Jet Propulsion Laboratory
California Institute of Technology
MS 301-472
4800 Oak Grove Drive
Pasadena, California 91109-8099

(818) 354-1181

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Environmental Evaluation and Recommendation for NASA Routine Payload Categorization of the Aquarius Project

The proposed Aquarius mission has been reviewed in accordance with the Routine Payload criteria established by the "*Final Environmental Assessment of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station Florida and Vandenberg Air Force Base California,*" dated June 2002 and Finding of No Significant Impact (FONSI) dated June 18, 2002. This review shows that the Aquarius mission meets all of the Routine Payload Criteria and therefore it is recommended that Aquarius be designated a NASA Routine Payload. Supporting mission description and Routine Payload Checklist documentation are attached.

8/22/05

V.S. Mowrey, Supervisor
Launch Approval Planning
Group

Date

Concurrence:

8/22/05

R. E. Wilcox, Manager
Cross-Program Launch
Approval Engineering

Date

Concurrence:

8/22/05

Amit Sen
AQUARIUS Project Manager

Date

Description of Proposed Mission:
The Aquarius project, an element of the NASA Earth System Science Pathfinder (ESSP) Program in the NASA Science Mission Directorate (SMD), is implemented jointly with the Argentina Comisión Nacional de Actividades Espaciales (CONAE). The CONAE mission is called Satelite de Aplicaciones Cientificas, flight D (SAC-D). This joint undertaking is referred to as the Aquarius/SAC-D Mission. The implementation of Aquarius/SAC-D is governed by the international Memorandum of Understanding (MOU) signed between the two countries on 2 March 2004 in Buenos Aires.

The Aquarius spacecraft would be launched in March 2009 on-board a Delta II 7320-10 expendable launch vehicle from Vandenberg Air Force Base (VAFB), California. The end of the baseline portion of the Aquarius mission would be April 2012 and the baseline SAC-D mission would end in April 2014.

Aquarius will retrieve sea surface salinity (SSS) by microwave remote sensing of surface brightness temperature at L-band, which is governed by the surface salinity, temperature and roughness (due to wind and waves). An integrated L-band microwave radiometer/scatterometer will be developed and deployed as the salinity measuring instrument, consisting of three beams in a pushbroom configuration. The radiometers will measure the L-band microwave surface brightness temperature and the scatterometer will measure the brightness temperature correction due to surface roughness. Ancillary measurements of surface temperature, surface wind and other geophysical corrections needed to convert brightness temperature to salinity will be obtained from other operational observing systems and models. Aquarius will provide global sampling on an orderly, comprehensive, spatial and temporal pattern from a low earth orbiting satellite over the open ocean (uncontaminated by land and ice surfaces which have much higher brightness temperature than the ocean). The observatory will be in a sun-synchronous orbit with the sensors oriented away from the sun to minimize contamination by the L-band solar radiation. Independent calibration and validation will be applied to verify SSS retrieval accuracy. SSS measurements will be provided in practical salinity units (psu) according the international standard Practical Salinity Scale, which is based on seawater electrical conductivity, and represents salt concentration in g/kg.

Statement of Purpose and Need:
The ESSP Aquarius Project will implement an Exploratory Measurement Mission designed to make pioneering space-based measurements of SSS with the precision, resolution, and coverage needed to characterize salinity variations and investigate the linkage between ocean circulation, the Earth's water cycle, and climate variability. Salinity is required to determine seawater density, which in turn governs ocean circulation. SSS variations are governed by freshwater fluxes due to precipitation, evaporation, runoff and the freezing and melting of ice. The Aquarius SSS measurements will be used to address two key areas of NASA's Earth Science research strategy described ESSP-3 Announcement of Opportunity (AO-01-OES-01):

1. **Earth System Variability and Trends:** How are global precipitation, evaporation, and the cycling of water changing?

2. **Earth System Responses and Feedback Processes:** How can climate variations induce changes in the global ocean circulation?

In meeting these objectives, Aquarius will also validate a space-based measurement approach and analysis concept that could be used for future systematic SSS monitoring missions.

Space-based SSS measurements are required to provide systematic global mapping because the existing compilation of *in situ* ship and buoy observations is inadequate to meet the science objectives. The *in situ* spatial and temporal sampling is sparse, irregular and largely confined to shipping lanes and the summer season. About 25% of the world oceans have never been sampled, including vast regions of the southern hemisphere. More than 73% of the world oceans have fewer than 10 observations per one-degree square, insufficient to resolve the annual water cycle, interannual variability, or the spatial fronts, eddies and current systems that affect oceanographic circulation processes.

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME:	**Aquarius**		DATE OF LAUNCH:	March 23, 2009	
PROJECT CONTACT:	David Durham	PHONE NUMBER:	818 354-7355	MAILSTOP:	306-460
PROJECT START DATE:	Aug. 2003	PROJECT LOCATION:	JPL		
PROJECT DESCRIPTION:	Earth orbiting observatory in a circular, sun synchronous 657 km orbit accommodating an L-band radiometer/scatterometer instrument system for making precise measurements of the Earth's sea surface salinity. Observatory operations are conducted out of Argentina using an Argentine service platform contributed per a US-Argentine Memorandum of Understanding. Aquarius instrument operations and data processing during the science mission will be performed at NASA's GSFC.				

