SHUTTLE OPERATIONAL TEST AND SCIENTIFIC INVESTIGATIONS

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One of my jobs is to be the interface between the Life Sciences Organization and the Shuttle Program Office. If there's something we in the scientific world want to do on board the shuttle I help usher the paperwork through the system and try to keep things in order and make sure we meet all the right schedules.

What I would like to talk about is something that you have been talking about -- the Detailed Test Objectives (DTOs) and Detailed Supplementary Objectives (DSOs). What are they and how do we meet them with on-board experiments?

Each shuttle mission has a primary objective, such as delivering satellites into orbit or taking a large scientific package up for Earth or planetary observations. Along with this primary objective there usually are a collection of secondary objectives. One type of secondary objective are experiments which may be performed either in the cargo bay or in the orbiter cabin. Other types of investigation which are not as formal, rigorous, or as complex as scientific experiments, are classified as DTOs and DSOs.

The DTO originated as a test or measurement made to verify the function of a vehicle system for certification of a vehicle system (Figure 1). At the start of the shuttle program about seven or eight orbital test flights were planned, but a schedule acceleration cut that number to four. As a result of a reduced flight test program, some system testing and verification continued into the operational flight phase. These tests are DTOs. Other examples of DTOs are tests of the thermal protective system, avionics, landing gear and vehicle aerodynamics.

The DSO is a demonstration or test that has a lower priority than a DTO. It is not a mandatory task and is usually a scientific or medical measurement or observation (Figure 2). A DSO also may be a test of prototype flight hardware or checkout of an operational procedure. Examples of DSOs include the microbial sampling performed on several flights, especially flights on which animals were flown, and is the prototype plant growth chamber, which was tested prior to actual use in support of a full scientific experiment. Often, from the results of prototype testing, we can save money and time in the design of the actual flight hardware.

The major DSO emphasis presently is on investigations related to space motion sickness. They are our highest priority DSOs, so if they are submitted in a timely manner they are routinely approved, provided stowage space and planned in the crew time line. To date all DSOs have been performed in the orbiter or in the cabin. A review system establishes DSO priorities, by category, if there is not enough time to perform all of them on any given flight.

A handbook should be available shortly describing the required procedures for submitting a DSO proposal, the formats, the reviews and available assistance.

Figure 3 indicates the approval criteria that internal NASA review boards use in judging a DSO proposal. Is there some procedure, technique or measurement to be

performed that can contribute significantly to upcoming flights? The space motion sickness related DSOs are in the operational urgency category and therefore are readily approved. Most of these DSOs also directly relate to solving a known problem.

DSOs involving tests of prototype equipment should be designed to gain technical information that cannot be obtained during tests in a one-g earth environment. The DTO and DSO proposals can be very competitive -- often from a scientific viewpoint, certainly from an equipment stowage volume and crew time viewpoint. Therefore, it is important that the expected results are worthwhile and not in a "nice to know" category. A DSO sponsor can expect the review boards to ask many questions and he should be prepared to "sell" his proposal.

Let me walk you through a DSO proposal. A brief overview of the review cycle is shown in Figure 4. The first step is to prepare the proposal and present it to the Science Management Review Board (SMRB) as a concept. The SMRB is chaired by Dr. Joseph Kerwin, Director of Space and Life Sciences. Members of the board are personnel from Dr. Kerwin's organization. The SMRB will review the proposal and decide whether more work is required or whether, in their judgment, the proposal is ready for flight. Usually suggestions are offered that will improve the concept or assist in the preparations for flight. The lead time for concept proposals can be from one or two years prior to a desired flight. The type of information to be submitted is listed in the figure and will be amplified in the handbook previously mentioned. Typical information required is equipment weight and volume, supporting studies, ground based tests, which space tests will supplement existing information and the description of the hardware. Questions include: Where is the hardware coming from? Is it off-the-shelf? Is it to be modified? Is it to be designed from scratch? Where are you in the design procedure?

Provide some scope of the procedures to be used in space. Will the procedure take 15 minutes or more or less time? Does it involve one or two crew members, or all of them? This information is very important because we will take it and coordinate it with the crew and the mission planners that must approve the DSO. We must get support from several organizations; therefore, we want to understand the concept before NASA resources are committed to a project. It is of considerable help in these projects to find someone in NASA who can be a co-sponsor or associate to help you through the system, to understand the terminology, to understand the procedures and to understand the documentation requirements.

When a proposal is determined to be ready for flight and a specific flight can be targeted, the proposal is reviewed again by the SMRB, this time to hear an update on the planning and to determine its overall readiness to fly. Following this SMRB review we can go to one of the Space Transportation System's control boards and ask that this DSO be included in the planning for an upcoming flight. If we have done our job correctly internally we would have completed our coordination with the mission planners, the crew representatives, stowage planners, safety office and organizations in the program office.

Let me tie the proposal process to a schedule. As mentioned, the concept milestone should be at least a year or two before flight and will depend a great deal on the DSO complexity and the amount of preparation required for flight. The flight proposal should occur from six months to a year before flight time in order to meet the program office crew activity "freeze point" of launch minus

five months (L-5). The crews are in their final phases of flight training by that time and must be familiar with all the procedures required in the DSOs.

The primary emphasis is to start your activity with NASA early. Get people thinking about your ideas; seek help in preparing your proposal.

