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SPACE SHUTTLE PROGRAM MANIFEST PROCESS & FLIGHT OPPORTUNITIES FOR SMALL PAYLOADS

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ABSTRACT

The Space Shuttle Program has, since the early flights, exerted great effort to maximize the cargo complement for each individual mission. Historically, because of the capabilities of the Space Shuttle, there have almost always been opportunities to fly what are termed secondary payloads on every mission. However, with the challenges associated with assembling the International Space Station, accommodations for secondary payloads are significantly limited. In an attempt to deal with this situation, the Space Shuttle Program has developed techniques that will identify and utilize flight opportunities, as well as policies that may create opportunities.

INTRODUCTION

The Space Shuttle is a unique national asset providing dependable access to space. Each Shuttle flight is prepared and executed carefully, utilizing the talents of thousands of dedicated individuals throughout the Shuttle and customer communities. The Space Shuttle Program has the responsibility of maximizing the science and technological return of each flight. Over the history of the Space Shuttle Program, a broad spectrum of payloads has been flown. They have ranged from small boxes weighing less than a pound to large complex payloads that consume most of the Shuttle's cargo bay and weigh over 40,000 pounds. The establishment of various categories of payloads as related to their respective Shuttle services is used as a manifesting tool and creates a mechanism by which the Shuttle's resources are exploited to the fullest extent possible.

The categories of payloads have historically been identified in two major classifications – Primary and Secondary – intended to establish the significance of Shuttle services required. This paper will focus only on the secondary, or small payloads that are accommodated in the Space Shuttle cargo bay. Typically cargo bay small payloads are of a size that is less than one quarter of the Space Shuttle cargo bay (less than fifteen feet in length) and usually weigh less than 6000 pounds. Examples include side-wall or cross-bay mounted Hitchhiker class and Get-Away-Special carrier payloads.

The ability of NASA to sponsor and support a substantial number of small cargo bay payloads has enabled the Shuttle Program to take advantage of surplus services on any given mission. Even though the Space Shuttle Program has been extremely successful in providing opportunities for small cargo bay payloads in the past, the forecast of opportunities in the next several years is limited. Because of the complexity and resource requirements for assembling the International Space Station, there has been a growing backlog of science and research technology payloads. To mitigate this situation, the Space Shuttle Program has, for some time, been pursuing two efforts. One is to develop techniques for identifying and developing strategies for utilizing mission specific Shuttle capabilities in excess of the respective International Space Station requirements. The second is to identify appropriate rationale for justifying additional Shuttle flights for science and research missions not related to the International Space Station.

IDENTIFYING PAYLOAD OPPORTUNITIES IN CONJUNCTION WITH INTERNATIONAL SPACE STATION ASSEMBLY AND UTILIZATION ACTIVITIES

For those flights which are related to the International Space Station, the complexity of the operational requirements, the size of assembly elements, and the limitations of the docked environment make it difficult to accommodate small cargo bay payloads. However, the Space Shuttle Program continues to diligently search for opportunities to fly small payloads in conjunction with International Space Station activities. As a part of the normal manifest planning process, opportunities can be identified for payloads that are in the early development phases. However, the Space Shuttle Program is also striving to create a process that allows more mature payloads to take advantage of late opportunities in a cargo manifest that may develop due to unexpected delays or replanning of International Space Station cargo complements.

The analyses performed by the Space Shuttle Program in support of our normal flight assessment process and of the International Space Station Design Analysis Cycles contain preliminary information that can be used to ascertain potential small payload opportunities. Because these opportunities will be fewer and farther between, we have developed a more formal process for identifying the unused resources. The relevant information can be depicted in a manner that allows for a quick determination of mission specific performance margin and available cargo bay real estate as shown in table 1. This allows the identification of the flights on which side-wall attach hardware (sill mounted beams) and/or cross-bay structures can potentially be accommodated. With this information, the Space Shuttle Program and its user community can then be queried to determine if development or readiness preparation strategies would be prudent or advantageous. Final determination of the mission specific complement is dependent on many factors. However, early identification of potential opportunities allows the Space Shuttle Program and its non-International Space Station users to develop long term strategies to better plan and posture ourselves to take advantage of opportunities that arise.

JUSTIFYING ADDITIONAL SHUTTLE SCIENCE & RESEARCH MISSIONS

As is readily understood from our previous discussion, the numbers of opportunities that can be identified today are limited. This leads to a situation that makes it extremely difficult on the science and research technology community to develop long term strategies and lobby for resources to support their endeavors. This has long been a concern of the Space Shuttle Program. In our effort to mitigate this problem, we have attempted to develop concepts that would allow the creation of new science and research missions. Although not all concepts have been successful, we have gained ground each time and, we believe, have built a successful plan using previous lessons learned.

