.
- k. Make available to SMC/TEL data and data products received from the CloudSat mission.
- l. Provide funding to SMC/TEO for any on-orbit operations and data product generation beyond 24 months, if required. GSFC shall be responsible for all CloudSat activity and operation after the 24 months specified in this agreement. GSFC must provide written notice to SMC/TEL and SMC/TEO 90 days prior to the expiration of SMC/TEO operations stating the planned course of action for the CloudSat mission.
- m. Provide an end-of- life plan for the CloudSat spacecraft, prior to launch, to be executed by SMC/TEL (via SMC/TEO) at the completion of on-orbit operations and data retrieval.
- n. Ensure the CloudSat end-of life plan is executed if the GSFC elects to continue operations of the CloudSat spacecraft, at the RSC or another operations facility, beyond the 24 months identified in this agreement.

4.0 TECHNICAL REQUIREMENTS:

The technical requirements for CloudSat are found in the documentation referenced in paragraphs 2.8 and 2.9 of this MOA.

5.0 MAJOR MILESTONES:

- 5.1 The CloudSat master mission schedule shall be established and maintained by GSFC with input and coordination from SMC/TEL, the spacecraft contractor, the launch services provider, and other experiment agencies. The RSC development schedule shall be established and maintained by SMC/TEL.
- 5.2 It shall be the joint responsibility of SMC/TEL and NASA to ensure consistency between various schedules and notify other parties whenever a schedule change occurs.
- 5.3 The following milestones are considered critical to the CloudSat ground support/mission operations effort.

- a. Critical Design Review (CDR) Third Quarter of Calendar Year (CY) 2001
- b. Spacecraft Integration and Testing Third Quarter of CY 2002
- c. Completion of Integrated Space Vehicle First Quarter of CY 2003
- d. Mission Readiness Review (MRR) L – 60 days
- e. Operational Readiness Review (ORR) L – 30 days
- f. Flight Readiness Review (FRR) L – 14 days
- g. CloudSat Launch Second Quarter of CY 2003 (nominal*)

*One-year before the nominal launch, a 3-month launch window will be established. Six months before launch, a one-month launch window will be confirmed.

6.0 PROGRAM FUNDING:

Funding for CloudSat ground support/mission operations by SMC/TEL; including retrieval of spacecraft and mission data, formation flying requirements, mission trending requirements, and any additional mission operations requirements specified in the documents identified in 2.8; for the 24 months of space operations, which includes 1 month of on-orbit checkout, will be provided as specified below. SMC/TEL will not fund the reduction and analysis of the raw mission data. GSFC shall be responsible for funding all CloudSat ground and mission operations support after 24 months of space operations, if these services are required.

Ground support/Mission Operations Funding

| CLOUDSAT | FY00 | FY01 | FY02 | FY03 | FY04 | FY05 | Totals |
|---------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|---------------|
| SMC/TEL Contribution (in millions) | \$0.075 | \$0.250 | \$1.575 | \$1.6 | \$1.0 | \$0.500 | \$5.0M |

7.0 POINTS OF CONTACT:

SMC/TEL: Lt Col David Parris
 Bldg 413, Rm 123
 3550 Aberdeen Ave SE
 Kirtland AFB, NM 87117-5776
 (505) 853-6623, (DSN 263-6623)
 Fax: (505) 846-8814
 E-mail: david.parris@kirtland.af.mil

NASA/GSFC: Don Lewis
 ESSP Program Office
 NASA Goddard Space Flight Center

Greenbelt, Maryland 20771
(301) 286-0015
FAX: (301) 286-0334
E-mail: Donald.H.Lewis.1@gsfc.nasa.gov

8.0 INFORMATION RELEASE:

The Parties retain the right to release public information regarding their own activities under this MOA. The Parties shall coordinate with each other in advance concerning public information activities, which relate to the other Party's responsibilities or performance under this MOA. The parties agree to identify the other party in this MOA in all public information releases.

9.0 DEFINITIONS:

- 9.1 CloudSat - CloudSat is a NASA mission which will provide, from space, the first global survey of cloud profiles and cloud physical and optical properties (with seasonal and geographical variations) needed to evaluate the way clouds are parameterized in global models, thereby contributing to predictions of weather, climate, and the cloud-climate feedback problem.
- 9.2 Ground Mission Requirements Document (GMRD) - Definition and Purpose: The GMRD will capture all high level operational requirements for the spacecraft and experiments. The customer generates this document very early in the program – possibly before awarding the spacecraft contract. The purpose of this document is to inform TEO/RSC of the impending requirements and allow them to generate a ROM for supporting operations. In those cases where the customer is researching several options for on-orbit operations support, this document should be used as a common basis for all possible on-orbit support providers to provide feasibility and ROM cost information. The customer should work closely with TEO before generating this document to ensure that all high-level requirements can realistically be met.
- 9.3 Ground Interface Control Document Suite (GICD Suite) - Definition and Purpose: These documents define the interfaces for data exchange between the space vehicle and the ground system, the spacecraft contractor and TEO, and each experimenter and TEO. TEO compiles this suite of documents based on inputs from all organizations involved in on-orbit operations.
- 9.4 Ground Specification Document (GSD) - Definition and Purpose: The GSD is a detailed expansion of the requirements listed in the GMRD. It is also written by the customer and is the governing functional specification for all TEO support to the mission. There should be enough detail to enable the RSC to generate a detailed operations concept and a good cost estimate.
- 9.5 Mission Operations System Description and Implementation Plan Document - Definition and Purpose: This document is the formal response to the requirements placed on the RSC in the GMRD/GSD. It provides a description of the operations concept and the operational system which will be put in place to support the mission, a requirements traceability matrix, the plan on how existing capabilities will be extended or modified to accommodate the mission, and the implementation schedule.
- 9.6 Orbital Operations Handbook (OOH) - Definition and Purpose: This document provides the detailed mission plan and timeline, as well as the sets of procedures, both nominal and

contingency, for executing each phase of the mission or each type of experiment operation. The MCT uses this document to develop exercise and rehearsal schedules, training plans, procedures, and passplans.

- 9.7 Space Vehicle Handbook (SVH) - Definition and Purpose: This document will contain the space vehicle description (what's there, how it works, etc); it will describe in detail the spacecraft subsystems and experiments and it will contain the spacecraft operating constraints for each phase of the mission or for each type of experiment operation. TEO uses the SVH to educate the MCT on the design of the space vehicle.