A. SAMPLE RETURN:	YES	NO
1. Would the candidate mission return a sample from an extraterrestrial body?		**X**

B. RADIOACTIVE SOURCES:	YES	NO
1. Would the candidate spacecraft carry radioactive materials?		**X**
2. If Yes, would the amount of radioactive sources require launch approval at the NASA Associate Administrator level or higher according to NPG 8715.3 (NASA Safety Manual)?		
Provide a copy of the Radioactive Materials Report as per NPG 8715.3 Section 5.8.3.		

C. LAUNCH AND LAUNCH VEHICLES:	YES	NO
1. Would the candidate spacecraft be launched using a launch vehicle/launch complex combination other than those indicated in Table 1 below?		**X**
2. Would the proposed mission cause the annual launch rate for a particular launch vehicle to exceed the launch rate approved or permitted for the affected launch site?		**X**
Comments:		

D. FACILITIES:	YES	NO
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?		**X**
2. If Yes, has the facility to be modified been listed as eligible or listed as historically significant?		
Provide a brief description of the construction or modification required:		

E. HEALTH AND SAFETY:	YES	NO
1. Would the candidate spacecraft utilize any hazardous propellants, batteries, ordnance, radio frequency transmitter power, or other subsystem components in quantities or levels exceeding the Envelope Payload characteristics (EPCs) in Table 2 below?		**X**
2. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the Envelope Payload (EP)?		**X**
3. Would the candidate mission release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?		**X**
4. Would launch of the candidate spacecraft suggest the potential for any substantial impact on public health and safety?		**X**
5. Would the candidate spacecraft utilize a laser system that does not meet the requirements for safe operation (ANSI Z136.1-2000 and ANSI Z136.6-2000)? For Class III-B and IV laser operations, provide a copy of the hazard evaluation and written safety precautions (NPG 8715.3).		**X**
6. Would the candidate spacecraft contain pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health?		**X**
Comments:		

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NASA Routine Payload Checklist (2 of 2)

PROJECT NAME:	**Aquarius**		DATE OF LAUNCH:	March 23, 2009	
PROJECT CONTACT:	David Durham	PHONE NUMBER:	818 354-7355	MAILSTOP:	306-460
PROJECT START DATE:		PROJECT LOCATION:	JPL		
PROJECT DESCRIPTION:	Earth orbiting observatory in a circular, sun synchronous 657 km orbit accommodating an L-band radiometer/scatterometer instrument system for making precise measurements of the Earth's sea surface salinity. Observatory operations are conducted out of Argentina using an Argentine service platform contributed per a US-Argentine Memorandum of Understanding. Aquarius instrument operations and data processing during the science mission will be performed at NASA's GSFC.				

F. OTHER ENVIRONMENTAL ISSUES:	YES	NO
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?		**x**
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?		**x**
Comments:		

Table 1: Launch Vehicles and Launch Pads

Launch Vehicle	Eastern Range (CCAFS Launch Complexes)	Western Range (VAFB Space Launch Complexes)
Atlas IIA & AS	LC-36	SLC-3
Atlas IIIA & B	LC-36	SLC-3
Atlas V Family	LC-41	SLC-3
Delta II Family	LC-17	SLC-2
Delta III	LC-17	N/A
Delta IV Family	LC-37	SLC-6
Athena I & II	LC-46 or -20	California Spaceport
Taurus	LC-46 0r -20	SLC-576E
Titan II	N/A	SLC-4W
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB airfield

Table 2: Summary of Envelope Spacecraft Subsystems and Envelope Payload Characteristics (EPC)

Structure	**Unlimited:** aluminum, magnesium, carbon resin composites, and titanium **Limited:** beryllium [50 kg (110 lb)]
Propulsion	Mono- and bipropellant fuel; 1000 kg (2200 lb) (hydrazine); 1000 kg (2200 lb) (monomethyhydrazine) Bipropellant oxidizer; 1200 kg (2640 lb) (nitrogen tetroxide) Ion-electric fuel; 500 kg (1100 lb) (Xenon) SRM; 600 kg (1320 lb) (AP)-based solid propellant
Communications	Various 10-100 W (RF) transmitters
Power	Solar cells; 150 A-Hr (Ni-H_2) battery; 300 A-Hr (LiSOC) battery; 150 A-Hr (NiCd) battery
Science instruments	10 kW radar ANSI safe lasers (Section 4.1.2.1.3)
Other	Class C EEDs for mechanical systems deployment Radioisotopes limited to quantities that are approved for launch by NASA Nuclear Flight Safety Assurance Manager Propulsion system exhaust and inert gas venting