A concept that was not implemented, but from which useful techniques were developed, was that of the 'Stand-By Research' mission. Earlier this year the Space Shuttle Program in conjunction with the Office of Space Flight developed a concept to identify a candidate cargo, initiate documentation and analyses, and proceed to a program integration milestone approximately ten (10) months from flight. At that point, the mission would march in place until a flight opportunity appeared. However, flight opportunities resulting from unexpected events in the International Space Station assembly process would be difficult to identify early enough to orderly prepare, even on this shortened template. Secondly, the fact that the cargo could be held in limbo for an extended period of time was not a prudent utilization of resources. Thus, the 'Stand-by Research' mission concept was dropped. However, developing a scheme for implementing the concept proved useful.

With lessons learned in hand, the Space Shuttle Program, in conjunction with the Office of Space Flight, developed a different proposal. This proposal took advantage of existing manifested flights to the International Space Station, titled 'Launch-on-Need' missions, for which no specific cargo had been identified. Due to the success-oriented nature of the International Space Station assembly sequence and the anticipated need for additional flights, these missions were placed on the manifest in target timeframes to acknowledge this perceived need. To avoid showing a delay in the Station's completion for flights that may not be needed, the flights were manifested on a vehicle that is not currently configured to dock with the International Space Station, OV-102 – Columbia. Applying the scheme for our 'Stand-by Research' mission to the International Space Station 'Launch-on-Need' flights, we could essentially identify the 'Launch-on-Need' cargo as being 'stand-by' cargo. This would allow the Space Shuttle Program to identify the Columbia flights as research missions and manifest existing payloads that were lacking an opportunity to fly. The reality of an implemented 'Launch-on-Need' flight to the International Space Station would be fulfilled by one of the other vehicles anyway, thus assuring the fulfillment of the research missions assigned to OV-102.

The Space Shuttle Program strongly embraces the need to continue to fly science and research technology missions on the Shuttle. We believe that there is an on-going desire for short-term science and research technology in low earth orbit. We in the Space Shuttle Program are committed to ensuring that those opportunities are there today and will continue to be there in the future.

Table 1. Example of weight and volume opportunity matrix as of 7/1/99

Flight			STS-102		STS-100		STS-104		STS-105		STS-107		STS-106	
Cargo			ISS-5A.1		ISS-6A		ISS-7A		ISS-7A.1		SH-DM		ISS-UF1	
Crew Size			5		7		5		7		6		5	
Available MLE			0		0		7		0		0		37	
Bay	Item	WT kg (lb)	Port	Star.	Port	Star.	Port	Star.	Port	Star.	Port	Star.	Port	Star.
	Middeck/MLE	23 (50)	0		0		7		0		0		37	
1	Side wall on OV-102	230 (500)	0	0	0	0	0	0	0	0	0	0	0	0
2	GAS Beam/side	320 (700)	0	0	0	0	0	0	0	0	1	1	0	[illegible]
3	GAS Beam/side	320 (700)	1	1	1	1	1	0	1	1	1	0	1	1
4	GAS Beam/side	320 (700)	1	0	0	0	0	0	0	0	0	0	1	1
5	GAS Beam/side	320 (700)	0	0	0	0	0	0	0	0	0	0	[illegible]	0
6	GAS Beam/side	320 (700)	0	0	0	0	0	0	0	0	0	0	[illegible]	0
7	GAS Beam/side	320 (700)	0	0	0	0	0	0	0	0	0	0	0	0
8	GAS Beam/side	320 (700)	0	0	0	0	1	1	0	0	0	0	0	0
9	APC/ICAPC	230 (500)	0	0	0	0	1	1	0	0	0	[illegible]	0	0
10	APC/ICAPC	230 (500)	0	0	0	0	1	0	0	0	0	[illegible]	0	0
11	APC/ICAPC	230 (500)	0	0	0	0	0	0	0	0	0	0	0	0
12	APC/ICAPC	230 (500)	0	0	0	0	0	0	0	0	0	0	0	0
13	GAS Beam/side	455 (1000)	1	1	1	1	1	1	1	1	0	0	1	1
Total weight kg (lb)			1,860 (4,100)		1,545 (3,400)		2,700 (5,950)		1,545 (3,400)		950 (2100)		3,020 (6,650)	
Available APM kg (lb)			760 (1,670)		540 (1,200)		430 (950)		680 (1500)		0 (0)		5,900 (13,000)	
Planning Potential kg (lb)			**760 (1,670)**		**540 (1,200)**		**430 (950)**		**680 (1500)**		**0 (0)**		**3,020 (6,650)**	

ACRONYMS

APC	Adaptive Payload Carrier
APM	Ascent Performance Margin
GAS	Get-Away-Special
ICAPC	Increased Capacity Adaptive Payload Carrier
ISS	International Space Station
Kg	Kilograms
Lb	Pounds
MLE	Middeck Locker Equivalent
OV	Orbiter vehicle
SH-DM	SpaceHab Double Module
Star	Starboard
STS	Space Transportation System
UF	Utilization Flight
WT	Weight