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Mission Calendar

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TABLES OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

1.1 Purpose

This document aims at providing information about the mission, its phases and some of the environmental conditions. It contains an overview of Venus Express mission phases. It gives the dates for the different mission phases from launch to extended mission. It presents the eclipse periods, occultations and conjunctions in the third section. It also gives the list of spacecraft incident that occurred until the writing of this document.

1.2 Reference documents

[RD1] EVTF_FDLVMA_DA_____00001.VEX: Flight Dynamics Event File.
[RD2] VEX-RSSD-PO-001, VEX Science Overview, 8th January 2007.
[RD3] VEX-RSSD-PO-005, VEX Extended Overview, 6th February 2008.

2. GENERAL DATA ON THE MISSION

In this section, Table 1 shows the different mission phase from launch until the end of the extended mission phase. The phases and acronyms are discussed in section 4.

Phase Acronym	Phase name	Start Date	End Date	Duration (days)
LEOP	Launch and Early Orbit Phase	09/11/05	11/11/05	3
NECP	Near Earth Commissioning Phase	12/11/05	16/12/05	21
ICP	Interplanetary Cruise Phase	17/12/05	04/04/06	107
VOI	Venus Orbit Insertion	05/04/06	21/04/06	16
VOCP	Venus Orbit Commissioning Phase	22/04/06	03/06/06	42
NMP	Nominal Mission Phase	04/06/06	02/10/07	486
EMP	Extended Mission Phase	03/10/07	May 2009	

Table 1: Mission timeline

3. Eclipse periods, occultations, conjunctions

In this section, the eclipse seasons, the occultations and the conjunction seasons are given. The dates are given from the 14th May 2006, which corresponds to the orbit number 23 and the first day of commissioning operations. For instance, the eclipse season may begin before the 14th May 2006, but we give this starting date because this date was the first day of operations in orbit.

Eclipses [RD1] [RD2][RD3]:

Eclipse season #	Dates
1	14/05/06-31/05/06 Orbit 23-40
2	05/08/06-13/09/06 Orbit 106-145
3	16/11/06-10/01/07 Orbit 209-264
4	17/03/07-26/04/07 Orbit 330-370
5	28/06/07-21/08/07 Orbit 433-487
6	27/10/07-08/12/07 Orbit 554-596
7	09/02/08-01/04/08 Orbit 659-711
8	06/06/08-22/07/08 Orbit 777-823
9	23/09/08-10/11/08 Orbit 886-934
10	16/01/09-28/02/09 Orbit 1001-1045
11	04/05/09-23/06/09 Orbit 1110-1160
12	28/09/09-11/10/09 Orbit 1226-1270
13	15/12/09-01/01/10 Orbit 1335-1360

Table 2: Eclipse periods

Earth Occultations [RD1][RD2][RD3]:

Occultation season #	Dates
1	11/07/06-30/08/06 Orbit 81-131
2	22/11/06-31/01/07 Orbit 215-285
3	26/04/07-01/07/07 Orbit 370-436
4	04/09/07-18/09/07 Orbit 501-515
5	04/01/08-13/03/08 Orbit 623-692
6	05/06/08-01/08/08 Orbit 776-833
7	28/10/08-31/12/08 Orbit 921-985
8	01/07/09-06/09/09 Orbit 1168-1236
9	09/12/09-01/01/10 Orbit 1328-1360

Table 3: Occultation periods

Conjunctions[RD2],[RD3]:

Conjunction season #	Dates
1 superior	17/10/06-08/11/06 Orbit 179-201
2 superior	29/05/08-19/06/08 Orbit 769-790
3 superior	08/12/09-30/12/09 Orbit 1328-1350

Table 4: Conjunction periods

4. Mission Phases

In this section, the different mission phases are described.

4.1 LEOP

This phase lasted 3 days from few hours before launch until the execution of the TCM-1. Once the separation of the spacecraft from the launch vehicle is completed, the control took over.

4.2 NECP

The Near Earth Commissioning Phase lasted 3 weeks. It included the following activities for the spacecraft:

- spacecraft commissioning.
- deployment of the MAG Boom.
- Payloads commissioning.

4.3 ICP

The Interplanetary Cruise Phase started after the Near Earth Commissioning Phase and ended shortly before Venus Orbit Injection when the spacecraft enters the Venus approach phase.
During the cruise, the SC was kept in a 3-axes stabilized attitude (solar arrays Sun facing, HGA-2 Earth pointing) and communications with the ground was established at each daily pass.
Spacecraft monitoring was done with a frequency of one pass per day for routine monitoring and control activities.
Payloads science operations were excluded from the cruise phase.

