

No. 51738*

**United States of America
and
India**

Memorandum of Understanding between the United States National Aeronautics and Space Administration (NASA) and the Indian Space Research Organisation (ISRO) on cooperation concerning NASA's Miniature Synthetic Aperture Radar Instrument on ISRO's Chandrayaan - 1 Mission. Bangalore, 9 May 2006

Entry into force: 9 May 2006 by signature, in accordance with article 21

Authentic text: *English*

Registration with the Secretariat of the United Nations: *United States of America, 4 March 2014*

**No UNTS volume number has yet been determined for this record. The Text(s) reproduced below, if attached, are the authentic texts of the agreement /action attachment as submitted for registration and publication to the Secretariat. For ease of reference they were sequentially paginated. Translations, if attached, are not final and are provided for information only.*

**États-Unis d'Amérique
et
Inde**

Mémoire d'accord entre l'Administration nationale de l'aéronautique et de l'espace (NASA) des États-Unis et l'Organisation indienne de recherche spatiale (ISRO) relatif à la coopération concernant l'Instrument de miniature du radar à synthèse d'ouverture de la NASA sur la mission Chandrayaan-1 de l'ISRO. Bangalore, 9 mai 2006

Entrée en vigueur : 9 mai 2006 par signature, conformément à l'article 21

Texte authentique : *anglais*

Enregistrement auprès du Secrétariat des Nations Unies : *États-Unis d'Amérique, 4 mars 2014*

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[ENGLISH TEXT – TEXTE ANGLAIS]

Memorandum of Understanding
between the United States
National Aeronautics and Space Administration (NASA)
and the
Indian Space Research Organisation (ISRO)
on Cooperation Concerning
NASA's Miniature Synthetic Aperture Radar Instrument
On
ISRO's Chandrayaan-1 Mission

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Preamble

The United States National Aeronautics and Space Administration (hereinafter referred to as NASA) and the Indian Space Research Organisation (hereinafter referred to as ISRO);

As the Parties to this Memorandum of Understanding (MOU) (hereinafter the Parties);

CONSIDERING that the United States and India have agreed upon a major initiative to enhance joint activities in space cooperation;

CONSIDERING ISRO's plan to fly a mission, Chandrayaan-1, designed to map the Moon from polar lunar orbit in 2007;

CONSIDERING the release of the Announcement of Opportunity by ISRO, calling for proposals from interested foreign investigators to fly instruments on Chandrayaan-1;

CONSIDERING the selection by ISRO of the "Mini-SAR: An Imaging Radar for the Chandrayaan-1 Mission" proposal to characterize and map the environment and deposits of the lunar polar regions;

RECOGNIZING the need for a mission to collect these data to understand better the nature and properties of the lunar polar regions, this information being critical to the future of humanity on the Moon; and

CONSIDERING that cooperation on such a mission would be beneficial to both nations and to future human activities on the Moon;

Have agreed as follows:

Article 1 - Purpose

This MOU sets forth the terms and conditions under which the Parties will cooperate on the Chandrayaan-1 Mission with regard to the Miniature Synthetic Aperture Radar (Mini-SAR) instrument.

Article 2 - Definitions

As used in this MOU, the following terms shall have the specified meanings:

- 2.1 "S-band radar data" is data as received from the Mini-SAR instrument, including sensor and housekeeping data.
- 2.2 "Payload resource evaluation data" is the portion of the S-band radar data composed of the instrument sensor data.
- 2.3 "Instrument housekeeping data" is engineering health and status data necessary

for the daily operation of the Mini-SAR instrument in flight as well as for providing surface location knowledge necessary to produce validated flight data products.

Article 3 - Mission Description and Participation

- 3.1 The primary objective of the Chandrayaan-1 Mission is to map key properties of the Moon from polar orbit to better understand its history, evolution, and current state. These objectives include the mapping of Polar Regions and their deposits to address the scientific and resource questions regarding the volatile content of the lunar poles.
- 3.2 The NASA-sponsored Miniature Synthetic Aperture Radar (Mini-SAR) instrument, selected by ISRO for flight on Chandrayaan-1 after an international solicitation and competition, is a collaboration between NASA and ISRO on the acquisition and interpretation of data from the Mini-SAR developed for NASA and flown by ISRO. The Mini-SAR instrument is to be designed, developed, fabricated, integrated and tested by the Naval Air Warfare Center (NAWC), with support from the Johns Hopkins University Applied Physics Laboratory (JHU/APL), and is to be provided to ISRO for integration and flight on the Chandrayaan-1 spacecraft by JHU/APL.
- 3.3 The Chandrayaan-1 Mission is conceived, designed, built and flown by ISRO. This Indian mission is aimed at expanding the scientific knowledge about the Moon, and is to provide, through the independent initiative and effort of India, an exceptional international contribution to planetary research. The NASA Mini-SAR instrument on the Indian Chandrayaan-1 spacecraft has been accepted in exchange for the joint sharing of the collected scientific final data products. The Chandrayaan-1 spacecraft, integrated and tested under ISRO responsibility, is to carry the Mini-SAR instrument, which is to be operated by the plan and procedure that will be provided by a resource evaluation and engineering team at JHU/APL during the Chandrayaan-1 Mission. The Payload Operations Center (POC), which is to prepare the plan and procedure to operate the instrument in flight, process and archive the data to the NASA International Planetary Data System (PDS), is to be located at JHU/APL. The POC is a ground system comprising two primary subsystems (a) a command/sequence generation subsystem for instrument operations, and (b) a data processing subsystem for calibrating and processing raw scientific flight data of the lunar surface (the Indian Space Science Data Center (ISSDC) is to also have a POC Data Processing Subsystem replica (delivered by JHU/APL) to mutually process collected raw scientific and resource-related flight data).
- 3.4 Mini-SAR is to map both poles from 80 degrees latitude poleward in both right- and left-circular polarizations at a resolution of 150 m (75 m/pixel). The poles are to be mapped in both left- and right-look directions to minimize ambiguities.