Proposing an experiment is a bit more formal, but because it is more formal it also has some guarantees. An experiment is considered to be more complex than a DSO and to have more shuttle interfaces. The DSO might be considered a mini-experiment or some portion of an experiment. The experiment must be proposed through NASA Headquarters on a standard NASA Form 100 and will receive an internal NASA review as well as an outside peer review. If the experiment proposal is approved by Headquarters it will be scheduled for a specific flight. Once scheduled, a "manifested" experiment carries a higher priority than a DTO or a DSO. The formality for experiment approval is a little more rigid, but once approved it is guaranteed to be flown.

Flight Planning

Development Test Objective (DTO) - A test or measurement made to verify the function or capability of a vehicle system or subsystem.

- Designed to complete STS verification and for continued development
- Examples - Ascent performance data collection
  - Thermal protective system evaluation
  - Crosswind landing performance
  - EMU/EVA evaluation
- STS-5 - 47 DTO's and DSO's scheduled

Figure 1

Flight Planning

Detailed Supplementary Objective (DSO) - Tests, demonstrations, or investigations that are not mandatory to achieve mission objectives or systems verification.

- Includes scientific medical tests/investigations, hardware prototype tests, television and photo documentation

- Examples
  - Microbial sampling
  - Plant growth chamber
  - Space motion sickness investigations

- Performed in the orbiter

- Priorities established - A - B - C

Figure 2

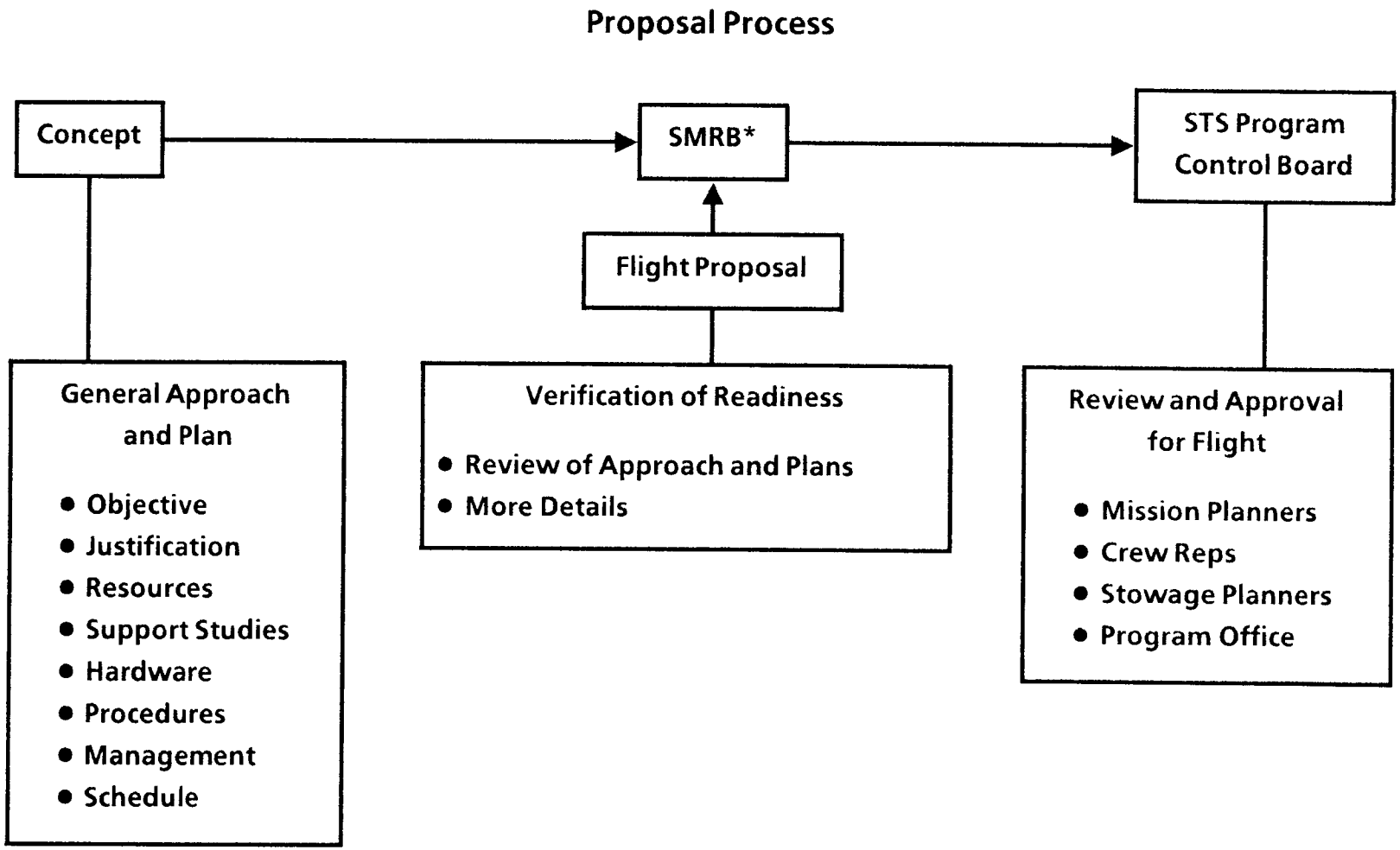
Detailed Supplementary Objective

Approval Criteria -

- Operational urgency
- Solve a known problem
- Gain equipment/technical information (design/procedural information - "can't be done on the ground")
- Man/system safety/operation
- Not - "nice to know"

Figure 3

Detailed Supplementary Objective



*Science Management Review Board
Chairman - Director of Space and Life Sciences

Figure 4