4.4 VOI

The Venus Orbit Insertion Phase lasted a little bit more than 2 weeks. It started just before the Venus capture manoeuvre and ended when the satellite had reached the operational orbit.
At the end of NECP, on the 29th March, a final course adjustment was performed to fine tune the arrival hyperbola for the orbit insertion.
The Venus Orbit Insertion manoeuvre took place on 11 April 2006. To enable capture of the spacecraft, it was first slewed such that the main engine was aligned to the direction of travel.
The main engine burn lasted around 50 minutes and decelerated the spacecraft by approximately 1251 meters/second (~ 4500 kilometers/hour).
The spacecraft initially entered a highly elliptical polar orbit with a pericentre of 400 km, an apocentre of 350 000 km and a period of 9 days.

To achieve the final operational orbit a series of correction manoeuvres were necessary:

Date	Activity	Velocity Change (m/s)
15 April 2006	Pericentre Control Manoeuvre #1	5.8
20 April 2006	Apocentre Lowering Manoeuvre #1	199.9
23 April 2006	Apocentre Lowering Manoeuvre #2	105.3
26 April 2006	Apocentre Lowering Manoeuvre #3	9.2
29 April 2006	Apocentre Lowering Manoeuvre #4	8.0
2 May 2006	Apocentre Trim	2.0
6 May 2006	Pericentre Control Manoeuvre #2	3.1

4.5 VOCP

The Venus Orbit Commissioning Phase started once the operational orbit was reached and ended when it was declared ready for science data acquisition and transmission to the Earth.
An initial post-cruise checkout was performed and then the readiness of the SC (and payloads) and the ground segment capability to operate their operational scenarios and environment was verified.
The operation of the payloads was carried out off-line via the on-board Mission Timeline.
During this phase, the Commissioning timeline was followed and the use of the Mission Planning System will be gradually phased in. This phase was used as a transition from the pre-defined activity scheme used in all previous critical phase involving the payloads, to a more dynamic approach based on the use of the full MPS functionality.

4.6 NMP

The Nominal Mission Phase started at the end of the VOCP and lasted two Venusian days (486 Earth days).
The selected operational orbit was inertially fixed, so that coverage of all planetocentric longitudes was accomplished in one Venus sidereal day (243 Earth days).
The Nominal Mission Phase consisted in science data acquisition from the payloads, data storage in the SSMM and data transmission to the Earth.

Once Venus Express is in operational orbit, the orbit is divided into two periods: the Earth Pointing period and the Observation period.

The Earth pointing periods were dedicated to communication with Earth and battery charging. It was used whenever the spacecraft is not in the observation period. In the Earth pointing periods, one of the two High Gain Antennas was oriented towards Earth. The antenna was selected according to the season, so that the spacecraft's cold face remained always protected from illumination by the Sun. The rotation angle around the Earth direction was optimised in order to avoid any entrance of Sun light on the side walls radiators. High rate communication was performed 8 hours per day in X-band, in order to transmit to Earth all science data stored in the SSMM.
An average of 2 Gbits of science data was downlinked every day to the new ESA ground station of Cebreros, Spain.

The observation periods consisted of several different modes of observation, depending on the payload configuration and spacecraft orientation: Nadir pointing, Limb observation, Star occultation, Radio Science.

4.7 EMP

The Extended Mission Phase has started at the beginning of October 2007 and will end at the beginning of May 2009.

5. Spacecraft incident

5.1 Safe Modes

Table 5 summarizes the Safe modes that has occurred from the first day of operations in orbit (4th June 2006) to the writing date of this document (31 March 2008).

Safe Mode number	Start date	End date
Safe Mode 1	13/06/06 Orbit 53	13/06/2006 Orbit 53
Safe Mode 2	25/08/06 Orbit 126	25/08/2006 Orbit 126
Safe Mode 3	22/09/06 Orbit 184	22/09/2006 Orbit 184
Safe Mode 4	27/09/06 Orbit 159	27/09/06 Orbit 159
Safe Mode 5	09/10/06 Orbit 171	09/10/06 Orbit 171
Safe Mode 6	27/01/08 Orbit 620	28/01/08 Orbit 620

Table 5: Safe Mode list from 4/06/06 to 31/03/08.

5.2 Other incidents

Table 6 lists the other incidents that have affected the spacecraft from 4/06/06 to 31/03/08.

Incident Name	Start date	End date
VIRTIS H shutdown due to cooling motors	13/08/07	4/11/07
VIRTIS M shutdown	13/08/07	31/08/07
Payload Off due to SADE-A misalignment	25/08/07	27/08/07

Table 6: List of the spacecraft incidents other than Safe modes that has occurred from 4/06/06 to 31/03/08.

6. Acronyms

AOCS	Attitude and Orbit Control System
DMS	Data Management System
EMP	Extended Mission Phase
ICP	Interplanetary Cruise Phase
LEOP	Launch and Early Orbit Phase
MAG	Magnetometer
MPS	Mission Planning System
NECP	Near Earth Commissioning Phase
NMP	Nominal Mission Phase
SC	Spacecraft
SSMM	Solid State Mass Memory
TCM	Trajectory Correction Manoeuvre
VOCP	Venus Orbit Commissioning Phase
VOI	Venus Orbit Insertion