ANNEX 4

Tables of technical data useful to proposers

This Annex provides data related to past ESA missions, which may be of assistance to proposers in establishing the class of mission being proposed as well as in defining basic features in relation to potential mission profiles.

Two broad categories of mission groups are considered: (a) Astronomical observatories and (b) Planetary type missions. Tables 1 and 2 provide data based on past missions falling within these two categories.

Table 1: Mission Overall Summary

Mission	Launcher	Launch wet Mass (kg)	Orbit (km)	Launch date	Cost (e.c. 2006)	TM (kb/s)
		Observatory	**Type**	**Missions**		
XMM	A5	3800	114000x7000	1999	919	66
Integral**	Proton	3954	153000x9000	2002	397	113
GAIA	Soyuz Fregat-2B	2030	L2	2011	550	5000
		Planetary	**Type**	**Missions**		
MEX	Soyuz Fregat	1223	11560x258	2000	204	38-230
Rosetta	A5 G+	2900	N/A	2004	825	22
VEX	Soyuz Fregat	1241	66000x250	2005	203	28-262

** *Launcher provided by RSA (Russian Space Agency) as part of an international collaboration*
Current ESA launcher policy restricts ESA-only missions to 3 launcher types: Ariane-5 ECA (125 ME), SF-2B (40 ME) and Vega (22 ME) [c.f. Table 3]. However, Rockot KM is being accepted as a back-up to Vega.

Table 2: Past Mission Summary

Mission	S/C dry Mass (kg)	P/L Mass (kg)	Mass Ratio	S/C Pwr. (W)	P/L Pwr. (W)	Pwr. Ratio
		Observatory	**Type**	**Missions**		
XMM	3234	2147	0.62	1000	675	0.68
Integral	3414	2013	0.59	2377	719 (max)	0.30
		Planetary	**Type**	**Missions**		
MEX	510 (71)	116	0.26	1500 [650]	140	0.21
Rosetta*	1322 (~110)	170 (27)	0.11	850@ 5 AU	190	0.22
VEX	633	93	0.15	1100(Venus)	150	0.13

(*) The additional Lander mass is included in the total dry spacecraft mass.
[ ] Power at maximum distance from Sun. Power available varies depending on Mars position.

Table 3: Launcher Data

Launcher	Diameter[1]	Mass HEO	Mass GTO[2]	Mass LEO[3]	SSO	Mass L1/L2[4]	Mass Escape[5]
A5 ECA	4570	7000 to 9000 kg depending on orbit	9600 kg	> 10 000 kg in 800 km	>10 000 kg, 800 km	6600 kg	4300 kg (V_{inf}=3.5 km/s)
Soyuz Fregat 2B	3800 (ST)	1400 kg to 2600 kg depending on orbit	3060 kg	5300 kg	4 900 kg, 660 km	2000 kg	1600 kg (V_{inf}=0)
Vega	2380	No information yet available		2300 kg (5.2º)	1 500 kg, 700 km	*(500 Kg)*	N/A
Rockot-KM	2100 / 2380	N/A	N/A	1850 kg (63º)	1 000 kg 800 km	*(500 Kg)*	N/A

http://www.arianespace.com/site/documents/ariane5_man_index.html
http://www.arianespace.com/site/documents/soyuz_man_csg_index.html
http://www.arianespace.com/site/documents/vega _man_index.html
http://www.eurockot.com/alist.asp?cnt=20040718

Note: actual launcher vehicle performance depends on several parameters. Performance levels indicated in the table above need to be verified against actual trajectory requirements (refer to user manuals at URL indicated under the table). The performance indicated does not include use of separate/specific boost stages to perform orbit raising maneuvers. In particular, such boost stages allow light payloads being launched on smaller launchers to higher orbits: the example quoted between brackets for Vega and Rockot-KM, using the LISA-PF case which carries a boost stage to reach L1, allows to deliver a mass of about 500 Kg to L1.

1 *Here the Diameter refers to the inner useable diameter of the fairing expressed in mm*
2 *The GTO refers to the mass (kg) into Geostationary Transfer Orbit (250 x 3,000 km). It assumes a GTO for Arianne 5 for a shared launch with a mass and cost of 50% the total*
3 *LEO refers to the mass (kg) into 300 km altitude Low earth Orbit with a typical orbital period of 90 minutes. Unless specified otherwise, an equatorial orbit is assumed*
4 *L1/2 refers to mass (kg) to L1 or L2*
5 *Escape refers mass (kg) for an interplanetary escape trajectory.*

Table 4 shows key performance parameters for the ESA ground stations. The two 35 m stations are typically used for Deep Space Missions while other missions would use the 15 m antennas.

Table 4: The ESA Ground Station Network

Ground station	Size	Receive Band	Transmit band	G/T ratio[1] S	X	Ka
New Norcia	35 m	S & X (& Ka[2])	S & X		49.5	(54.9)
Cebreros	35 m	X & Ka	X & Ka[3]		50.8	55.7
Kourou	15 m	S & X	S & X	29.9	41.4	
Maspalomas	15 m	S & X	S	29.2	37.5	
Perth	15 m	S & X	S & X	26.6	42.5	

[1] The G/T ratio is calculated for 10 degree elevation
[2] Upgrade to Ka band reception is currently planned.
[3] Upgrade to Ka band transmission is planned for BepiColombo

Mission costs require detailed analysis based on a well studied mission profile. However tables 5a and 5b list the main building blocks which enter into such a model, for respectively a Class M and a Class L mission. It should be used as a rough guide to assist the proposers in assessing the cost to ESA of their proposed mission.

Table 5a: Main Cost Elemnts for Class M Missions

Activity	% of Total ESA CaC
Pre-Implementation Phase	2
Total spacecraft industrial activities	38
Launch services from CSG (Soyuz Fregat-2B launcher) *	13
Ground segment (MOC and SOC)	18
ESA internal costs	11
Contingency	18

* use of Vega Launch services would reduce the cots from 13% to 8 % of the overall CaC.

Table 5b: Main Cost Elements for Class L Mission Concepts

Activity	% of Total ESA CaC
Pre-Implementation Phase	1
Total spacecraft industrial activities	45
Launch services from CSG (Soyuz Fregat-2B launcher)	6
Ground segment (MOC and SOC)	16
ESA internal costs	11
Contingency	21

It is assumed that the technology preparation is performed outside of the mission CaC. For the ESA contribution, this would be covered under the ESA Science Core Technology Programme.

Table 6 summarizes the ESA Technology Reference Levels used in any assessment of the technological maturity for both spacecraft and payload units.

Table 6: Technology Readiness Levels (TRL)

Level	Description
1	Basic principles observed and reported
2	Technology concept and/or application formulated
3	Analytical and experimental critical function and/or characteristic proof-of concept
4	Component and/or breadboard validation in laboratory environment
5	Component and/or breadboard validation in relevant environment
6	System/subsystem model or prototype demonstration in a relevant environment (ground or space)
7	System prototype demonstration in a space environment
8	Actual system completed and "flight qualified" through test and demonstration (ground or space)
9	Actual system "flight proven" through successful mission operations